
SKF
®

0

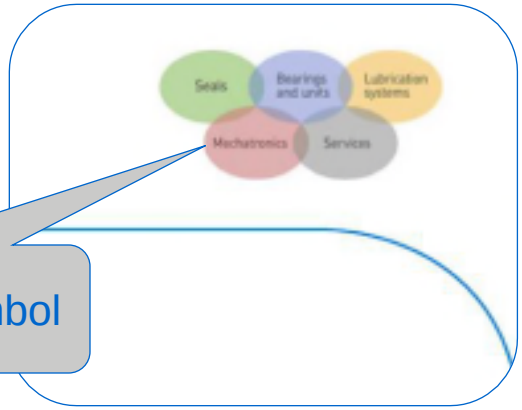
INSTRUCTIONS

Buttons and navigation

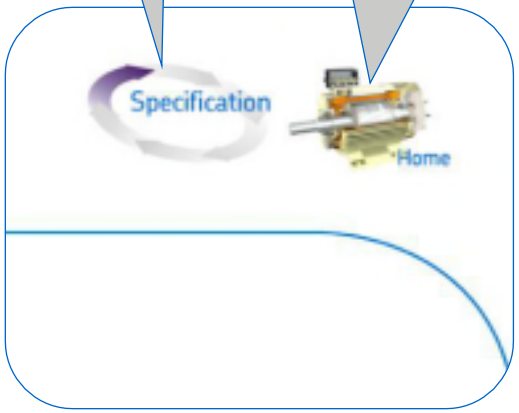
1. The motor “back” button is on every slide in the upper right corner. It will bring you back to the **LCM entry slide**.
2. Within chapters, you can return to the start of that **LCM chapter** by clicking on the LCM symbol.
3. The platforms symbol will take you to the **platforms solutions slide**.

The LCM symbol takes you back to the beginning of chapter.

The motor symbol will always take you back to the LCM Entry slide.



The platforms symbol



The Electric motor - SKF solutions throughout its lifecycle

Click on specific *offer names* and you get to that offer in the LCM chapter nearest to it.

Remember: some offers (e.g. lubrication) can show up in several LCM chapter

Click on the *platform icon* and you link to the platform offer slide.

The LCM Entry Slide

Design and develop

Automated Stator Testing System

Systems

Certified Rebuilder program

Operate and monitor

Click on the name of the *lifecycle management step* and you link to that LCM chapter

Special applications

SKF Electrical Discharge Detector Pen

SKF Online Motor Analysis System - NetEP

Electric Motors – SKF Capabilities

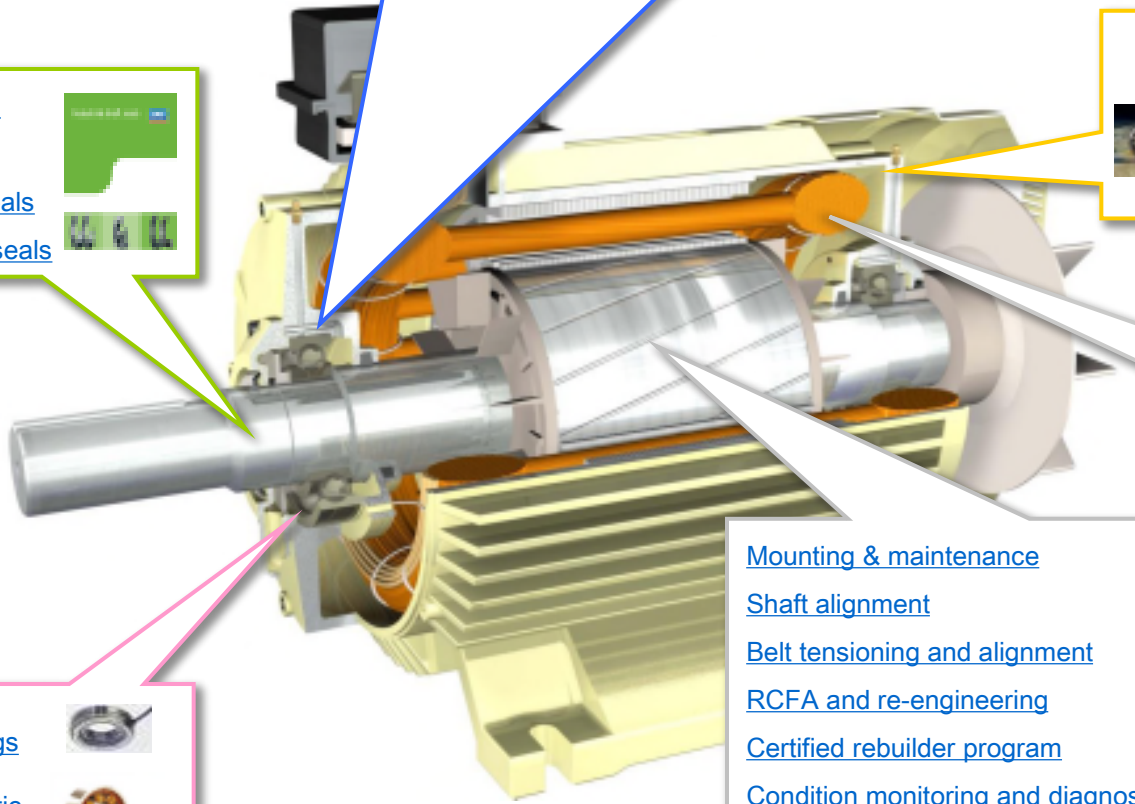
October 2014

The Electric Motor - SKF solutions

Bearings: Ball and roller bearings, Performance classes, CARB toroidal roller bearings

Special Technology: Insulated bearings , Quiet running deep groove ball bearings

Units: Flanged housing units, Traction motor bearing units



Integral seals

ICOS

Axial shaft seals

Radial shaft seals

Lubricants

Lubrication equipment

Lubrication systems (grease and oil)

Analyzers to test motor insulation and electrical circuit quality

Mounting & maintenance

Shaft alignment

Belt tensioning and alignment

RCFA and re-engineering

Certified rebuilder program

Condition monitoring and diagnosis

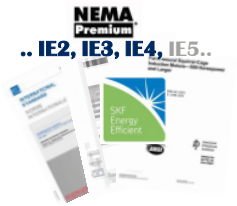
Engineering Consultancy Service

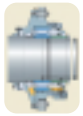
Sensor Bearings

Magnetic Bearings

The electric motor - SKF solutions throughout its lifecycle

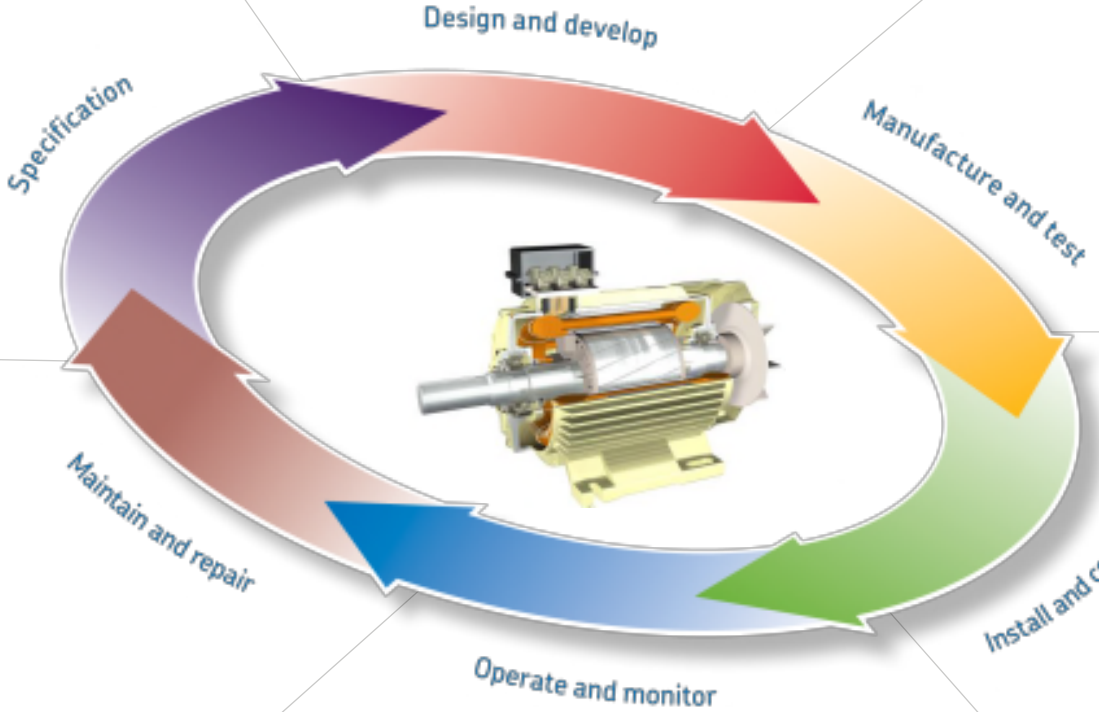
Examples





Flanged housing unit

Automated Stator Testing System



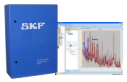
Lubrication Systems

SKF Belt Tension System

Certified Rebuilder program

Special applications

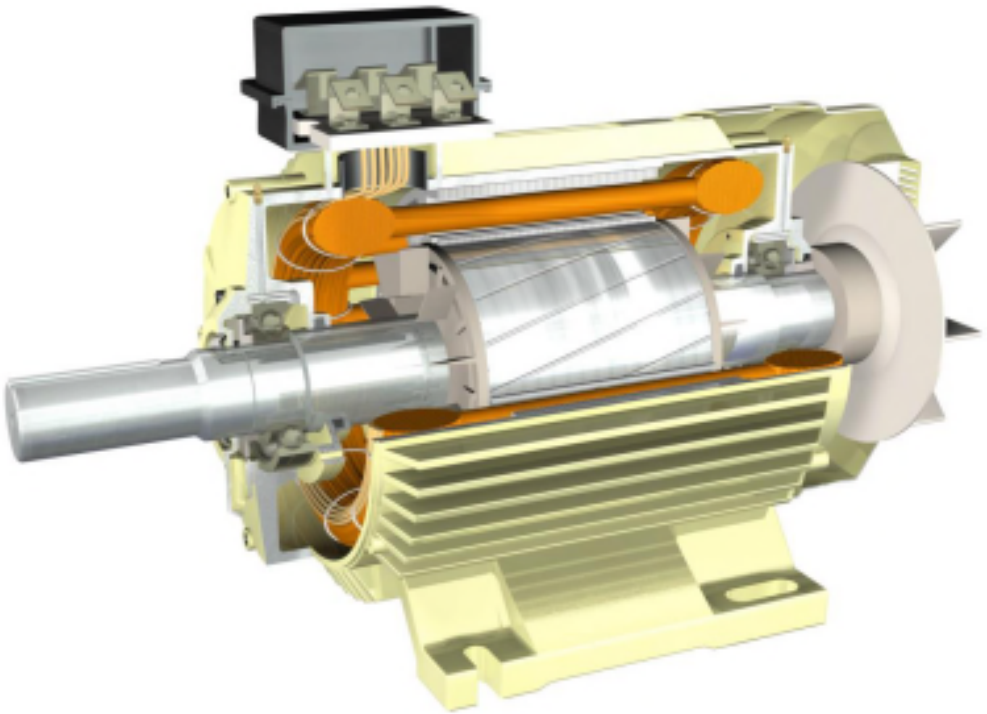
SKF Electrical Discharge Detector Pen



SKF Online Motor Analysis System - NetEP

1

Specification



SKF Life Cycle Management

Working with designers to find
the right solution, from the start

Specification

SKF can help design engineers get off to a great start by tapping into decades of application knowledge from manufacturers and end users.

Electric motor specifications

Industry specifications

Professional Organizations, such as

- IEC (e.g. defines efficiency classes)
- IEEE (e.g. specs in IP, efficiency)

Industry Associations such as

- Manufacturers:
  - NEMA (MG1)
- Trade:
  - API (specs in electrical insulation, Condition Monitoring)

Legislation

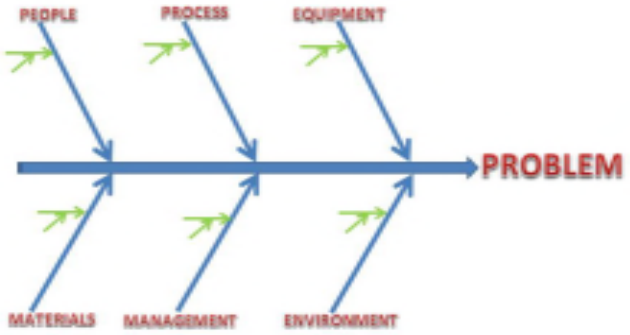
Safety, efficiency (MEPS) such as

- USA (EISA)
- EU (DIRECTIVE 2009/125/EC)
- CHINA (GB18613)

Customer Specifications

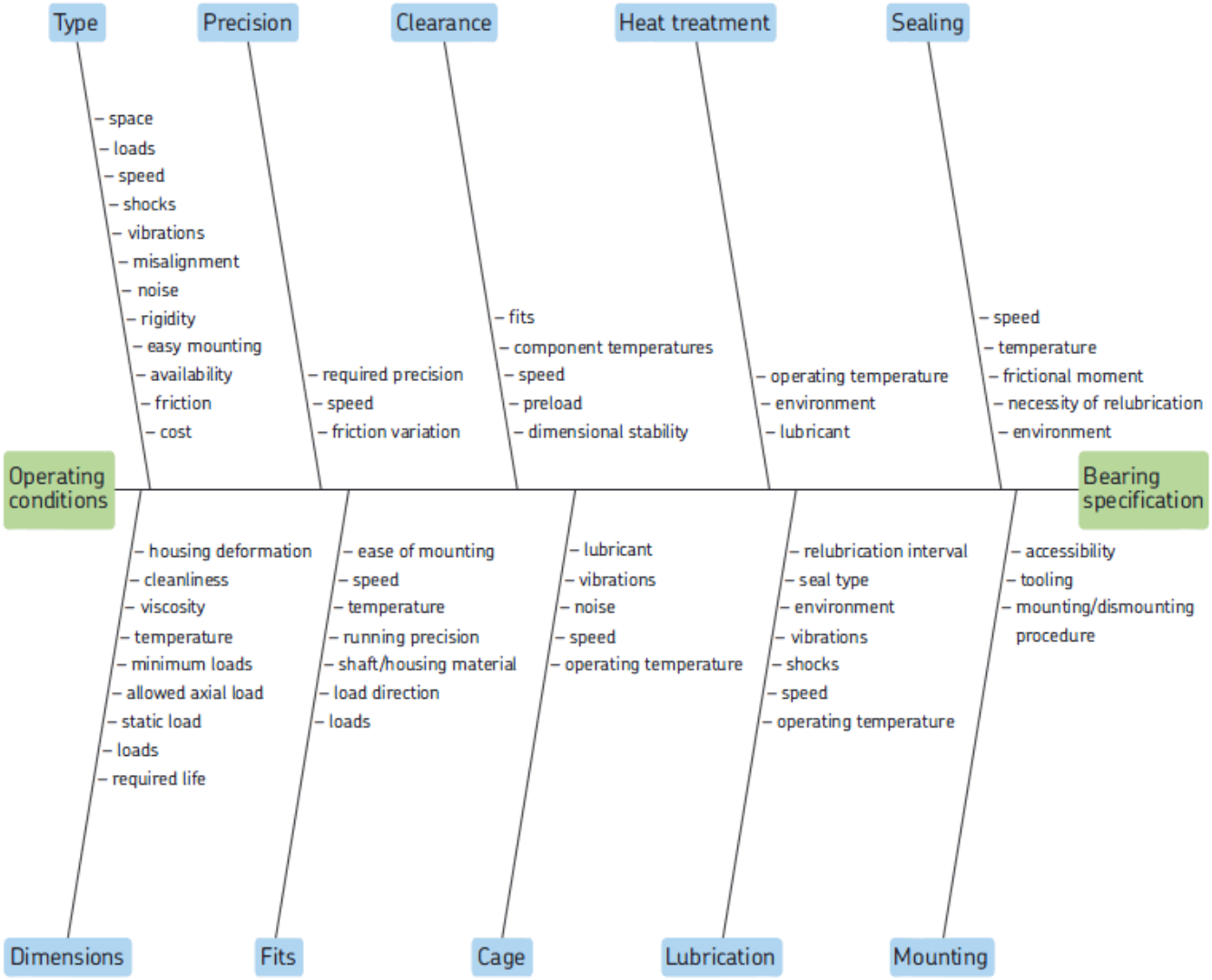
SKF solution for Customer Specs:

- Bearing damage analysis as input for Root Cause Analysis of damages



=> Countermeasure recommendations

Fishbone – Potential root causes for bearing failures



Root Cause Failure Analysis – First Steps

ISO classification of bearing damage and failure modes

SKF Certified Rebuilder Electric Motors

The ISO 15243 standard is based primarily on features that are visible on the rolling elements, raceways and other functional surfaces

Causes of pre- operational damage:
- Incorrect shaft and housing fits
- Defective bearing seats on shafts and in housings
- Static misalignment
- Faulty mounting practices
- Passage of electric current through the bearing (secondary voltage)
- Transportation, handling and storage

Causes of operational damage:
- Material fatigue
- Ineffective lubrication
- Ineffective sealing
- Vibration (false brinelling)
- Operational misalignment
- Passage of electric current through the bearing (current leakage)

Fatigue

Subsurface initiated fatigue
Spalling of particles as a result of microcracks below the raceway surface

Surface initiated fatigue
Dullness of the surface. Failure of the rolling contact metal surface asperities due to inadequate lubrication

Wear

Abrasive wear
The result of inadequate lubrication or the ingress of contaminants

Adhesive wear
Material transfer from one surface to another as a result of frictional heat

Corrosion

Moisture corrosion
Oxidation of the surfaces in the presence of moisture

Fretting corrosion
The oxidation and wear of surface asperities under oscillating micromovement between mating surfaces

False brinelling
Shallow depressions in raceway/rolling element contact caused by cyclic vibrations on a non rotating bearing

Electrical erosion

Excessive voltage
Sparking and localised heating from current passage in the contact area because of ineffective insulation

Current leakage
The generation of shallow craters from (low) current passage. They develop over time into flutes

Plastic deformation

Overload
Permanent deformation caused by static or shock overloads (true brinelling)

Indentation from debris
Dents as a result of particles that are over-rolled in the raceway/rolling element contact areas

Indentation from handling
Bearing surfaces that are dented or gouged by hard, sharp objects

Fracture and cracking

Forced fracture
A fracture resulting from a stress concentration in excess of the material's tensile strength

Fatigue fracture
A fracture resulting from frequently exceeding the fatigue strength limit of the material

Thermal cracking
Cracks that are generated by high frictional heating. They usually occur perpendicular to the direction of the sliding motion.

This poster is provided as a courtesy of:

For more information on bearing damage, refer to the chapter "Bearing damage and their causes" in the SKF bearing maintenance handbook.

Relationships of characteristics and causes of damage on bearings

SKF Certified Rebuilder Electric Motors

Failure modes with characteristics		Possible causes: Operating — Overload	Overspeed	Excessive freq. of load/speed changes	Vibrations	Shaft/housing deflection	Environmental factor — Temperature too high/low	Dust and dirt ingress	Water ingress	Electrical leakage	Lubrication — Wrong viscosity	Grease (Consistency) additives selection	Lack of lubricant	Excess of lubricant	Impurities	Mounting — Incorrect handling (shock loads)	Mounting procedures	Fit too tight	Fit too loose	Tilting/misalignment	Incorrect sealing	Incorrect locating (clamping)	Other — Storage	Transportation (Vibration/shock)	Bearing selection	Equipment design	Manufacturing concerns	Material concerns
Fatigue	Flaking, spalling, peeling	×				×	×				×	×	×			×	×	×		×	×			×	×	×	×	×
	Burnishing, micro cracks		×	×	×		×	×	×	×	×	×	×	×	×		×				×		×		×	×		×
Wear — Abrasive	Excessive wear		×	×	×	×	×	×	×	×	×	×		×				×	×	×	×	×			×			×
	Scratches, scores		×	×				×				×		×		×	×							×				
Wear — Adhesive	Soiling marks, smearing	×		×		×	×				×	×	×	×				×	×	×						×	×	×
	Hot runners	×	×	×		×	×				×	×	×	×				×	×		×	×				×	×	×
Corrosion	Moisture corrosion								×			×			×		×						×	×		×		
	Fretting corrosion	×			×	×	×													×	×	×	×			×	×	×
	False brinelling				×	×						×								×			×	×	×				
Electrical	Craters, fluting									×																×		
Plastic deformation	Depressions	×				×	×							×		×	×	×		×	×	×	×	×	×	×		×
	Debris indentation							×							×	×	×									×	×	
	Nicks, gouges															×	×										×	
Fracture and cracking	Forced fracture	×	×				×									×	×	×		×	×	×			×	×	×	×
	Fatigue fracture	×	×	×	×	×														×	×	×			×	×	×	×
	Thermal cracking	×	×	×			×				×		×	×			×	×		×						×		×

This poster is provided as a courtesy of:

SKF®

Motor failure countermeasures - examples

Electric Erosion

- Insulated bearings

Overload (fatigue failure)

- Explorer Performance Class
- Bearing system
- Bearing types

Lubrication failure

- Lubrication type (oil or grease)
- Grease selection
- Lubrication systems

Contamination

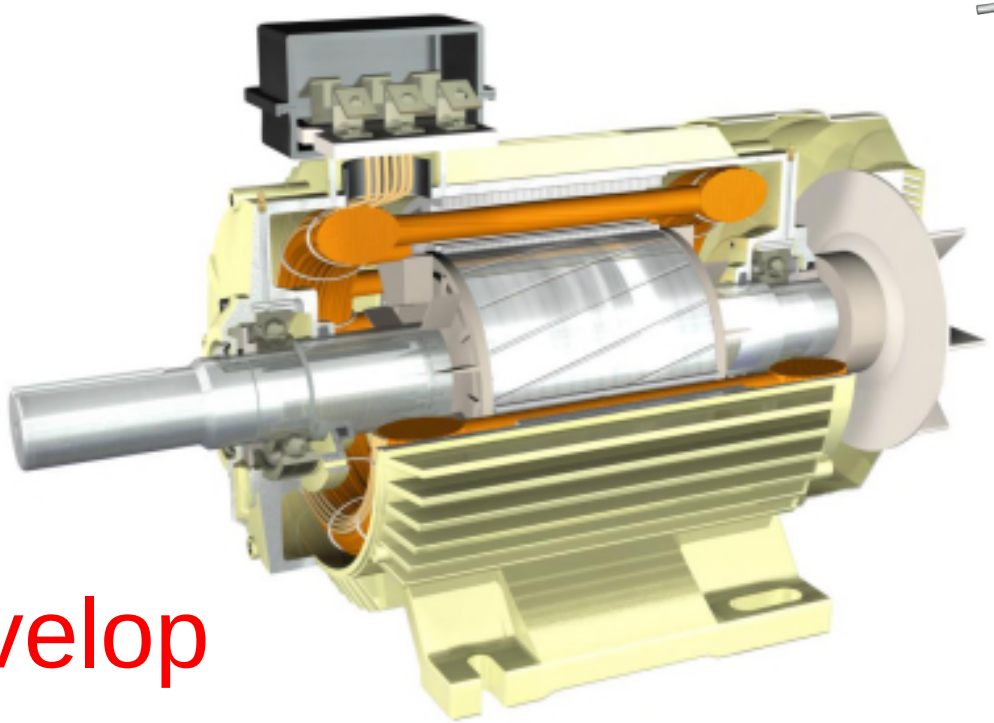
- Sealing system selection (design & material)
- Capped bearings
- Lubrication systems

Unexpected failure (mechanical and electrical)

- Condition Monitoring

2

Design and develop



Home

SKF Life Cycle Management

Solving application challenges with a systems approach to designs

Design and develop

By looking at your design from an all-around, systems perspective, SKF can help you develop integrated solutions that:

- Extend operating life
- Reduce maintenance needs
- Improve energy efficiency
- Reduce Total Cost of Ownership
- And more …

Design and develop – SKF solutions

Bearing Systems

- Performance classes
  - Energy efficiency (E2)
  - Durability/Robustness/Load capability (Explorer)
- Bearing types
- Specials (insulated, integrated, noise, sensor, material)

Sealing Systems

- Bearing integral seals
- Shaft seals
- ICOS
- Speedi-Sleeve

Lubrication Systems

- Capped bearings
- Greases
- Manual & automatic lubrication systems

Condition Monitoring Systems

- Preparation

Services (Design tools)

- Handbook
- Catalogues
- Online calculation tools
- Drawings
- Engineering Consultancy Services

2.1

Design and develop

Bearing systems

SKF bearing performance classes

SKF Energy Efficient (E2)

For use in light to medium loaded applications

Available bearing types:

- Deep groove ball bearings
- Cylindrical roller bearings
- Angular contact ball bearings
- Spherical roller bearings ..

Benefits[1]:

- Friction reduction
- Longer service life
- Less heat generated (=> lower running temperature)
- Smoother running (=> less noise)

1) Compared to SKF Explorer bearings of same type and size, bearing type specific speed and load requirements apply

SKF Explorer

For use in applications not suitable for E2 bearings

Available bearing types:

- Deep groove ball bearings,
- Cylindrical roller bearings,
- Angular contact ball bearings,
- Spherical roller bearings,
- CARB toroidal roller bearings….

Benefits[2]:

- higher dynamic load carrying capacity
- reduced noise and vibration levels
- less frictional heat
- significantly longer bearing service life

2) compared to standard bearings

SKF bearing offers for electric motors - types

Cylindrical roller bearings

Deep groove ball bearings

Angular contact ball bearings

CARB toroidal roller bearings

Spherical roller bearings

Spherical roller thrust bearings

SKF bearing offers for electric motors - specials

Hybrid bearings

INSOCOAT® bearings

Magnetic bearings

Traction motor bearing units

Sensor bearing units

Flanged housing units

Bearing types I

Offer	Usage	Features	Benefits
Deep groove ball bearings 	Most typically found in both locating and non-locating positions of small to medium sized electric motors and in the locating position of medium to large motors & generators.	• Large assortment of greased-for-life bearings. • Variety of greases including SKF standard grease for ultra quiet running • Low friction and reduced sensitivity to misalignment. • Highly efficient sealing options	• Runs cooler • Increased uptime and productivity • Reduced noise and vibration levels • Longer bearing service life • Longer lubricant life • Excellent high speed performance • Lower maintenance and operating costs
Cylindrical roller bearings 	Typically used in belt or gear driven medium to large sized electric motors where heavy radial loads prevail. Usually used in the non-locating drive side position, in combination with a deep groove ball bearing in the locating position.	• Large number of configurations • Separable design; the double flanged ring with the roller and cage assembly can be separated from the other ring which simplifies mounting and enables tight shaft and housing fits.	• High radial load carrying capability • High-speed capability

Bearing types II

Offer	Usage	Features	Benefits
CARB - toroidal roller bearings 	CARB toroidal roller bearings are used as non locating bearings in belt and geared motors to accommodate heavy radial loads. It can be mounted in standard housings as well as special housings designed for large motors and generators.	• Unique design accommodates axial elongation of the shaft internally like a cylindrical roller bearing and misalignment like a spherical roller bearing • Self-guiding rollers that will always adopt the position where the load is evenly distributed over the roller length • Ability to accommodate heavy radial loads irrespective of whether the inner ring is axially displaced and/or misaligned relative to the outer ring	• Accommodates heavy radial loads • Accommodates shaft elongation within the bearing • Allows misalignment • Adapts to angular misalignment and axial displacement simultaneously • Allows compact design with low friction
Spherical roller bearings 	Spherical roller bearings are commonly used in large, oil lubricated electric motors and generators. Spherical roller bearings are also found in large motors and generators that use plummer block housings.	• Self-guiding rollers that enable the bearings to generate less heat • Available with either a cylindrical or tapered bore • Special design for vibratory applications also available. • Standard assortment of sealed spherical roller bearings that can significantly simplify the sealing arrangement.	• Self-aligning and consequently insensitive to misalignment. • Can be mounted in standard housings as well as special housings designed for large motors and generators

Bearing types III

Offer	Usage	Features	Benefits
Angular contact ball bearings 	Angular contact ball bearings are used primarily as locating bearings in vertical electric motors when heavy axial loads cannot be accommodated by deep groove ball bearings.	• Available in either a single or double row design • SKF manufactures as standard universally matchable bearings, which provide a very controlled clearance or preload when the bearings are mounted back-to-back or face-to-face for most popular sizes	• Ability to accommodate heavy axial loads • Ability to accommodate high speeds
Spherical roller thrust bearings 	Spherical roller thrust bearings are used as locating bearings in large vertical electric motors when heavy axial loads cannot be accommodated by angular contact ball bearings. Spherical roller thrust bearings can also be used as a replacement for hydrostatic or hydrodynamic bearings.	• Highest carrying capacity of all thrust roller bearings • Heavy thrust and radial load carrying capability • Self aligning bearing • Separable bearing • Grease lubrication possible in moderate speed applications	• Ability to accommodate heavy axial and radial loads • Self-aligning, therefore insensitive to misalignment • Simplified mounting • Cost efficient (internal oil pumping action compared to hydrostatic bearings that require an oil pressure system)

Bearing specials: insulated bearings - INSOCOAT®

INSOCOAT ® bearings

These bearings have been specifically developed to protect against electric current passage. The electrically insulated rolling bearings are an economical solution compared with other insulation methods to protect the bearing. Integrating the electrical insulation function into the bearing the machine's reliability and uptime can be increased by virtually eliminating electric erosion problems.

Features and benefits

- Withstand voltages up to 1 kV DC (2 kV and 3 kV available upon request)
- Defined minimum electrical resistance of 50 MΩ (>>150 MΩ on request)
- Insensitive to moisture and humidity.
- Robust and can be handled in the same way as normal non-insulated bearings.
- Reduces maintenance costs.
- Global availability – in more than 130 countries and at 7 000 distribution locations worldwide.

INSOCOAT® bearings – recommended range

Coating on the outer ring

- NU 315 ECP/VL0241
- NU 317 ECM/C3VL0241
- NU 319 ECM/C3VL0241
- NU 322 ECM/C3VL0241
- NU 324 ECM/C3VL0241

- 6215/C3VL0241
- 6216/C3VL0241
- 6217/C3VL0241
- 6218/C3VL0241
- 6219/C3VL0241
- 6220/C3VL0241
- 6222/C3VL0241
- 6224/C3VL0241

- 6314/C3VL0241
- 6315/C3VL0241
- 6316/C3VL0241
- 6317/C3VL0241
- 6318/C3VL0241
- 6319/C3VL0241
- 6320/C3VL0241
- 6322/C3VL0241

Coating on the inner ring

- 6226/C3VL2071
- 6230/C3VL2071

- 6324/C3VL2071
- 6326/C3VL2071
- 6328/C3VL2071
- 6330/C3VL2071

Electrical behaviour of INSOCOAT® bearings

	DC	AC
Electric variable	Resistance **R**	Impedance **Z**
Behaviour	Ohmic resistance	Resistance parallel to capacitance
Unit	Ohm [Ω]	Ohm [Ω], Farad [F]
Freqency range	0	1 Hz - 1 kHz High frequency: 1 kHz up to MHz
DC- Resistance	More than 50 MΩ	-----
Impedance	-----	Dependent on frequency (see figure 1)
Capacitance	-----	Constant over frequency (see figure 2) The absolute value is dependent on the size of the bearing

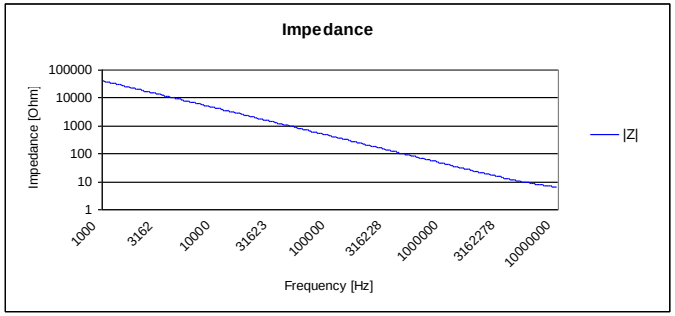


Figure 1: Impedance of an INSOCOAT – bearing depending on the frequency

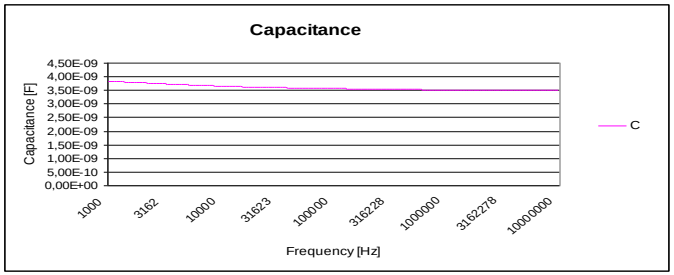
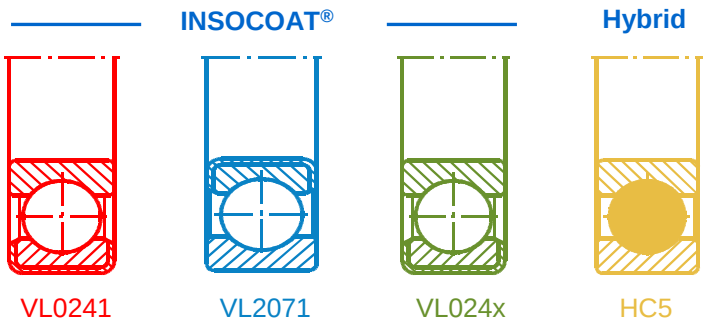


Figure 2: Capacitance of an INSOCOAT - bearing



Bearing specials – insulated bearings – Hybrids

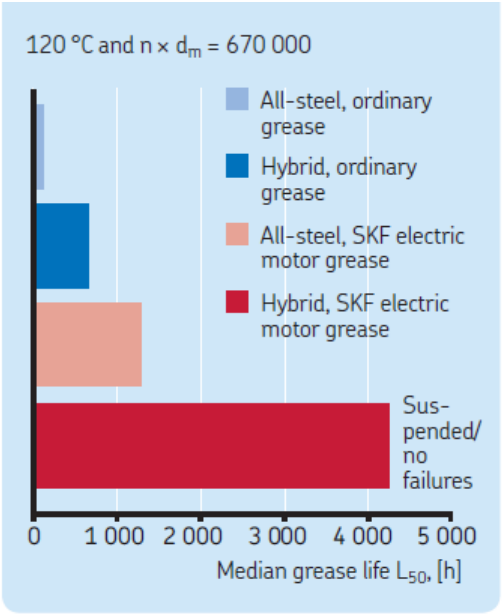
Hybrid bearings

In applications with modern drives, INSOCOAT® bearings may not always be sufficient. In these cases, Hybrid bearings offer a more effective solution, eliminating electrical erosion issues on motors.

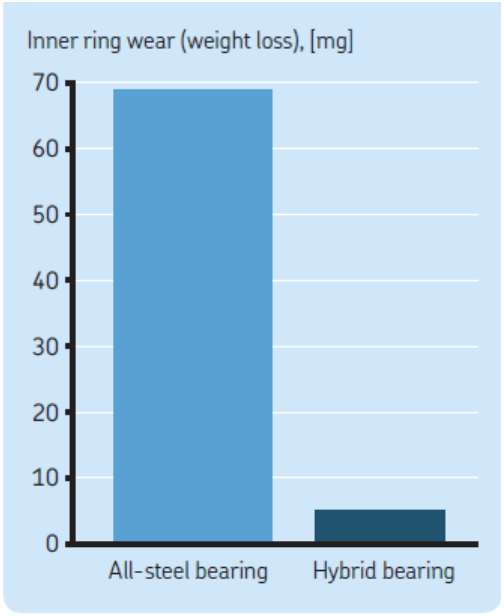
Features and benefits

- Rolling elements in non-conductive materials
- Preventing all current types from circulating
- Ability to run at higher speeds
- Improve service life of the application
- Improve grease life
- Resist wear caused by solid particle contamination
- Resist vibration

Hybrid bearings - performance



Grease life performance – test result where the grease life in SKF hybrid bearings is four times longer than in the corresponding all-steel bearings



Wear performance under contaminated lubricant conditions

Comparison of material properties

Properties	Bearing steel	Bearing grade silicon nitride
Compressive strength [MPa]	~2 300	3 000
Tensile strength [MPa]	~1 900	800
Elastic modulus [GPa]	210	310
Hardness HV10 [kg/mm^2]	700	1 600
Electr. resistivity [Ωm]	0,4 × 10^{-6} (conductor)	10^{12} (insulator)
Density [g/cm^3]	7,9	3,2
Coefficient of thermal elongation [10^{-6}/K]	11,7	3

Bearing specials – SKF Sensor bearing units

Offer description

SKF Sensor Bearing Units are mechatronic machine components that combine sensor and bearing technology.

They are designed to perform as:

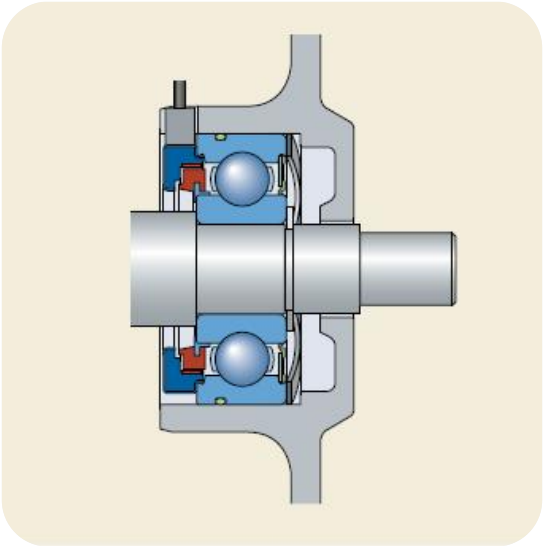
- Incremental encoder

or

- Angular position monitor

for motor and/or machine control.

These units use a sensor that is shielded from external influences. The sensor body, impulse ring and bearing are mechanically attached to each other, forming an integrated ready-to-mount unit. They are intended for applications with a rotating inner ring and stationary outer ring.

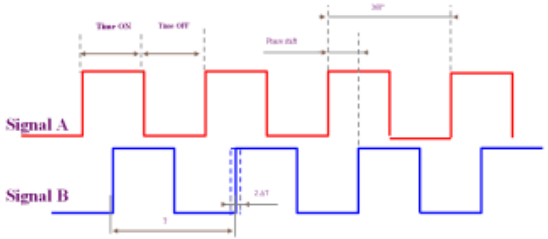


Bearing specials – SKF Sensor bearing units

SKF Motor Encoder Unit (incremental)

Bearing unit integrating SKF Explorer deep groove ball bearing, encoder components, cable and connector

Output: 2 square digital signals suitable for AC induction motor control



Features

- Integrates bearing function with sensor electronics in compact design (only 6 mm of extra space in axial direction)
- Enables speed and direction control
- Temperature range: – 40 to +120 ° C
- Resolution from 32 to 80 pulses per revolution
- Accurately detects speeds from zero to 14,000 r/min (depending on bearing size)
- Wide range of cable length and connectors available

Benefits

- Compact: Allows compact axial design (no extra space is needed outside the motor)
- Reliable: unit protected within the motor, airgap tightly controlled within the most precise motor component, MTBF* of electronics is longer than the bearing lifetime
- Robust: designed for environments with thermal shocks and vibrations
- Cost efficient: simplifies motor assembly as one less component to mount
- Customized to your requests: cable length, connector and interfaces

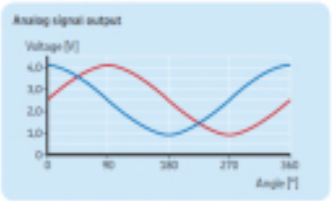
* MTBF : Mean Time Between Failures

Bearing specials – SKF Sensor bearing units

SKF Rotor Positioning Sensor Bearing Unit (absolute)

Bearing unit integrating SKF Explorer deep groove ball bearing, encoder components, cable and connector

Output: 2 analog sine and cosine voltage output signals for brushless permanent magnet motor control.



The highly reliable sensor, which monitors angular position starting from 0 to 12 000 r/min, sends an analogue signal to the electronic control unit. This is particularly important for controlling torque and energy use during start-up and operation.

Features

- Typical angle accuracy < ±1
- Angle repeatability < 0,1°
- Temperature range: –40 to +125 ° C
- Withstand electromagnetic interferences and electric motor magnetic field
- Angular position from 0 r/min (true power-on signal)
- High speed ability (bearing size dependent): up to 12 000 rpm on shielded bearing 6206

Benefits

- Improved electric motor efficiency
- Fewer electronic interfaces
- Supports stable torque level
- Reduced complexity - Bearing, target wheel and sensor delivered in one unit
- Highly reliable
- Compact
- Easy to install
- Signal accuracy not affected by motor mechanical tolerances

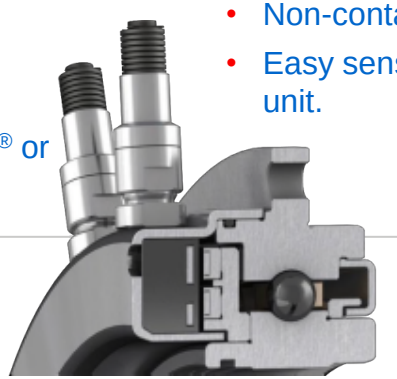
Bearing specials – Traction motor bearing unit

Traction motor bearing unit

The traction motor bearing unit (TMBU) design offers a maintenance-free solution for an extended service interval. This solution is based on a very compact and space-saving design. The total motor length can be reduced or a given motor envelope iron length of rotor and stator can be increased to achieve a higher power rating. This subsystem design principle incorporates several features into one unit like grease, sealing and locating functions. The integrated flange design enables very easy mounting.

Features

- Customized and space saving design for less space, lower mass, fewer parts
- Robust execution
- Sealed and greased for life (standard),
- Regreasing feature possible (increases service life up to 18 years or 3 Mio km depending on application)
- Superior performance under poor lubrication (ceramics)
- Flanged unit concept on IR and OR
- Insulating feature implemented (INSOCOAT® or Ceramic)



Mechatronic feature options:

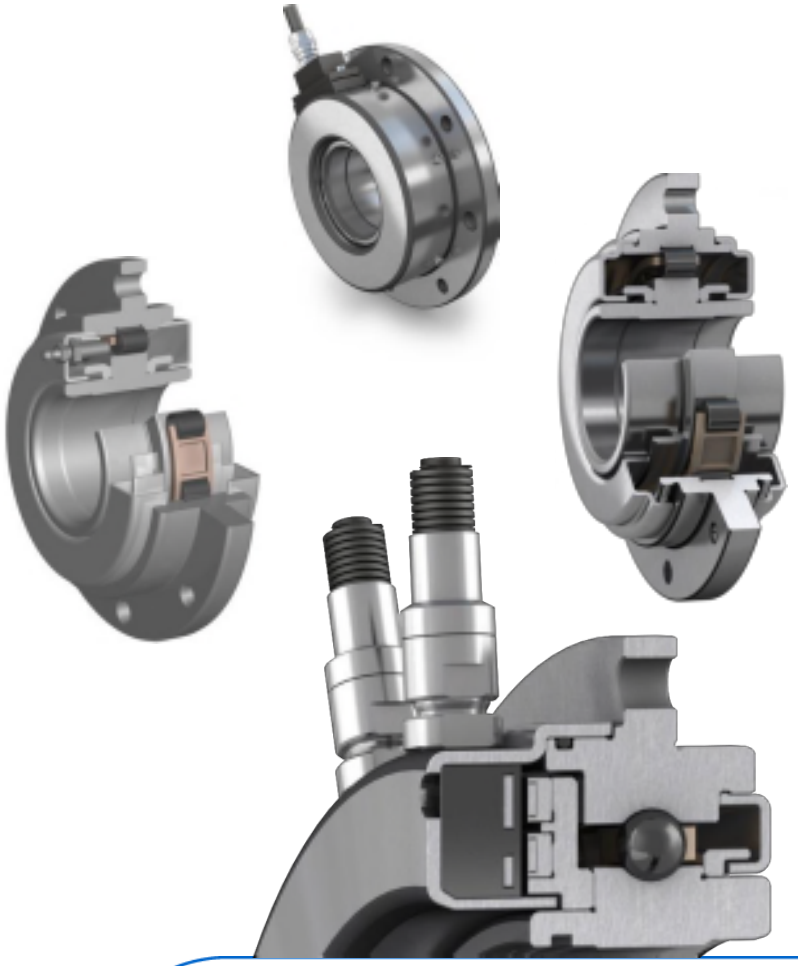
- Integrated incremental speed sensor (IIS) for shaft speed and direction of rotation
- High accuracy & resolution absolute position sensor (HAPS) for motor control
- Additional features (option): operating temperature
- Non-contact sensing principle for long operational life
- Easy sensor replacement without dismounting the unit.

Bearing specials – Traction motor bearing unit

Benefits

Reduced maintenance and lifecycle costs due to:

- Easy mounting due to flange execution
- Increased reliability
- Improved machine uptime
- Compact motor design
- Higher robustness with ceramic elements
  - Reduced risk of smearing
  - Less sensitive to contamination (liquid and solid)
  - Prevents all current types from circulating
- Higher power output with ceramic elements
  - Low friction
  - Ability to run at higher speeds
  - Longer service life with grease lubrication
  - Lower and more stable friction under changing operating conditions



Bearing specials – SKF flanged housing units

Offer description

To counteract the high cost of a sleeve bearing system, SKF developed a shaft system that consists of two flanged housings (SKF AFC housings), each equipped with a roller bearing.

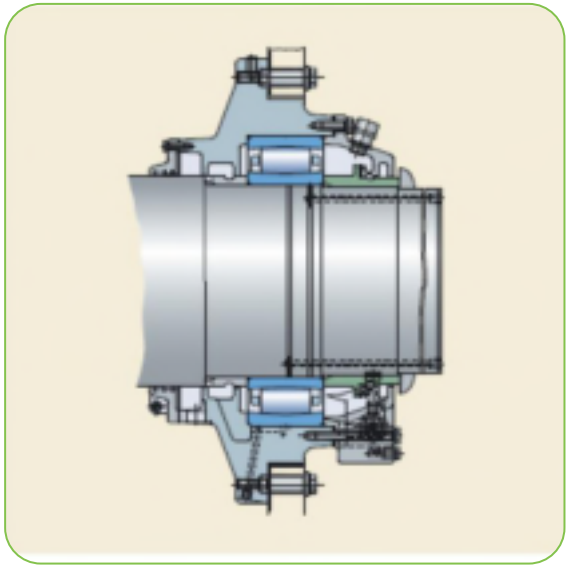
Features

- Preferably equipped with a spherical roller bearing as the locating bearing and a CARB bearing as the non-locating bearing to prevent axial overload due to heat elongation of the shaft during operation. The non-locating bearing side can also be equipped with a spherical roller bearing instead of the CARB bearing.
- Specially designed labyrinth seals to keep the lubricant in and contaminants out
- IEC frame size (shaft height): 630 mm to 1250 mm
- Shaft diameter (under bearing seat): 180 mm to 380 mm (420 mm)

Bearing specials – SKF flanged housing units

Benefits [1)]

- Reduced friction losses
- Less heat generated, cooler running
- Improves motor efficiency
- Copes with reverse directions
- Copes with low speeds (high inertia run down)
- Accommodates shaft deflections
- Does not need expensive oil circulation systems, which eliminates the need for pumps, pipes, oil sumps and coolers => increases system efficiency
- No need for extra components like thrust bearings or hydrostatic jacking devices
- Compact design compared to the most popular sleeve bearing design used in the marketplace
- Compared to a sleeve bearing unit, the SKF shaft system is a cost-effective solution that is simpler, has fewer components, and is easier to maintain.



A flanged housing unit with a CARB bearing

1) Compared to hydrodynamic (sleeve) bearings

Bearing specials – SKF flanged housing units

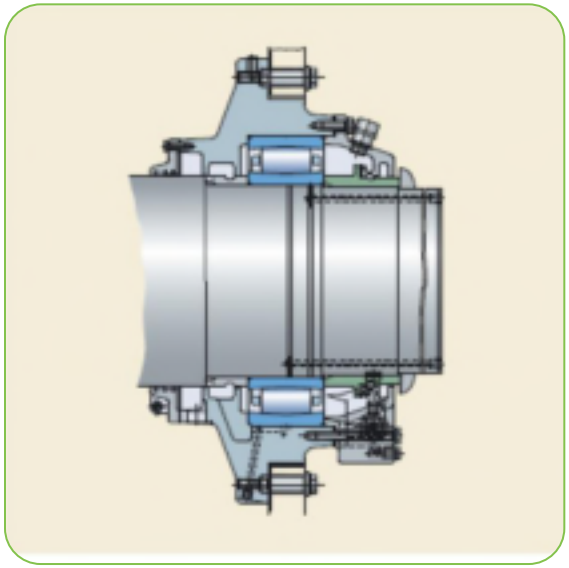
SRB-CARB System – Benefits [1)]

Secured, frictionless axial expansion at non-locating bearing irrespective of

- friction between bearing ring and housing (or shaft)
- corrosion
- fretting or wear
- distortion of housing
- flexibility of support structure
- machining accuracy of support structure

Benefits

- Lower axial load on both bearings
- Perfect load distribution over three roller rows
- Lower operating temperature, longer relubrication interval
- Reduced vibration levels
- Less risk from low loads
- Longer bearing life
- Optimized solution
- Smaller bearings can give same service life
- Downsizing - cost reductions



A flanged housing unit with a CARB bearing

1) Compared to hydrodynamic (sleeve) bearings

Bearing specials – SKF Active magnetic bearings

SKF Active magnetic bearing (AMB)

An SKF AMB is a mechatronic system that consists of mechanical components, electro magnets, sensors and a digital control system. AMBs are mainly used for high variable speed (HVS) electric motors to drive centrifugal compressors in the oil and gas industry, refrigeration, air compression and high-speed electric generators in the energy sector.

Features

- No physical contact between rotating and stationary parts
- No need for lubrication
- High load capability (up to 350 kN)
- Shaft diameter up to 600 mm
- Immune to electromagnetic interferences and electric motor magnetic field
- Very high speed capability (ndm = 3.5 Mio)
- Built in condition monitoring for remote diagnostics
- Virtually vibration free

Benefits

- Very high reliability – no contact and no wear
- Robust in harsh applications and process environments:
  - Shaft unbalance, compressor surge loads, dynamic loads
  - Reverse rotation
  - Frequent start-stop
  - Wide temperature range
- Reduced environmental impact:
  - Clean technology, non contaminating, no particle generation
  - System energy losses lower than those of rolling or sleeve bearing systems

2.2

Design and develop

Sealing systems

SKF Sealing offers for electric motors

Bearing integral seals

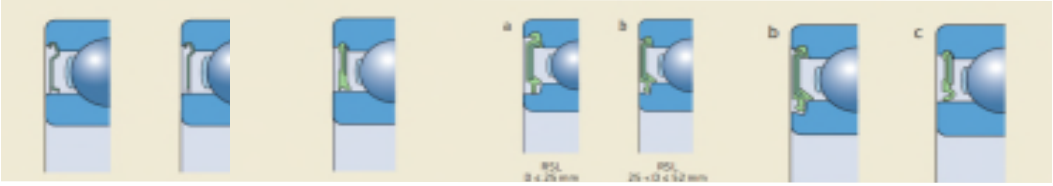
SKF SPEEDI-SLEEVE

SKF shaft seals

ICOS

SKF Bearing Integral Seals for electric motors

Capped
deep groove
ball bearings



Selection guidelines for SKF sealing solutions

Requirement	Shields	Non-contact seals	Low-friction seals	Contact seals	
	Z	RZ	RSL	RSH	RS1
Low friction	+++	+++	++	o	o
High speed	+++	+++	+++	o	o
Grease retention	o	+	+++	+++	++
Dust exclusion	o	+	++	+++	+++
Water exclusion					
static	–	–	o	+++	++
dynamic	–	–	o	+	+
high pressuree	–	–	o	+++	o

Symbols: +++ = best ++ = very good + = good o = fair – = not recommended

SKF shaft seals for electric motors

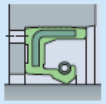
Design and develop

Home

Seal designs and their relative performance

V-ring seal

MVR seal



Radial shaft seal

Type	axial	axial	radial
Application			
Grease	Yes	Yes	Yes
Oil	Mist	Mist	Yes
Horizontal	Yes	Yes	Yes
Vertical	Yes	Yes	Yes
Performance			
Low friction	++	++	+
Speed	++	++	+
Endurance/life	++	++	+
Lubricant retention	++	++	++ (+++)[1]
Dust exclusion	++	++	+++
Water exclusion			
• Static	+	+	++
• Dynamic	o	o	++ (+++)[1]
• High pressure	–	o	+

Symbols: +++ = best ++ = very good + = good o = fair – = not recommended

[1] For SKF Wave sealing lip configuration.

SKF®

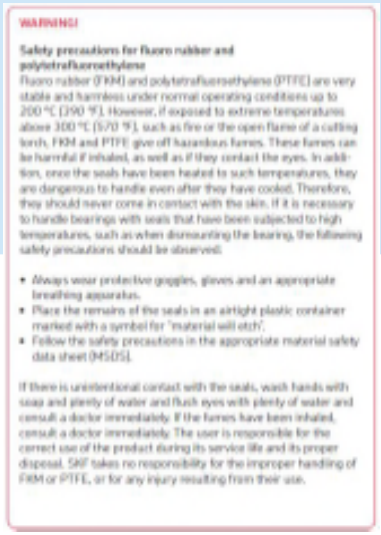
SKF seals materials

Table 3

Seals materials performance overview

	Silicone rubber	Nitrile rubber	SKF Duralip	SKF Duratemp	SKF Duralife	Polytretrafluoro-ethylene
Designation according						
• ISO	MVQ	NBR	XNBR	HNBR	FPM	PTFE
• ASTM	VMQ	NBR	XNBR	HNBR	FKM	PTFE
• SKF	S	R	D	H	V	T
Temperature [°C]						
• low	–70	–40	–40	–40	–40	–80
• high	+160	+100	+100	+150	+200	+250
Wear resistance	–	o	+	+	++	+++

Symbols: +++ = best ++ = very good + = good o = fair – = not recommended



WARNING!

Safety precautions for fluoro rubber and polytetrafluoroethylene

Fluoro rubber (FKM) and polytetrafluoroethylene (PTFE) are very stable and harmless under normal operating conditions up to 200 °C (390 °F). However, if exposed to extreme temperatures above 300 °C (570 °F), such as fire or the open flame of a cutting torch, FKM and PTFE give off hazardous fumes. These fumes can be harmful if inhaled, as well as if they contact the eyes. In addition, once the seals have been heated to such temperatures, they are dangerous to handle even after they have cooled. Therefore, they should never come in contact with the skin. If it is necessary to handle bearings with seals that have been subjected to high temperatures, such as when dismounting the bearing, the following safety precautions should be observed:

- Always wear protective goggles, gloves and an appropriate breathing apparatus.
- Place the remains of the seals in an airtight plastic container marked with a symbol for "material will etch".
- Follow the safety precautions in the appropriate material safety data sheet (MSDS).

If there is unintentional contact with the seals, wash hands with soap and plenty of water and flush eyes with plenty of water and consult a doctor immediately. If the fumes have been inhaled, consult a doctor immediately. The user is responsible for the correct use of the product during its service life and its proper disposal. SKF takes no responsibility for the improper handling of FKM or PTFE, or for any injury resulting from their use.

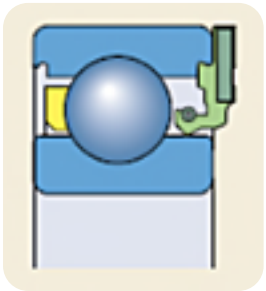
Seals – Compact oil seal unit

SKF Integrated compact oil seal (ICOS)

SKF's compact oil seal unit (ICOS) integrates a unique spring loaded radial shaft seal into a bearing. ICOS can be used in either grease or oil lubricated applications without additional seals and requires less space than the typical two-component arrangement, that can be found in gear motors. The ICOS unit simplifies mounting and avoids expensive machining of the shaft because the bearing's inner ring shoulder serves as an optimal seal counterface.

Features

- Deep groove ball bearing combined with a radial shaft seal
- Unique spring loaded radial shaft seal
- For oil or grease lubricated applications



Benefits

- Compact unit saves space
- Simple and quick mounting
- Effective sealing
- No expensive machining of shaft as seal counterface
- Reduce total cost

Seals – SKF SPEEDI-SLEEVE

SKF SPEEDI-SLEEVE

SKF SPEEDI-SLEEVE is a well-proven solution used to provide an excellent sealing surface for radial shaft seals, while reducing the need for costly shaft machining or maintenance. Its surface properties result in a better seal counterface than can often be achieved on a shaft. SKF SPEEDI-SLEEVE can be fitted virtually anywhere there is a radial shaft seal.

The new generation of SKF SPEEDI-SLEEVE further enhances the sealing system's performance by reducing the wear on both the sleeve and sealing lip.

Features

- Proprietary stainless steel material and manufacturing processes for increased strength and excellent ductile properties of the sleeve.
- Imperceptible lubricant pockets enable the lubricant to reside on the sleeve and thereby prevent dry running of the sealing lip.
- Wear resistant seal contact surface manufactured to minimize directionality (0° ±0,05) with a finish of Ra 0,25 to 0,5 µm *(10 to 20 µin.)*.
- Removable flange for simplified installation.
- Thinwalled design [0,28 mm *(0.011in.)*] allows the original size to be used for the replacement seal.

Benefits

SKF SPEEDI-SLEEVE offers enhanced sealing system performance and benefits for both OEM and aftermarket customers, helping to achieve the following:

- Higher productivity
- Reduced warranty claims
- Increased mean time between failures
- Reduced maintenance and repair costs
- Reduced environmental impact

2.3

Design and develop

Lubrication (-systems preparation)

Lubrication – selecting the lubricant

Special lubrication

If rolling bearings are to operate reliably and realize their full service life they must be adequately lubricated. The function of the lubricant is to form a protective oil film that separates the rolling contact surfaces and prevent metal-to-metal contact.

The lubricant also protects the bearing and related components against corrosion. When grease is used as a lubricant, it can also help protect the bearing against contaminants such as dirt, dust and water.

Lubrication - challenges

Customer challenges

- Extend bearing life without increasing pricing
- More robust designs
- Universal components for lower logistic costs
- Sustainable solutions
- Complying with laws and regulations
- Service life and warranty period

End user challenges

- Increased motor availability
- Lower maintenance and repair costs
- Clean motor
- Sustainable solutions

Lubrication solutions for electric motors

Integrated SKF lubrication solutions combine our expertise in bearings, seals and condition monitoring with our tribology knowledge.

Lubrication – SKF greases
for electric motors – examples

LGHP 2

SKF high performance, high temperature bearing grease
- Electric motors: small, medium and large

LGHP 2 is premium quality mineral oil based grease, using a modern Polyurea (di-urea) thickener. It is suitable for ball (and roller) bearings required to run extremely quiet, operating at a wide temperature range from –40 °C (–40 °F) up to 150 °C (302 °F), at medium to high speeds.

LGMT 2

SKF general purpose industrial and automotive bearing grease
- Small electric motors

LGMT 2 is mineral oil based lithium soap thickened grease with excellent thermal stability within its operating temperature range. This premium quality, general purpose grease is suitable for a wide range of industrial and automotive applications.

LGMT 3

SKF general purpose industrial and automotive bearing grease
- Large electric motors

LGMT 3 is mineral oil based lithium soap thickened grease. This premium quality, general purpose grease is suitable for a wide range of industrial and automotive applications.

Lubrication – system hardware OEM

Grease fittings

Grease fittings are the lubricant's entryway for motor applications that require relubrication of the bearing system. The grease fittings can be used with manual and automated relubrication setups.

Features

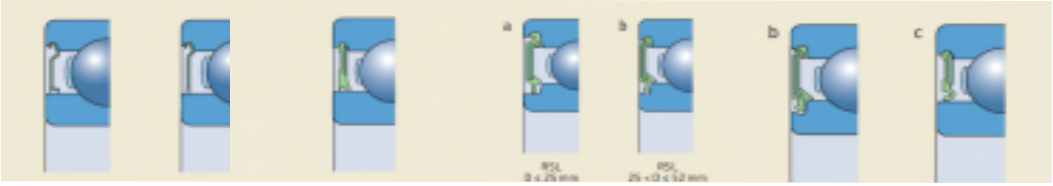
- Straight and Angled Fittings
- Carbon Steel, Stainless Steel, Monel
- Meets all applicable standards

Benefits

- Robust
- Reliable
- Cost efficient

The smallest lubrication system

Capped and greased for life deep groove ball bearings



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High speed	+++	+++	+++	o	o
Grease retention	o	+	+++	+++	++
Dust exclusion	o	+	++	+++	+++
Water exclusion					
static	–	–	o	+++	++
dynamic	–	–	o	+	+
high pressuree	–	–	o	+++	o

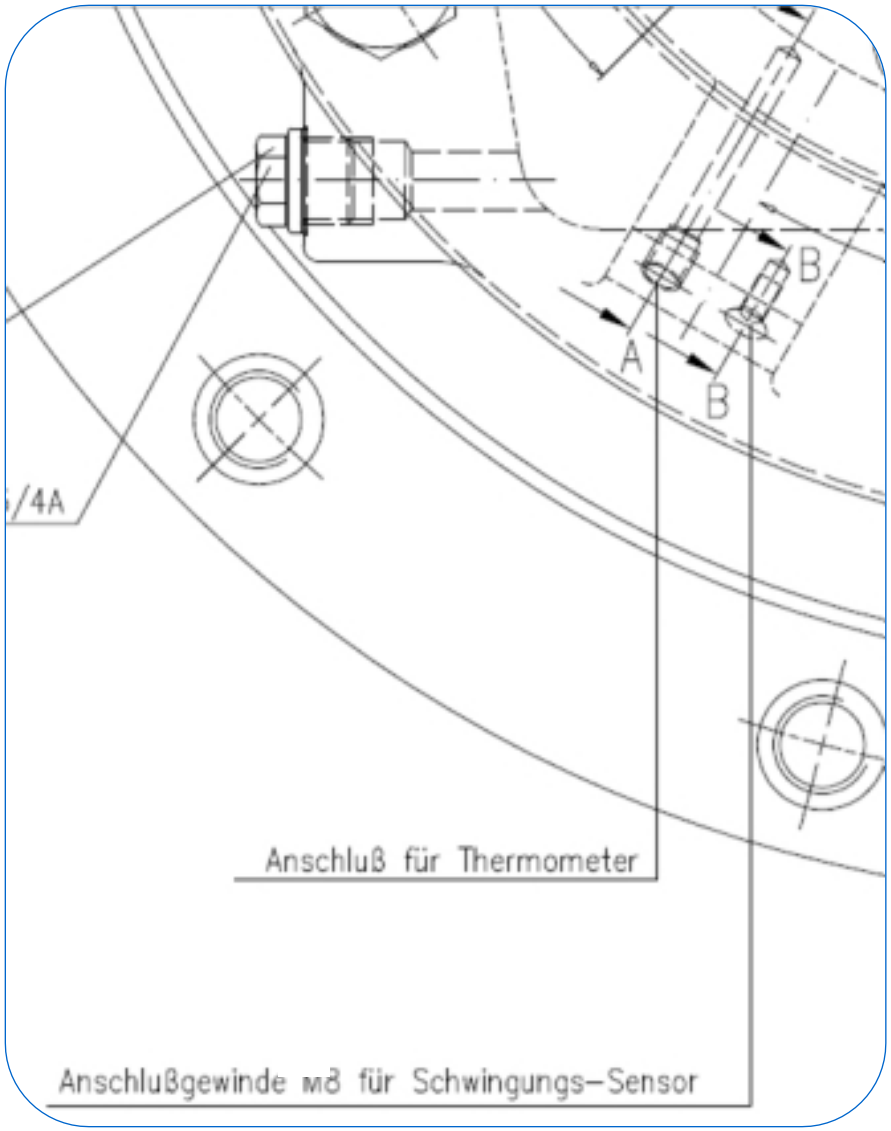
Symbols: +++ = best ++ = very good + = good o = fair – = not recommended

2.4

Design and develop

Condition monitoring systems – preparation

Condition monitoring preparation



Positioning and specification for condition monitoring sensors (temperature, vibration)

2.5

Design and develop

Services

Catalogues and handbooks - general

Handbooks and brochures - industry specific

SKF engineering tools

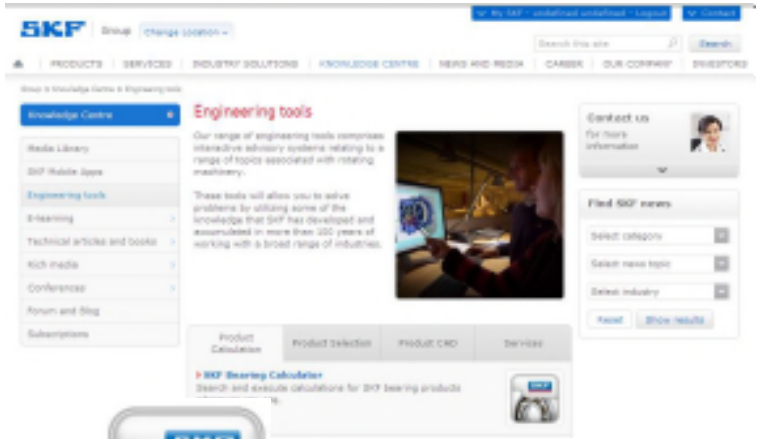
SKF engineering tools

SKF's range of engineering tools comprises interactive advisory systems relating to a range of topics associated with rotating machinery. These tools will allow you to solve problems by utilizing some of the knowledge that SKF has developed and accumulated in more than 100 years of working with a broad range of industries.

SKF's engineering tools are available in the Knowledge Centre Section @ skf.com and many of them as SKF Mobile Apps for use with your smartphone.

Examples

- SKF Bearing Calculator
- SKF Belt Calculator (check quality of belt drive design)
- SKF DialSet (bearing re-lubrication)
- SKF Engineering Calculator (typical maintenance engineering problems)
- SKF Frequency Calculator (provides typical vibration frequencies of rotating machinery components for your frequency spectrum analysis)



SKF Bearing Calculator App

SKF Engineering Consultancy Service

SKF Engineering Consultancy Service

SKF Engineering Consultancy Service has experienced engineers and project leaders that can support you with everything from material science, lubrication and tribology knowledge to verify your new designs using SKF's unique simulation programs. Working closely together with SKF's experts and state-of-the-art laboratories and research centers all over the world and applying proven processes as Design for Six Sigma enables you to develop robust solutions faster. We can combine the right SKF knowledge, experience and equipment into a tailor-made solution specific to your needs, and support you during the entire life cycle of your products.

Capabilities

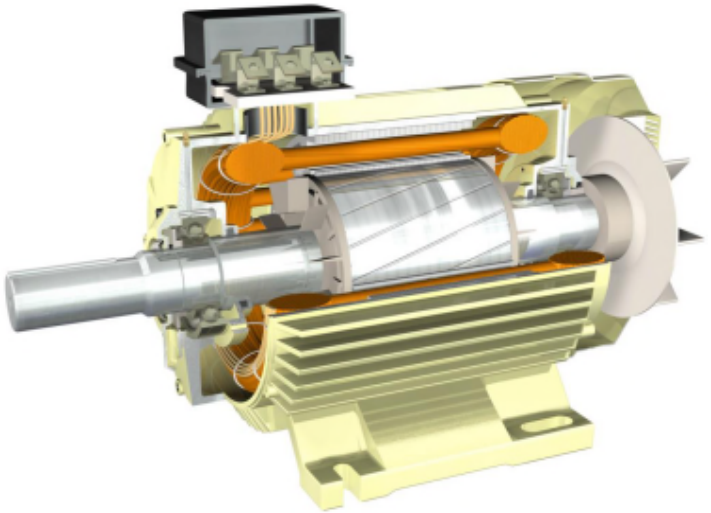
- Analytical modeling of complete bearing systems, consisting of shaft, housing, gears, couplings, etc.
- Static analysis to determine the elastic deformations and stresses in components of mechanical systems
- Dynamic analysis to determine the vibration behavior of systems under working conditions ("virtual testing")
- Visual and animated presentation of structural and component deflection
- Optimizing system robustness, leading to e.g. reduced temperatures, noise and vibration levels, and energy consumption
- Optimizing system costs

Benefits

- Faster development processes and reduced time to market
- Reduced implementation costs by virtual testing before production starts
- Improved bearing arrangement by reducing noise and vibration levels
- Extended service life by improving the lubrication or sealing system.

3

Manufacture and test



SKF Life Cycle Management

Delivering world-class solutions and validation services globally.

SKF offers for electric motors

Lubrication (equipment)

Mounting and dismounting tools

QA - Electrical

QA - mechanical

SKF mounting and dismounting tools

Mounting and dismounting tools

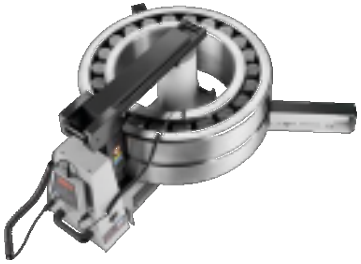
Mounting issues represent a relevant amount of total failures in bearing industrial applications. SKF tools allow for easier and safer bearing mounting procedures.

Features

- Different methods and solutions are available according to application restrictions, bearing dimensions and tolerances
- SKF tools are designed to be safe for users
- Tolerances and methods proposed derived by knowledge and SKF experience
- Advanced and customized solutions

Benefits

- Increased safety during assembly and disassembly
- Correct bearing mounting and dismounting
- Avoid bearing damages, such as brinelling, and premature failures (motor warranty)



SKF lubrication offers – manufacturing

Grease pumps

Grease guns

Greases

Motor Quality Assurance – electrical testing

High-volume automated stationary test systems

Baker WinAST
Automated Stator Test System

Lower-volume stationary and portable test systems

Baker WinTATS
Traction Armature Test System

Mobile equipment

Motor QA – automated testing systems

Automated motor testing: Baker WinAST and Baker WinTATS

Quality assurance and production control with manufacturing line test systems in medium to high-volume production environments. These systems reduce repair and service costs by finding quality issues before they can reach the customer.

Features

Fully automated, semi-custom Windows 7 based system performs an array of standard tests on each winding, including:

- Hipot (AC and/or DC), with micro-arc detection
- Winding resistance
- Surge
- Corona
- Inductance
- Rotation direction
- Field map and auxiliary relay matrix
- All test parameters and pass/fail limits are preprogrammed in master file

Benefits

- Reduced testing cycle time
- Improved manufacturing output
- Rugged reliability for continuous use in manufacturing environments
- Cost efficient
- Custom configurations
- Industry-leading support

Motor QA – mobile analyzing equipment

Portable motor test equipment

For low- to medium-volume production lines with a lot of variation, portable Baker AWA-IV and Baker DX static motor analyzers are the best choice. These static motor analyzers excel at tests for weak insulation and motor circuit issues in post production.

Features

Static motor analyzers measure the integrity of the motor's insulation system and motor circuits with

- Surge tests
- Polarization index tests
- DC step-voltage tests
- Megohm [MΩ] and Winding resistance tests
- DC coil and armature tests

Benefits

- Rock-solid test reliability
- Portability
- Automated (Baker AWA-IV) and manual testing (Baker DX)
- Full spectrum of insulation and circuit tests
- Cost efficient
- Rugged, field-proven designs

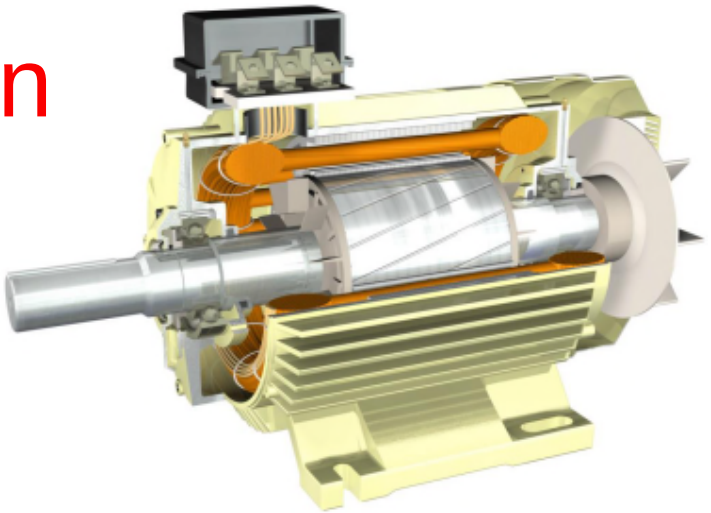
Testing mechanical properties

For example, vibration levels with SKF condition monitoring equipment

More info on SKF Microlog in “Operate and monitor” chapter

4

Install and commission



SKF Life Cycle Management

Providing expert on-site services, training, tools and auditable procedures.

Install and commission

Installation

Installation is a key milestone in the machinery life cycle.

Improper installation can:

- Reduce motor service life
- Affect product quality
- Drive up maintenance costs
- Cause unjustified warranty claims
- Reduce reliability
- Decrease uptime
- Increase TCO

Install and commission – examples of SKF offers

Machine installation

Precision alignment

Lubrication management

Check to conformance

On-line and on-site training

Start-up monitoring

Install – SKF shaft alignment tools

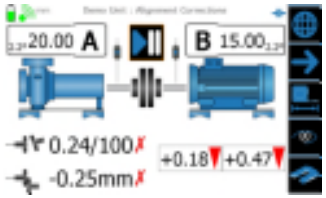
Shaft alignment tool

The shaft alignment tool is designed to assist users with managing alignment processes for any rotating machines. It consists of:

- a portable display unit,
- a pair of laser measuring units and
- mechanical parts to mount the measurement units on the shaft.

Features

- For horizontal and vertical alignment as well as soft foot check
- Pre-defined alignment process integrated into the portable instrument with step-by-step instructions
- Built-in wireless interface between the portable display unit and the measurement units. No cables needed.
- Energy efficiency indicator estimates extra energy consumption due to misalignment.



Benefits

- Accurate measurement: consistency of the process
- Guided process: reduced maintenance time
- Reduced energy consumption
- Increased driveline service life
- Reduced unplanned downtime
- Reduced maintenance costs

SKF shaft alignment tools – related SKF offers

Assistance to alignment

Calibrated shims

Adjustable chocks

Horizontal alignment tools

Maintenance tools

Belt alignment tools

Install – SKF Belt Tension System

SKF Belt Tension System

The SKF Belt Tension System enables controlled moving of the motor axis by hydraulic cylinders. With a hand-held hydraulic pump, the cylinders of the SKF Belt Tension System are moved upwards or downwards. Increasing or releasing the hydraulic pressure moves the motor and increases or releases the belt tension which is directly related to the pressure in the cylinders.

Features

- For IEC motor frame sizes 160 to 400 and several NEMA frame sizes
- Single acting hydraulic cylinders
- Mechanical locking with a hammer
- Hydraulic hand-pump (e.g. SKF THPT 1) available through SKF Maintenance Products

Benefits

- Assured repeatable maintenance quality
- Quick and reliable tension checks
- Easy preventive maintenance
- Safe, simple and fast belt replacement
- Reduced costs, due to prolonged belt life
- Higher uptime of the whole system due to less time consuming breakdowns
- Less vibrations and therefore higher efficiency due to correct belt tension
- Easy maintenance procedures minimize risk of injuries

Install – lubrication systems

Lubrication systems

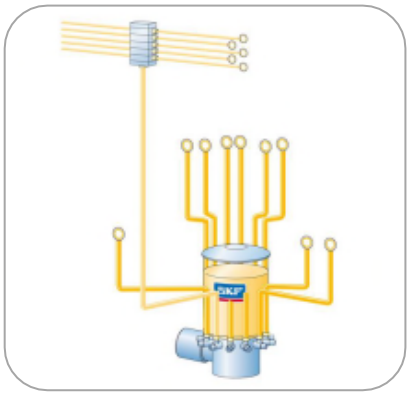
Installing the motor in hard to reach, dangerous and/or restricted access spaces?

Help your maintenance department reduce costs by considering SKF lubrication systems!

With its complete range of products, SKF is the world's leading manufacturer and systems supplier in the field of centralized lubrication for machinery, industrial plants, vehicles and off-road equipment.

Automatic grease and oil systems ensure an adequate supply of lubricant to bearings in large and production critical motors and generators.

Grease lubrication

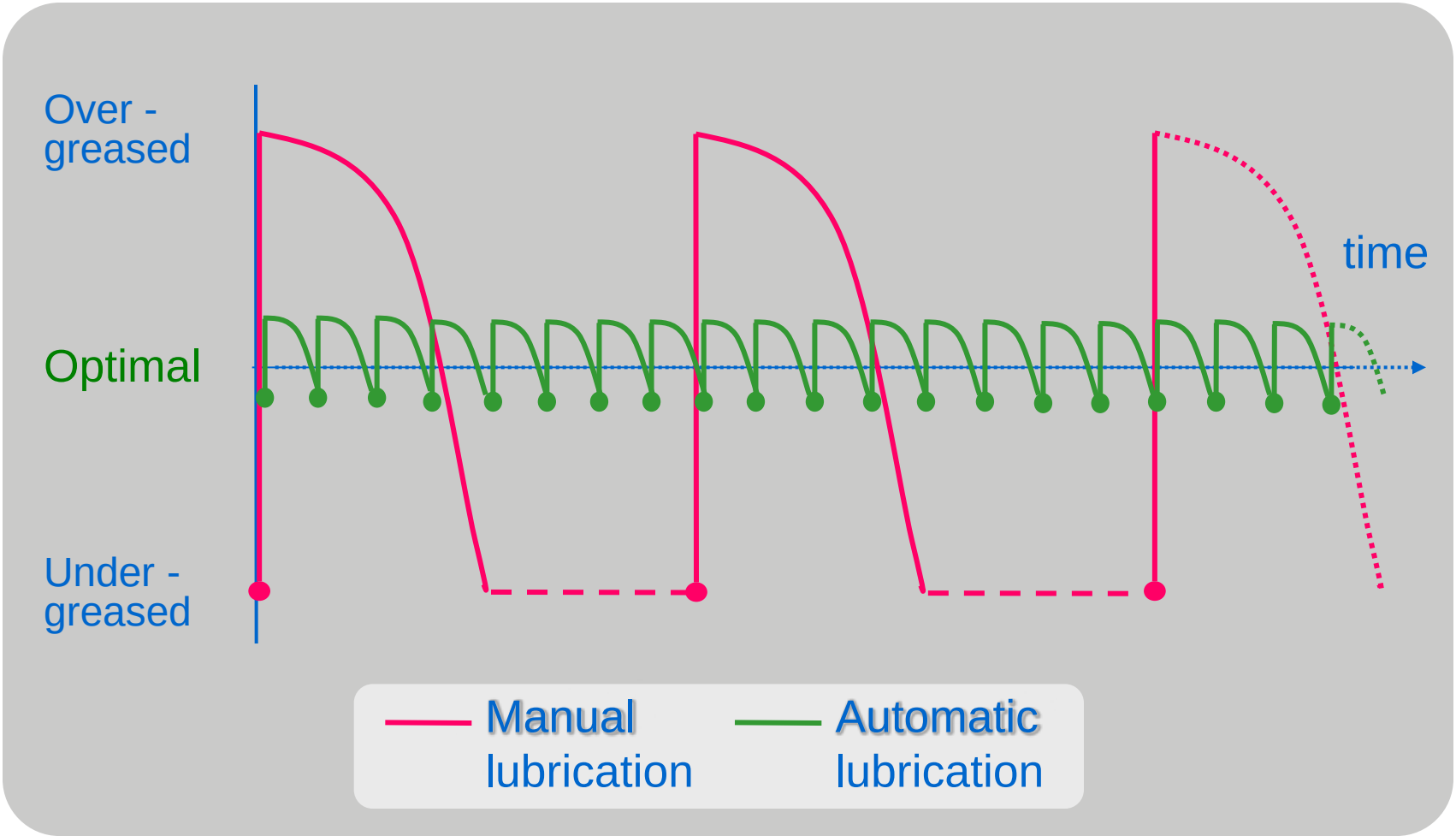


Grease systems

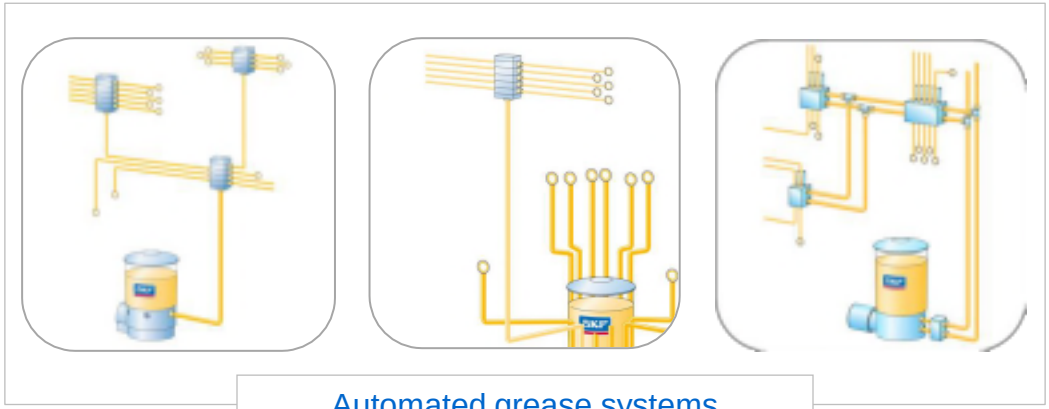
Oil lubrication

Oil systems

Automatic vs. manual lubrication



Install – SKF lubrication systems for electric motors

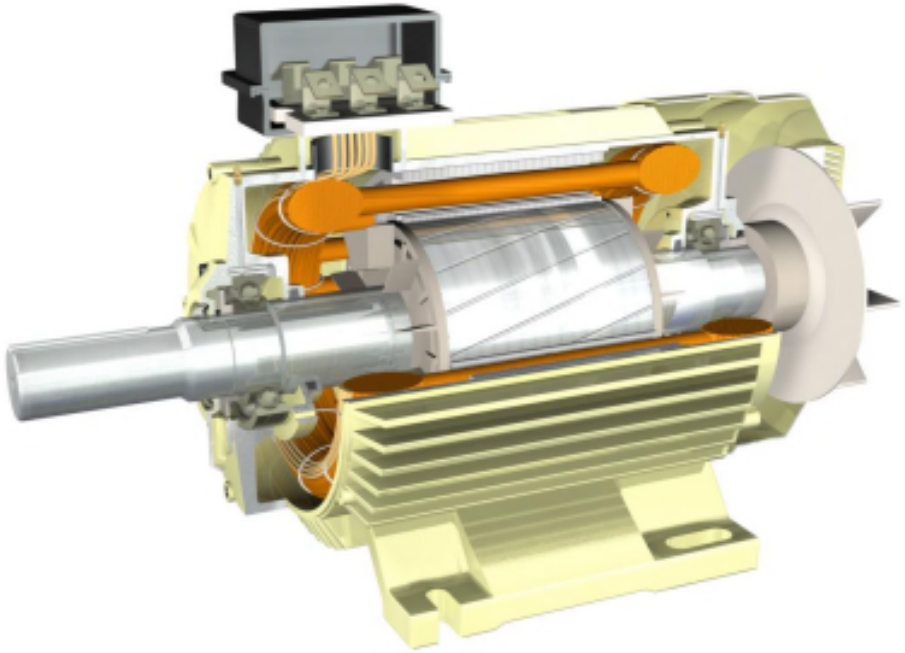


Automated grease systems

Single point
automatic lubricators

More information on
lubrication systems in the
“**Maintain**” chapter

5



Operate and monitor

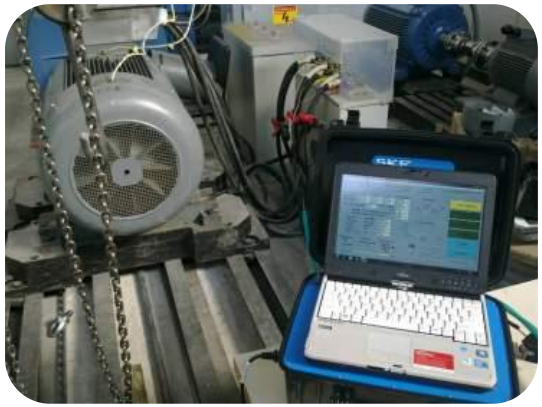
SKF Life Cycle Management

Deploy the right solutions at the right time
to improve productivity.

Monitor – benefits

General benefits

- Plan maintenance when convenient (no fire fighting)
- Plan maintenance when it is really needed (no personal opinions, no time-based maintenance)
- Increase uptime
- Increase reliability
- Reduce maintenance costs
- Avoid catastrophic failures



Integrated condition monitoring technologies

With the right machine data and the right tools to interpret it, you can optimize your maintenance program.

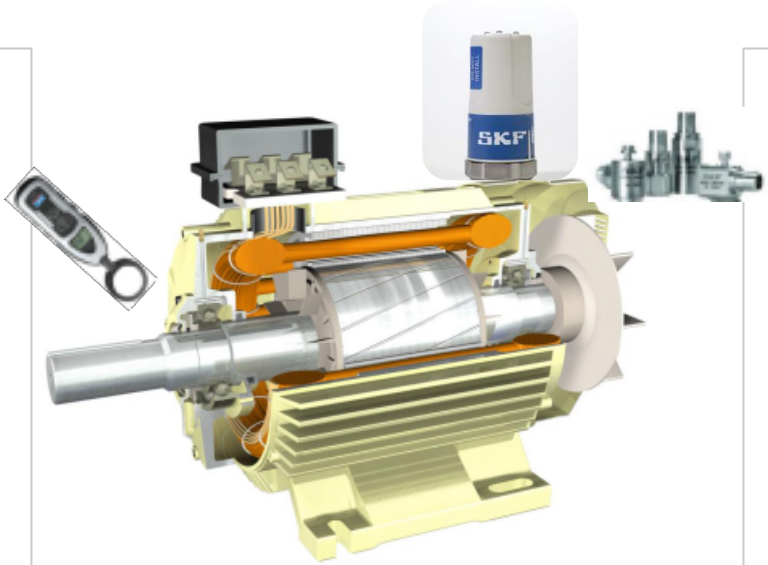
SKF has a complete, integrated range of condition monitoring tools and technologies to make it happen.

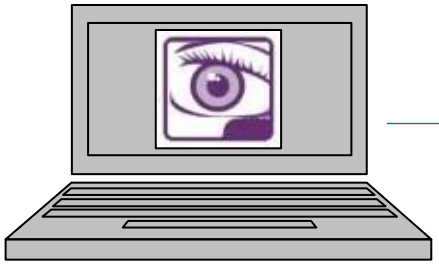
Operate and monitor – What would you like to be informed about?

Monitoring electrical properties

SKF static and dynamic motor analyzers

SKF Online Motor Analysis System - NetEP





SKF @ptitude Observer: Decision support system

Monitoring mechanical properties

SKF Microlog portable monitoring equipment

SKF Multilog IMX data acquisition system

5.1

Motor monitoring (and analyzing) solutions – electrical

SKF electric motor analysis and monitoring solutions

Static and dynamic electric motor condition monitoring drives successful predictive maintenance and quality assurance programs

SKF Static Motor Analyzer Baker AWA-IV

SKF Dynamic Motor Analyzer EXP4000

SKF Online Motor Analysis System - NetEP

Monitor – motor analysis equipment

Portable motor analysis equipment

SKF Dynamic Motor Analyzer – EXP4000 monitors for health and performance issues with a motor/machine system's power supply, load, and the motor itself

SKF Baker AWA-IV and Baker DX static motor analyzers test and analyze the condition of a motor's insulation system and motor circuits

Together they provide a full spectrum of test and monitoring capabilities that generate information maintenance professionals need to accurately diagnose and predict potential failures and make good maintenance decisions

Features

Dynamic motor analyzers

- Torque analysis
- Continuous monitoring
- Vibration
- Power condition

Static motor analyzers:

- Surge tests
- Polarization index (PI) tests
- DC step-voltage tests
- Megohm [MΩ] tests
- Winding resistance tests
- DC coil and armature tests

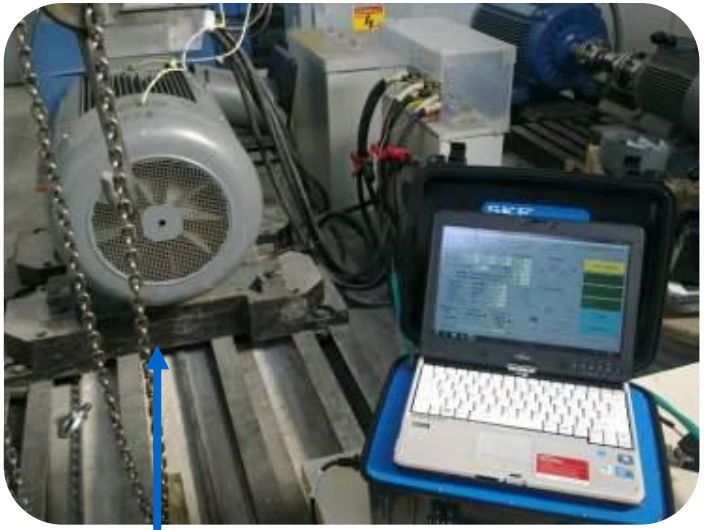
Benefits

- Comprehensive spectrum of motor condition tests for predictive maintenance and quality assurance
- Visibility into machine system (power + motor + load) health and performance
- Minimizes costs from unplanned downtime due to motor failure
- Accurate analysis for maintenance decision support
- Portability

System architecture – dynamic analyzer

Control panel

On board

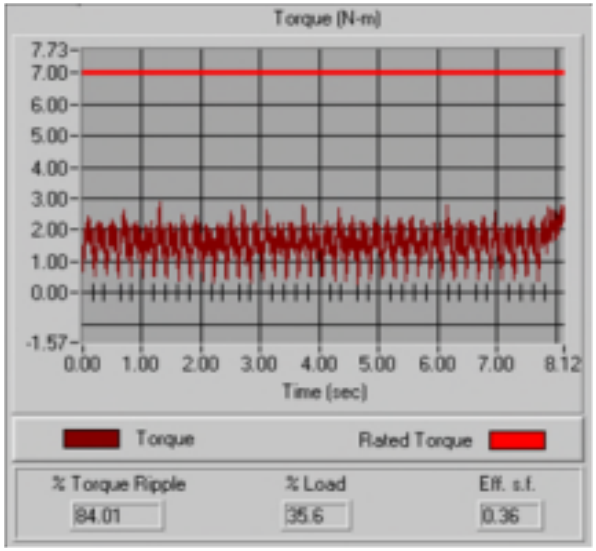


SKF EXP4000 dynamic motor analyzer capabilities

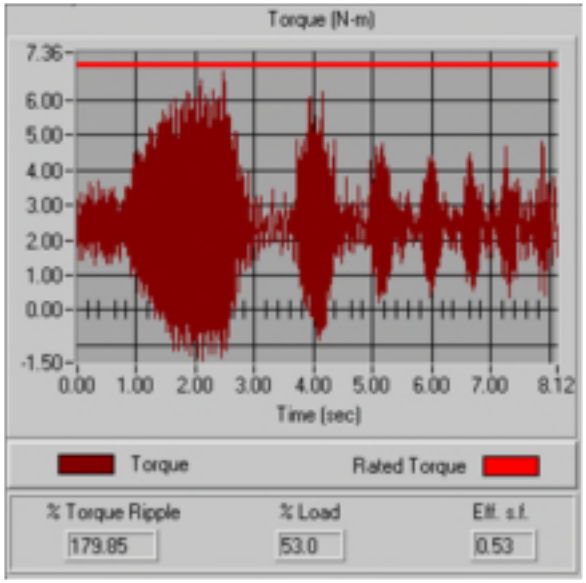
SKF EXP4000 dynamic motor analyzers monitor for problems across an operating machine system (with power quality, motor condition and load)

Example: TORQUE and LOAD condition data revealed cavitation resulting from broken impeller/end bell on submerged pump

Torque signature from EXP4000 under normal conditions



Cavitation identified by torque signature on EXP4000



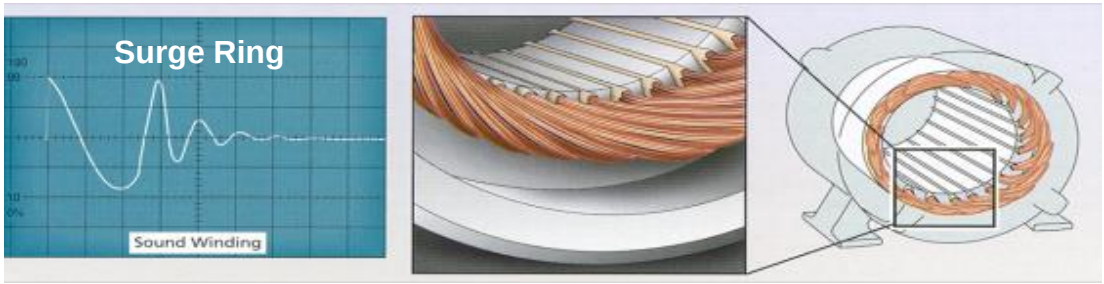
Monitor – SKF Baker static motor analyzers

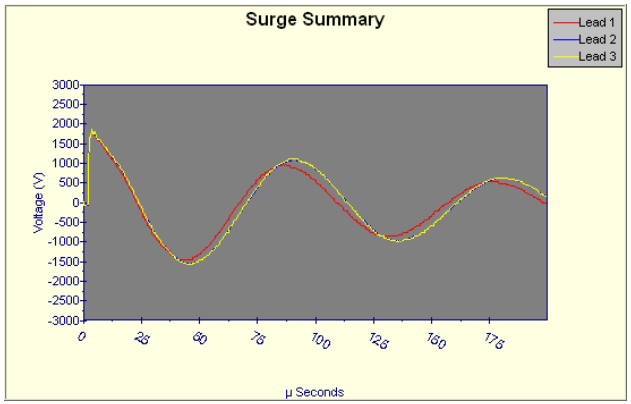
Features

Baker AWA-IV and Baker DX static motor analyzers assess insulation and motor circuit conditions with:

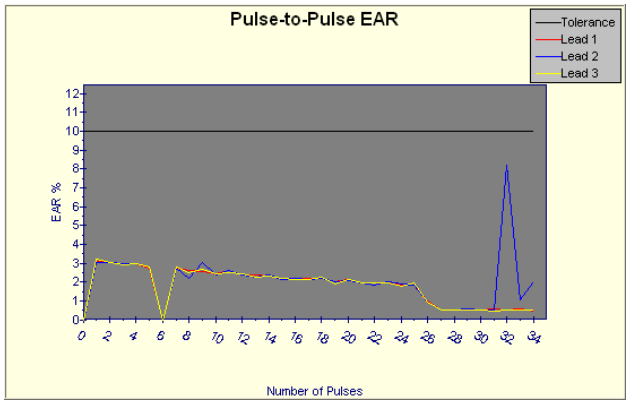
- Surge tests
- Polarization index (PI) tests
- DC step-voltage tests
- Megohm [MΩ] tests
- Winding resistance tests

These analyzers are used for predictive maintenance and troubleshooting





A surge test is the only means of identifying weak motor winding (turn-to-turn) insulation that will cause premature or otherwise unexpected motor failure



The pulse-to-pulse error-area ratio (EAR) algorithm helps accurately identify insulation problems that can lead to motor failure and costly unplanned downtime

Problems identified by SKF static and dynamic analyzers

Supply

- Power quality
- Poor-performing transformers
- Short, medium, long range trip settings
- Connection issues (junction box in motor)
- Lead-line insulation deterioration

Ground wall insulation

- Weakness
- Dirt
- Moisture
- Dry rot, brittle
- Cracks

Winding insulation and motor circuit

- Turn-to-turn, phase-to-phase, coil-coil insulation weaknesses
- Shorts, opens
- Reversed coils
- Phase unbalanced (turn count)
- Phase unbalanced (wire size)

Rotor

- Cracked bars
- Poor welds
- Broken bars
- Eccentricity (dynamic, static)

Loading issues

- Over/under loading
- Process

Mechanical

- Bearing faults
- Misalignment
- Fan unbalances
- Belt frequencies
- Worn Impellers
- Gear mesh frequencies

VFD

- Power quality
- Shorted IGBT’s
- Feedback loop
- Process information
- Tuning /setup

Soft start

- Tuning /setup
- Troubleshooting

Monitor – online motor monitoring

SKF Online Motor Analysis System – NetEP

NetEP is a stationary, fully-automated, network-connected, electric motor monitoring system. It acquires and analyzes machine system performance at regular intervals, minimizing the need to test each motor or generator with portable equipment at its location. This permanently-installed system operates with one voltage measurement per bus and current sensors installed for each motor.

Features

- Monitors more than 40 electrical parameters of electric motors and compares the results to limits, displaying alerts if limits have been exceeded
- Can be configured, monitored and operated 24/7 from any Internet network connection
- Collects data from up to seven different voltage busses with a maximum of 32 motors attached to a single NetEP unit
- Multiple NetEP systems connected to a single server can monitor hundreds of motors located anywhere in the world
- Acquires power quality every 10 seconds and time waveforms once per hour

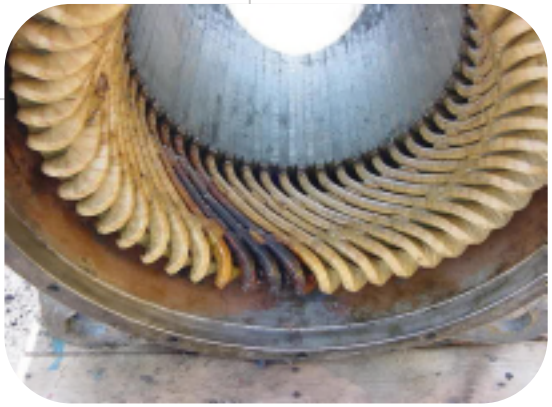
Benefits

- Plan maintenance when convenient (no fire fighting)
- Plan maintenance when it is really needed (no personal opinions, no time-based maintenance)
- Increase uptime
- Increase reliability
- Reduce maintenance costs

Monitor – benefits

General benefits

- Plan maintenance (reduces unplanned maintenance or downtime)
- Perform maintenance when it is actually necessary (no personal opinions, no time/route-based maintenance)
- Increase uptime
- Increase reliability
- Reduce maintenance costs
- Avoid catastrophic failures and costly unplanned downtime



5.2

Motor monitoring solutions – mechanical

Monitor – SKF Microlog

SKF Microlog Analyzers

SKF Microlog is a series of portable data collectors and analyzers made to support your condition monitoring program. SKF Microlog can handle all of the tasks required to perform predictive maintenance on your critical drivelines.

SKF Microlog analyzers automatically collect both dynamic (vibration) and static (process) measurements from almost any source, including handheld accelerometers, magnetically mounted accelerometers, permanently mounted vibration sensors and on-line monitoring systems.

Features*

Depending upon model chosen, features can be:

- Class I Division 2 or ATEX Zone 2
- IP 65 rated
- Complemented by a wide range of application specific firmware modules to fit your needs

Benefits

- Plan maintenance when convenient (no fire fighting)
- Plan maintenance when it is really needed (no personal opinions, no time-based maintenance)
- Increase uptime
- Increase reliability
- Reduce maintenance costs

* Available features differ in the various Microlog models

Monitor – monitoring system architecture

SKF Sensors

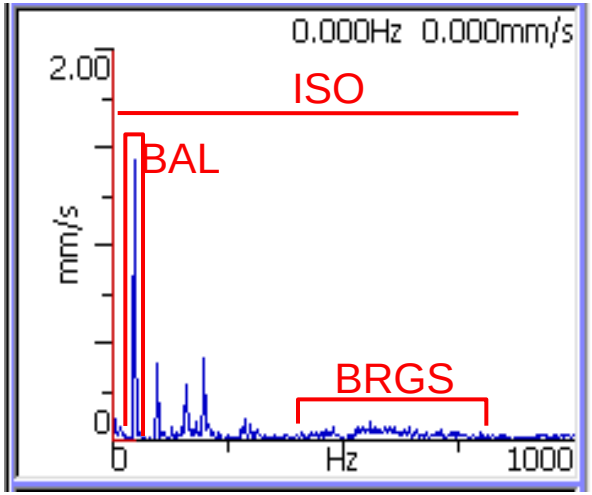
SKF Junction box

SKF Microlog GX

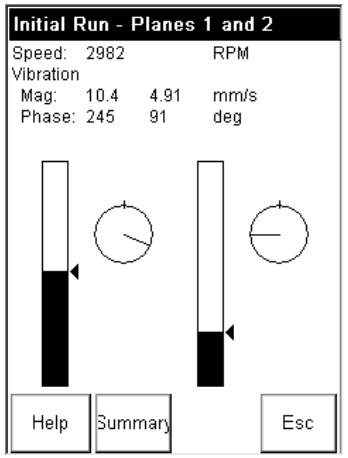
- Run up coast down
- FFT analyser
- Off route analyser
- Bump test
- Conformance test
- FFT analyser
- Frequency Response Function
- Digital signal recorder
- Balancing
- Route-based data collection

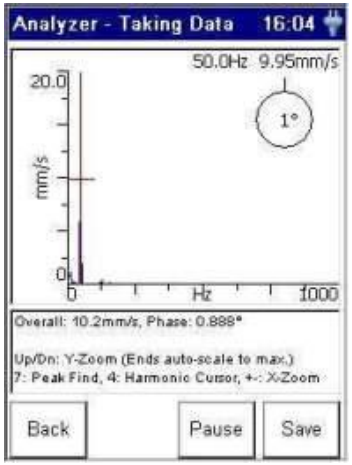
Monitor – Microlog views

Analyser

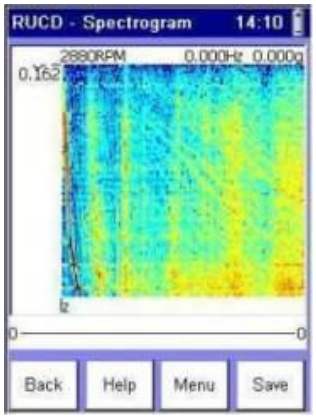


Balancing

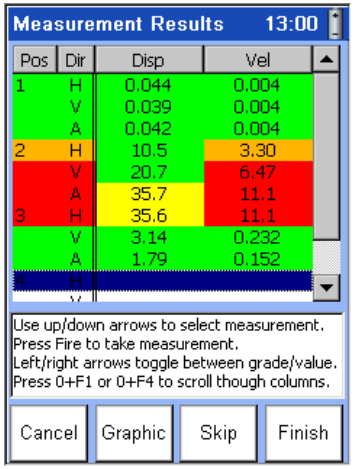




Run up / coast down



Conformance check



Monitor – The SKF Microlog family tree

Intended use?

Noise & vibration diagnostics and investigations **plus** Route-based predictive maintenance

Ex required?

ATEX: II 1G EEx

CSA Class i Div 2 Groups ABCD

Hardware?

4 channels 80kHz Large screen

2 channels 40kHz Small screen

AX

GX-S

GX-M

GX-R

CMXA51-IS

Noise & vibration diagnostics and investigations

Hardware?

2 channels 40kHz Small screen

CSA Class i Div 2 Groups ABCD ATEX Zone 2

MX

Monitor – SKF Multilog On-line System: IMx family

SKF IMx is a cost-effective solution for a variety of condition monitoring applications. It is a family of systems and a key component of an advanced:

CONDITION MONITORING SYSTEM

PROTECTION SYSTEM

It is a complete system for early fault detection and prevention, automatic advice for correcting existing or impending fault conditions to improve machine reliability availability and performance.

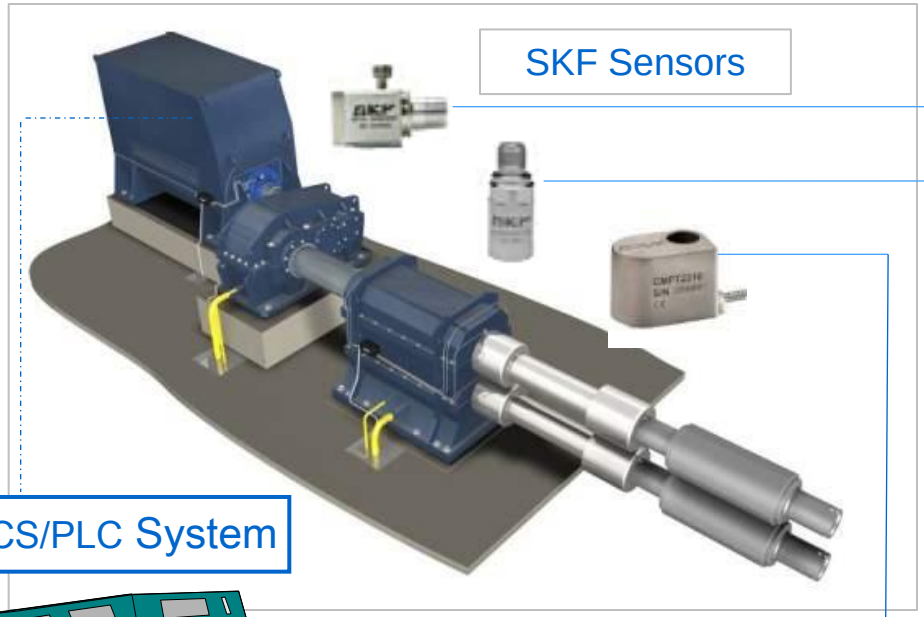
When part of a protection system relevant acquired data can be used used to drive the Distributed Control System (DCS).

IMx-S

IMx-P

IMx-M

Monitor – online monitoring system architecture



KEY FEATURES:

- 16-32-64 True simultaneous measurements of all analog channels
- 8-16-32 digital channels
- SKF enveloping filters to detect bearing and gear failures early
- Warning and alarm can be related to process data
- Output protection measurements: 4–20 mA analog output for each analog channel and relay cards.
- Run up, Coast down
- Single unit operation or as part of a network with multiple SKF Multilog IMx devices (including different types)

Monitor – benefits

General benefits

- Plan maintenance when convenient (no fire fighting)
- Plan maintenance when it is really needed (no personal opinions, no time-based maintenance)
- Increase uptime
- Increase reliability
- Reduce maintenance costs
- Avoid catastrophic failures

5.3

Other monitoring solutions

Monitor – SKF Electric Discharge Detector Pen

SKF Electric Discharge Detector Pen

The SKF Electrical Discharge Detector Pen (EDD Pen) is a simple to use handheld instrument for detecting electrical discharges in electric motor bearings. Electrical discharges can cause electrical erosion, lubricant degradation and ultimately bearing failure. Electric motors are more vulnerable to suffer electrical erosion in bearings when controlled by a Variable Frequency Drive. When incorporated into a predictive maintenance program, the EDD Pen can help detect bearings more susceptible to failure, and significantly reduce the chance of unplanned machine downtime.

Features

- Unique remote solution allows operation at a distance from the motors.
- SKF technology
- Capable of detecting electrical discharges on a time base of 10 seconds, 30 seconds or continuously
- LED backlit screen allows use in dark environments
- IP 55 can be used in most industrial environments
- Supplied standard with batteries, spare antenna and language free instructions for use in a carrying case

Benefits

- User doesn't need to touch machinery in motion
- No special training required

When incorporated in predictive maintenance program:

- Can help detect bearings more susceptible to failure
- Prevent unplanned machine downtime
- Increase uptime and reliability
- Reduce maintenance costs

Monitor – SKF Machine Condition Indicator

SKF Machine Condition Indicator

The standalone SKF Machine Condition Indicator (MCI) gives plants a reliable, affordable way to monitor non-critical motors. A vibration sensor and an alarm indicator in one unit, the fully sealed, battery-powered MCI requires no wired or wireless connections, installing directly on motors for permanent, periodic vibration and temperature monitoring. Motor condition lights on top of the MCI become illuminated when the unit detects developing issues, alerting maintenance technicians that the motor needs to undergo a root cause analysis.

Features

- Velocity measurements support overall motor health
- Measure enveloped acceleration detects bearing degradation
- Temperature measurements indicate uncharacteristic heat
- Two modes of operation address most industrial machines
- Built-in intelligence to avoid false alarms

Benefits

- Monitor non-critical motors cost-effectively
- Extend maintenance route intervals
- Cut maintenance demands and costs
- Free up maintenance staff for higher level/other tasks
- Integrate MCI units into an operator driven reliability program/maintenance routes

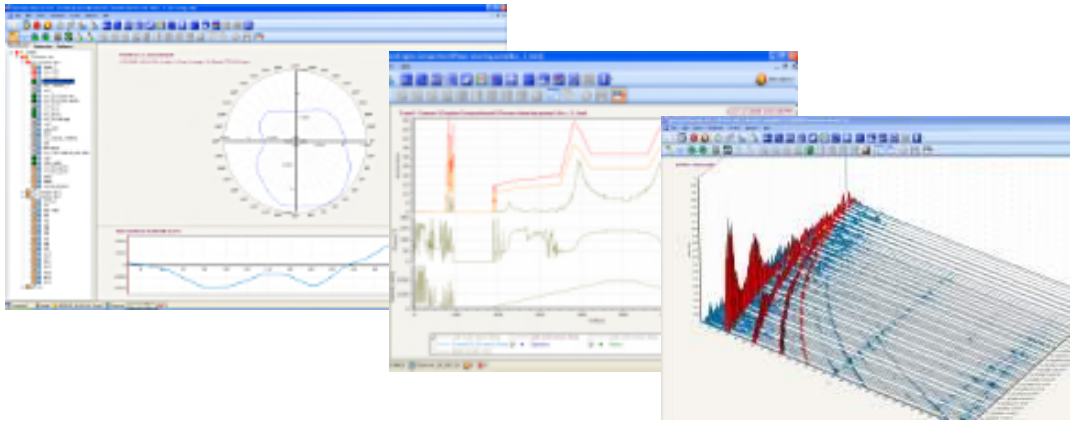
Monitor – related offers for condition monitoring







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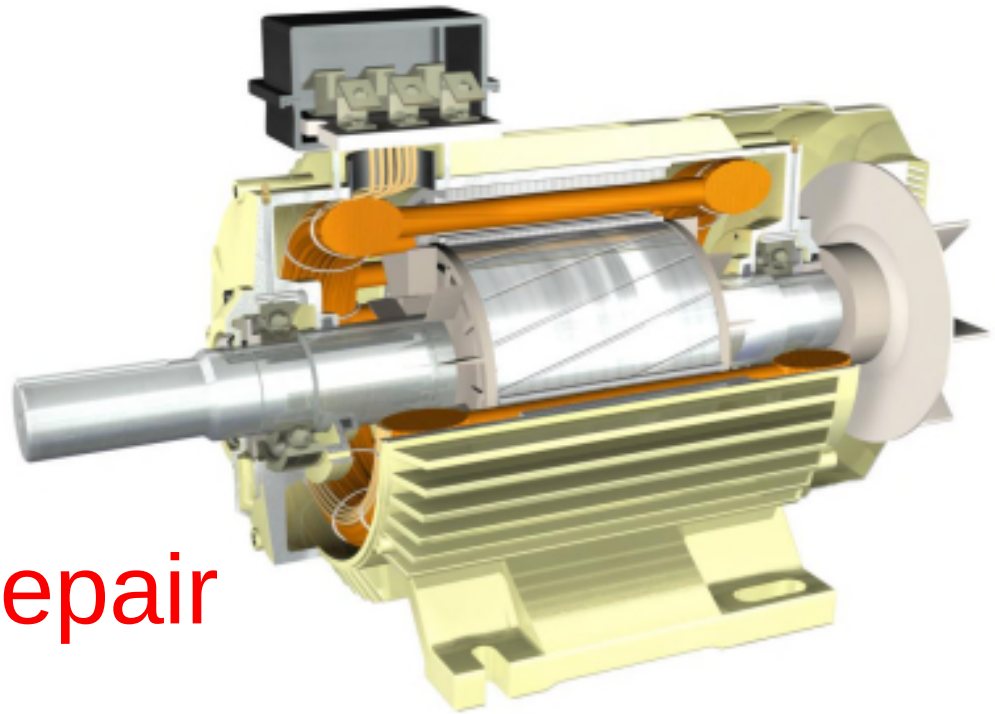

Maintain and repair

SKF Life Cycle Management

Supporting motor maintenance and operations with a range of tools and services.

Slide 106 6 October 2014

Maintain and repair

SKF support

When electric motors require maintenance or repair, SKF can support your operation with

- A broad assortment of lubrication and replacement products
- An array of specialized tools and testing equipment
- Mechanical maintenance and specialized services

SKF
Certified Rebuilder
Electric Motors

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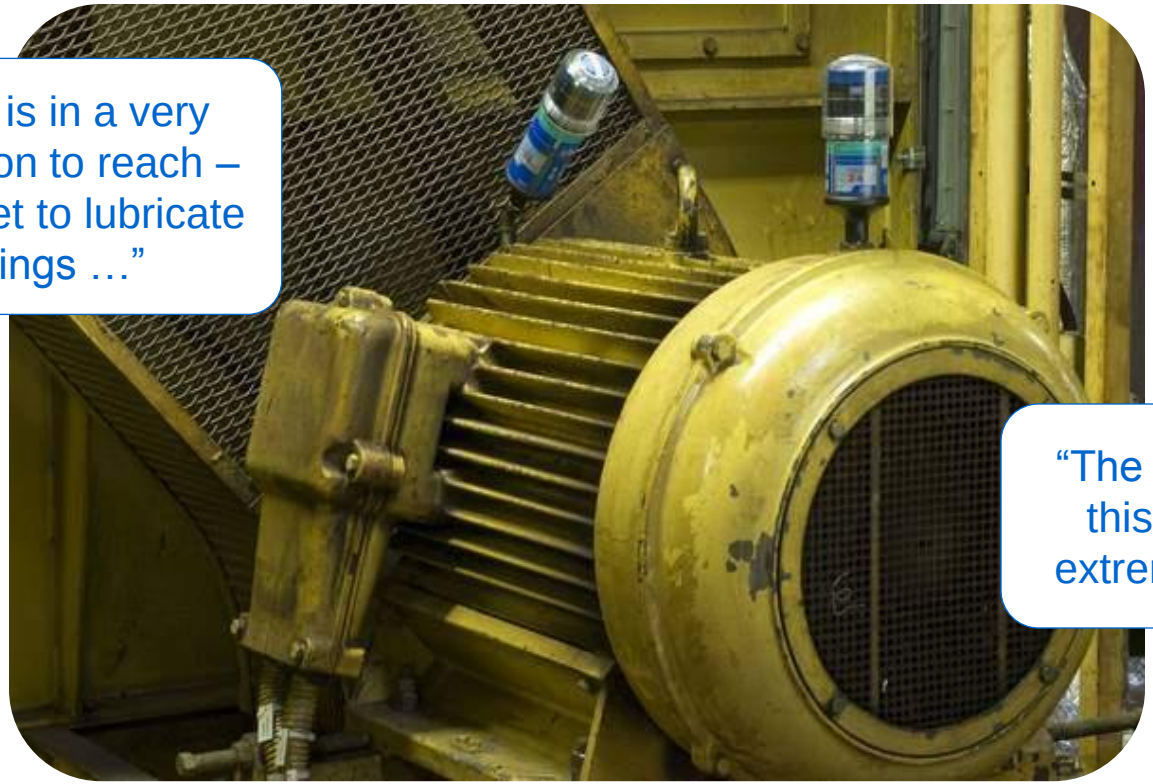
Maintain and repair

Maintain and repair

Home

Maintenance personnel sometimes neglect lubricating the bearings as they might have more critical issues to take care of.



"This motor is in a very difficult position to reach – often we forget to lubricate the bearings …"

"The bearings on this motor run extremely hot …"

SKF®

The importance of lubrication

Lubrication issues

Lubrication related issues are amongst the most common causes of failure for bearings in electric motors.

For example:

- too much lubricant
- too little lubricant
- wrong type of lubricant
- contamination of the lubricant with water, air, particles, etc
- cross-contamination (i.e. mixing of incompatible lubricants)

Poor fitting

16% *

Poor lubrication

36% *

Contamination

14% *

Fatigue

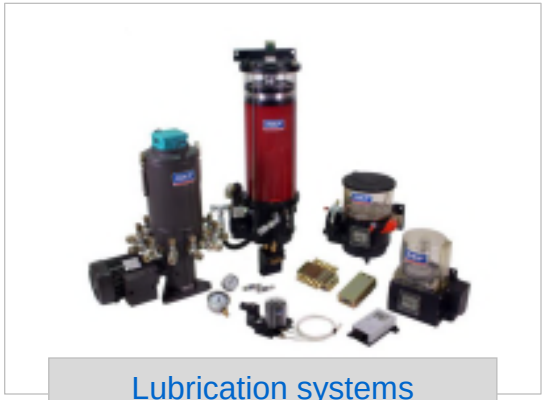
34% *

*Numbers shown are for general machinery and not from a motor specific study. Lubrication related numbers for motors could even be higher!

SKF®

Maintain and repair – SKF* Lubrication offers

Lubricants



Lubrication systems

Lubrication Equipment

* Includes these brands:

LINCOLN® SKF Spandau pumpen®

Maintain – lubricants

A wide range of SKF greases

SKF has developed several greases suitable for motors in any operating condition.

Selection criteria depends on operating temperature, load applied onto the bearing, speed and bearing dimensions.

LGFP 2

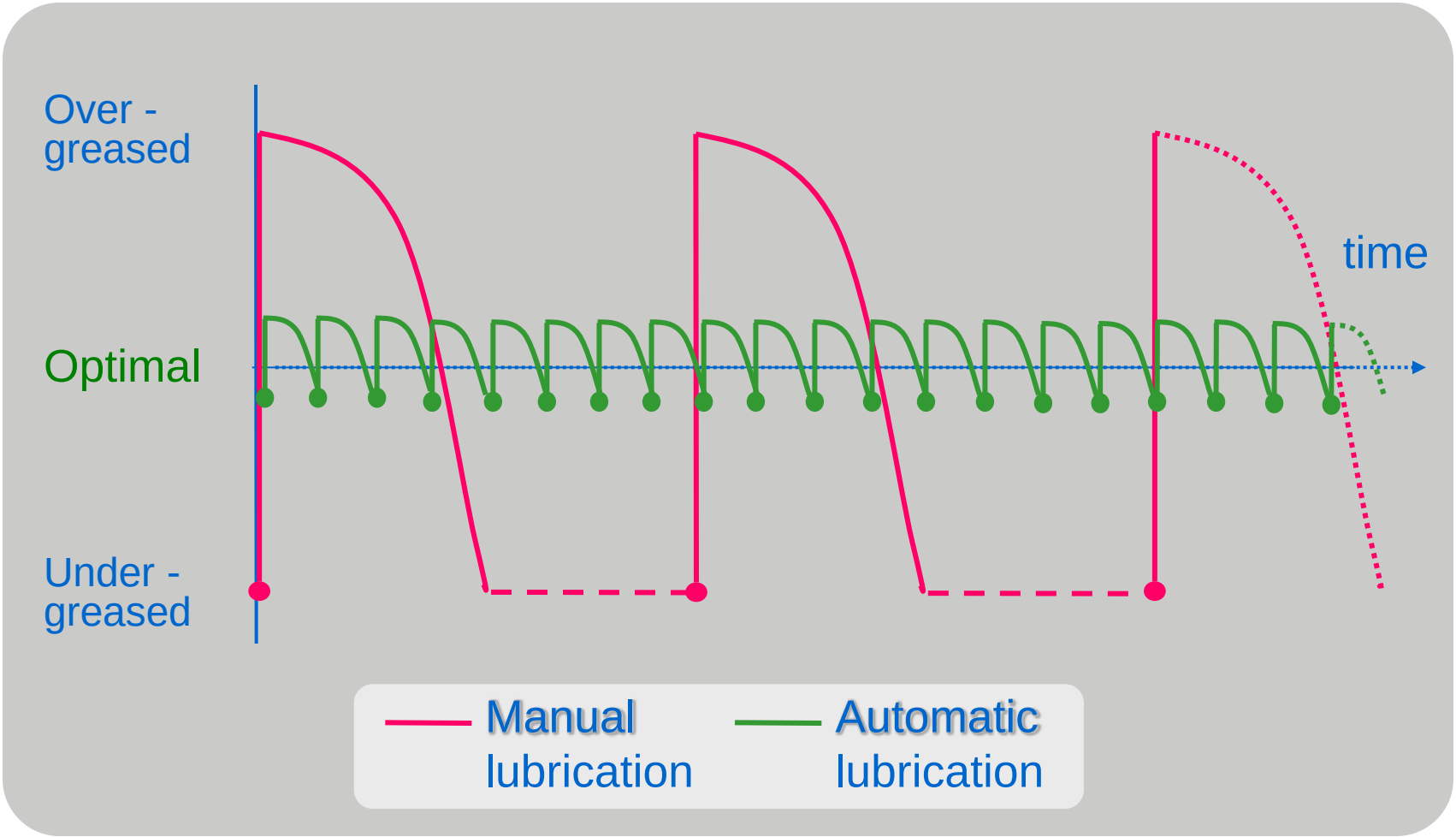
LGMT 2

LGHP 2

LGMT 3

LGLT 2

Automatic vs. manual lubrication



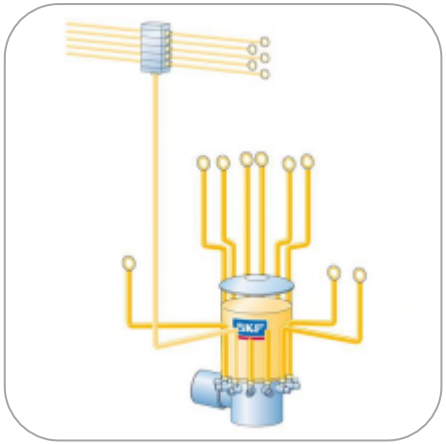
Maintain – SKF lubrication systems

Lubrication systems

With its complete range of products SKF is the world's leading manufacturer and systems supplier in the field of centralized lubrication for machinery, industrial plants, vehicles and off-road equipment.

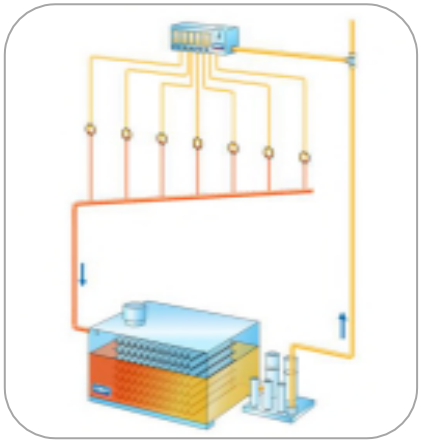
Automatic single- or multi-line grease and oil systems ensure an adequate supply of lubricant to bearings in large and production critical motors and generators.

Grease lubrication



Grease systems

Oil lubrication



Oil systems

Maintain – SKF Lubrication systems

Single point automatic lubricators

Multipoint automated lubrication systems

Maintain – SKF lubrication systems grease

SKF SYSTEM 24

SKF SYSTEM 24 is an automatic lubricator yielding a constant grease flow that can be adjusted by setting a dial for required lubricant flow rate. Typical applications include fans, blowers, conveyors and other hard-to-reach motors.

Features

- Automatic gas or electro mechanical driven single point lubricators
- Supplied ready to use straight from the box
- Filled with a wide range of high quality SKF lubricants
- Tool-free activation and time-setting allows easy and accurate adjustment of lubrication flow.
- IP 65 level allows the lubricator to be used in most dusty and wet environments

Benefits

- Ease of use
- Robust
- Reliable
- Reduced usage of lubricant
- Avoidance of failures due to lack of lubricant (or excessive lubricant)
- Reduced risk for wrong lubricant (vs manual lubrication)
- Improved maintenance procedures
- Reduced maintenance costs
- Helps avoid lubricant mix-up

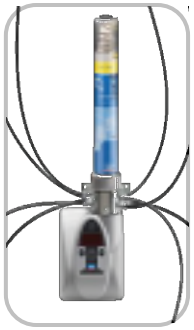
Maintain – automatic lubrication systems

SKF automated and centralized lubrication systems

Automated and centralized lubrication systems for multiple lubrication points usually consist of a lubricant reservoir, a pump, controller/timer, lubricant supply lines, metering devices and the lubricant feed lines. Typical applications for these systems include large electric motors, pump and motor combinations or sets of these machines.

Features *

- For oil or grease lubrication
- Monitoring proper system operation:
  - Blocked line detection
  - Low reservoir level
  - Alarm signals (remote notification)
- Injector systems with adjustable output for each lubrication point



* Depending upon system chosen

Benefits

- Avoidance of failures due to lack of lubricant (or excessive lubricant)
- Reduced usage of lubricant
- Reduced risk for wrong lubricant (vs. manual lubrication)
- Improved maintenance procedures
- Reduced maintenance costs
- Helps avoid lubricant mix-up

Maintain – Oil-Mist lubrication system

SKF Oil-Mist systems

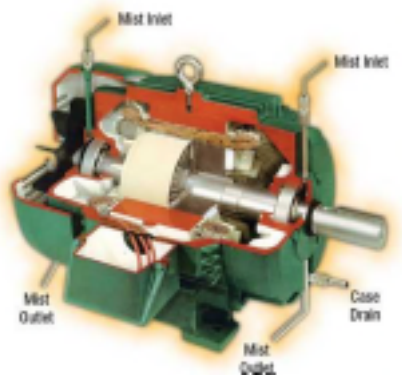
Oil-Mist is a reliable, effective centralized lubrication system that continuously and efficiently atomizes oil into small particles and then conveys and delivers the correct amount of the pressurized lubricant to the motor bearings.

Features

- Interchangeable nozzles allowing changing flow rates in the field
- Loader fitting to simplify manual filling
- Stainless steel suction strainer
- Air filter elements for clean air at lube points
- Pressure relief valve
- Simple rugged design

Benefits

- Increases service life of equipment by reducing component wear
- Contributes to an increase in production availability
- Significantly reduces bearing wear and temperature
- Lowers lubricant consumption, often by 80% or more
- Lubricates hard-to-reach points
- No moving parts to wear out



Repair – predictive motor maintenance test equipment

Portable motor analysis equipment

SKF Baker AWA-IV and Baker DX static motor analyzers test and analyze the integrity of the motor's insulation system and motor circuits. SKF Baker Dynamic Motor Analyzer EXP4000 monitors for health and performance issues with a motor/machine system's power supply, load, and the motor itself. Together they provide a full spectrum of test and monitoring capabilities that generate information required to accurately diagnose and predict imminent failures and make good maintenance decisions

Features

Static motor analyzers:

- Surge test
- Polarization index (PI) tests
- DC step-voltage tests
- Megohm [MΩ] tests
- Winding resistance tests

Dynamic motor analyzers:

- Torque analysis
- Continuous monitoring
- Vibration
- Power condition

Benefits

- Comprehensive motor testing that identifies problems before they can cause motor failure and downtime
- Motor/machine system condition monitoring and troubleshooting
- Cost-effective, accurate analysis that improves maintenance decision-making and management
- Portability, ease-of-use

Faults identified by the EXP4000 and Baker AWA-IV

Supply

- Power quality
- Poor performing transformers
- Short, medium, long range trip settings
- Connection issues (junction box in motor)
- Lead-line insulation deterioration

Ground wall insulation

- Weakness
- Dirt
- Moisture
- Dry rot, brittle
- Cracks

Winding insulation and motor circuit

- Turn-to-turn, phase-to-phase, coil-coil insulation weakness
- Shorts, opens
- Reversed coils
- Phase unbalanced (turn count)
- Phase unbalanced (wire size)

Rotor

- Cracked bars
- Poor welds
- Broken bars
- Eccentricity (dynamic, static)

Loading issues

- Over/under loading
- Process

Mechanical

- Bearing faults
- Misalignment
- Fan unbalances
- Belt frequencies
- Worn Impellers
- Gear mesh frequencies

VFD

- Power quality
- Shorted IGBT’s
- Feedback loop
- Process information
- Tuning /setup

Soft start

- Tuning /setup
- Troubleshooting

SKF®

Certified motor rewinders

"This motor has failed repeatedly in the last 3 years. We do not exactly know why."

"The seal popped out 2 days after the motor was repaired …."

"We have spent thousands on this motor!"

Repair – SKF Certified Rebuilder Program

SKF Certified Rebuilder Program

Developed as a collaborative effort among eligible repair shops, SKF Authorized Distributors and SKF, the SKF Certified Rebuilder Program enhances the expertise of qualified electric motor repair shops to meet the most stringent procedural standards and specifications.

Some electric motor rebuilders simply stand above the rest. The SKF Certified Rebuilder Program helps you find them.

Features

Employee training

- Root cause failure analysis
- Bearing installation
- Lubrication

Equipment technology upgrades

- SKF bearings
- SKF seals

New standards for repair consistency and quality

- Consistent procedures
- SKF condition monitoring equipment
- SKF quality control equipment

Benefits

- Increased motor service life
- Increased motor reliability and availability
- Stop recurring failures
- Higher Mean Time Between Failures
- Reduced unplanned downtime
- Reduced energy consumption
- Reduced maintenance costs
- Reduced total cost of ownership

Repair – motor quality assurance applications

Portable static motor test equipment

For low-to medium-volume production lines with a lot of variation, portable Baker AWA-IV and Baker DX static motor analyzers are an ideal choice. These static motor analyzers excel at tests for weak insulation and motor circuit issues in post production / repair for quality assurance prior to placing motors in service.

Features

Static motor analyzers measure the integrity of the motor's insulation system and motor circuits with

- Surge tests
- Polarization index tests,
- DC step-voltage tests,
- Megohm [MΩ] and
- Winding resistance tests

Benefits

- Rock-solid test reliability
- Portability
- Automated (Baker AWA-IV) and manual testing (Baker DX)
- Full spectrum of insulation and circuit tests
- Cost efficient
- Rugged, field-proven designs

Repair – related SKF offers

Bearings and seals

SPEEDI-SLEEVE shaft repair kits

Lubricants and lubrication equipment

Shaft grounding ring kits

Maintenance tools

Specialized training

RCFA

QA and condition monitoring equipment

Repair – SKF Shaft Grounding Ring Kits

SKF Shaft Grounding Ring Kits (TKGR)

The SKF Shaft Grounding Ring Kits have been developed to help prevent bearing failures due to electrical discharge currents which can occur when variable frequency drives are used to control AC motors.
They have been specifically designed for retrofitting existing IEC frame size industrial electric motors, reducing the need to spend time, effort and cost in replacing the existing bearings. Other SKF solutions designed to overcome the effects of electrical discharge currents include SKF INSOCOAT and SKF Hybrid bearings.

Features

The SKF Shaft Grounding Rings Kits (TKGR series) consist of the following items:

- Shaft grounding ring with an aluminium brush holder which helps ensure that the conductive brushes are in contact with the surface of the motor shaft
- Four different sets of mounting brackets (4 brackets per set) which virtually ensures that the SGR can be fitted to almost all IEC frame motors
- Selection of mounting screws, washer and Allen keys

NOTE: TKGRs are not suitable for use in explosive atmospheres.

Benefits

- Helps prevent electrical discharge current damage in rolling bearings
- Protects both motor bearings and the bearings in attached equipment
- Designed to be maintenance free
- Improves system reliability
- Helps reduce motor repair costs and unplanned downtime
- Flexible 3 or 4 bracket mounting design fits virtually any IEC motor
- Easy to order the SKF TKGR. Selection is based on the motor “D” dimension, clears slinger or shaft shoulder

Seals – SKF SPEEDI-SLEEVE

SKF SPEEDI-SLEEVE

SKF SPEEDI-SLEEVE is a well-proven solution used to provide an excellent sealing surface for radial shaft seals while reducing the need for costly shaft machining or maintenance. Its surface properties result in a better counterface than can often be achieved on a shaft. SKF SPEEDI-SLEEVE can be fitted virtually anywhere there is a radial shaft seal.

The new generation of SKF SPEEDI-SLEEVE further enhances the sealing system's performance by reducing the wear on both the sleeve and sealing lip.

Features

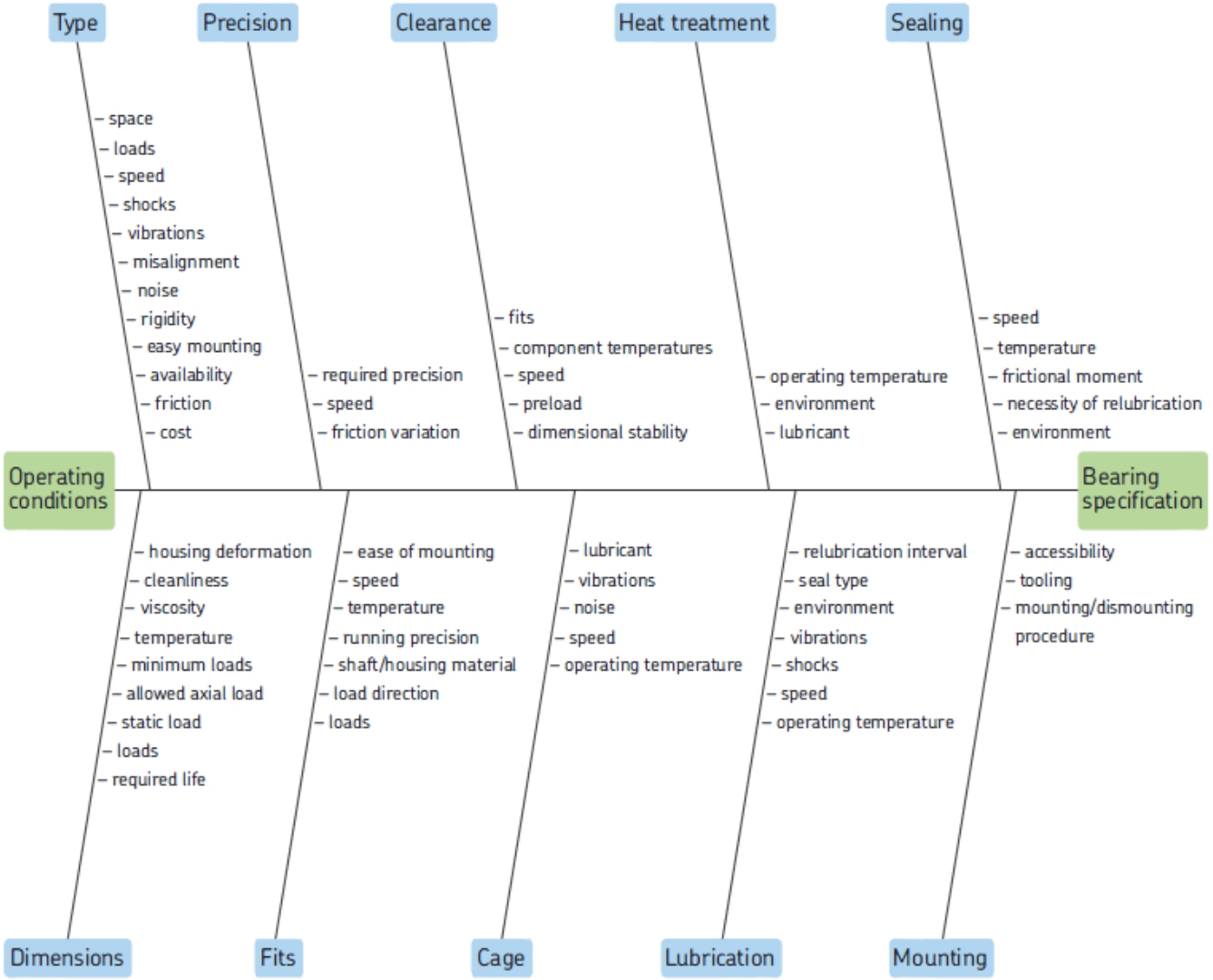
- Proprietary stainless steel material and manufacturing processes for increased strength and excellent ductile properties of the sleeve.
- Imperceptible lubricant pockets enable the lubricant to reside on the sleeve and thereby prevent dry running of the sealing lip.
- Wear resistant seal contact surface manufactured to minimize directionality (0° ±0,05) with a finish of Ra 0,25 to 0,5 µm *(10 to 20 µin.)*.
- Removable flange for simplified installation.
- Thinwalled design [0,28 mm *(0.011in.)*] allows the original size to be used for the replacement seal.

Benefits

SKF SPEEDI-SLEEVE offers enhanced sealing system performance and benefits for both OEM and aftermarket customers, helping to achieve the following:

- Higher productivity
- Reduced warranty claims
- Increased mean time between failures
- Reduced maintenance and repair costs
- Reduced environmental impact

Potential root causes for bearing failures



Root Cause Failure Analysis – First Steps

ISO classification of bearing damage and failure modes

SKF | Certified Rebuilder Electric Motors

The ISO 15243 standard is based primarily on features that are visible on the rolling elements, raceways and other functional surfaces.

Causes of pre-operational damage:
- Incorrect shaft and housing fits
- Defective bearing seats on shafts and in housings
- Static misalignment
- Faulty mounting practices
- Passage of electric current through the bearing (excessive voltage)
- Transportation, handling and storage

Causes of operational damage:
- Material fatigue
- Ineffective lubrication
- Ineffective sealing
- Vibration (false brinelling)
- Operational misalignment
- Passage of electric current through the bearing (current leakage)

For more information on bearings damage, refer to the chapter "Bearing damage and their causes" on the SKF bearing maintenance handbook.

This poster is provided as a courtesy of:

Relationships of characteristics and causes of damage on bearings

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Failure modes with characteristics			Possible causes: Operating					Environmental factor				Lubrication					Mounting						Other					
			Overload	Overspeed	Excessive freq. of loads/speed changes	Vibrations	Shaft/housing deflection	Temperature too high/low	Dust and dirt ingress	Water ingress	Electrical leakage	Wrong viscosity	(Consistency) additives selection	Lack of lubricant	Excess of lubricant	Impurities	Incorrect handling (shock loads)	Mounting procedures	Fit too tight	Fit too loose	Tilting/misalignment	Incorrect setting	Incorrect locating (clamping)	Storage	Transportation (vibrations/shock)	Bearing selection	Equipment design	Manufacturing concerns	Material concerns
Fatigue		Flaking, spalling, peeling	×				×	×			×	×	×	×			×	×	×		×	×			×	×	×	×	×
		Burnishing, micro cracks		×	×	×		×	×	×	×	×	×	×	×	×		×				×		×		×	×		×
Wear	Abrasive	Excessive wear		×	×	×	×	×	×	×	×	×	×	×		×			×	×	×	×	×			×			×
		Scratches, scores		×	×				×				×			×	×	×							×				
	Adhesive	Soiling marks, smearing	×			×		×				×	×	×	×				×	×	×						×	×	×
		Hot runners	×	×	×		×	×				×	×	×	×				×	×		×	×				×	×	×
Corrosion		Moisture corrosion								×			×		×			×						×	×		×		
		Frotting corrosion	×		×	×	×														×	×	×				×	×	×
		False brinelling			×	×							×								×			×	×	×			
Electrical		Craters, fluting									×																×		
Plastic deformation		Depressions	×				×	×							×		×	×	×		×	×	×	×	×	×		×	
		Debris indentation							×							×	×	×									×	×	
		Nicks, gouges															×	×									×		
Fracture and cracking		Forced fracture	×	×				×									×	×	×		×	×	×				×	×	×
		Fatigue fracture	×	×	×	×	×														×	×	×				×	×	×
		Thermal cracking	×	×	×			×				×		×	×			×	×			×					×		×

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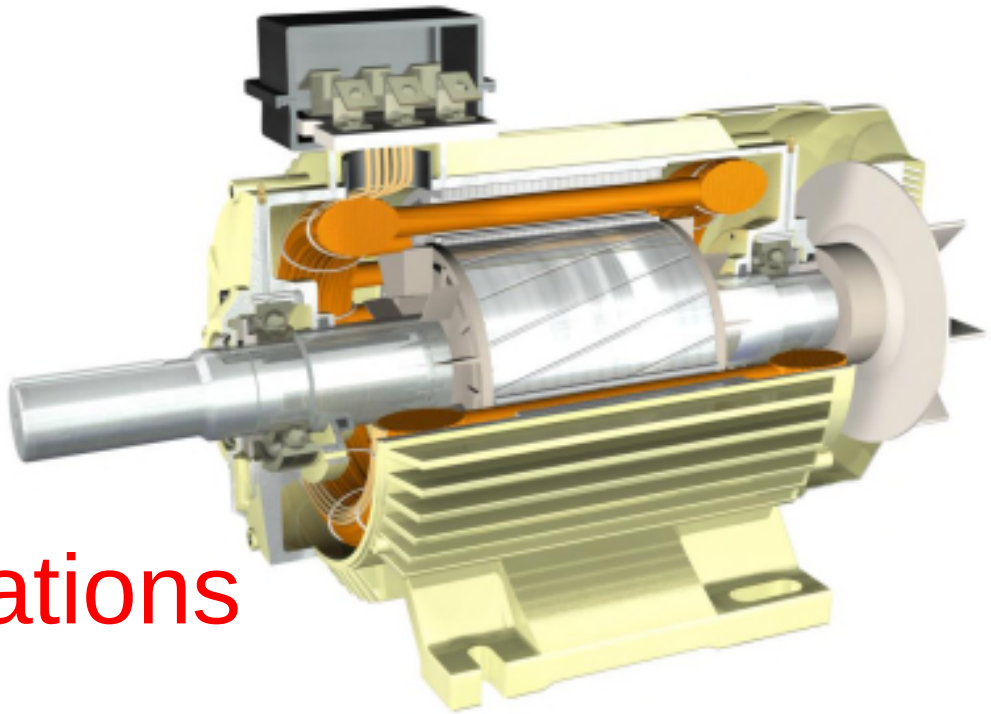


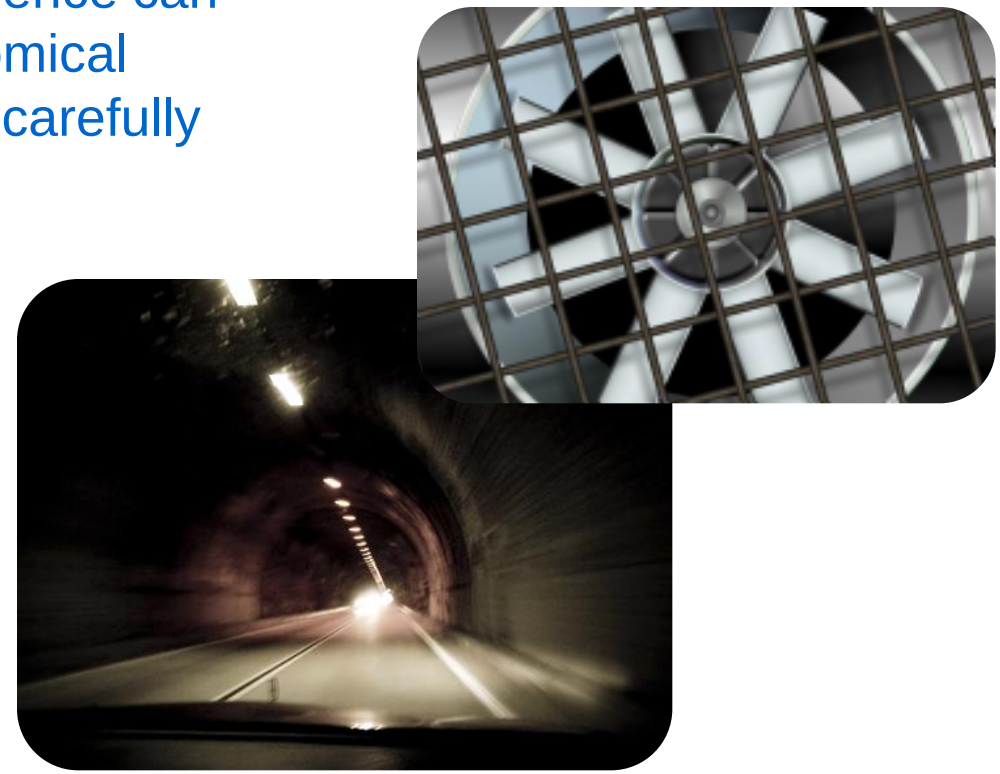
Special applications

Motors for smoke extraction fans

There is no “one size fits all” for the various requirements and specifications for emergency fans.

SKF knowledge and experience can help you develop an economical solution for your design by carefully selecting the bearings’:

- Materials
- Heat treatment
- Cage
- Sealing system
- Lubricant and
- Tolerances

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