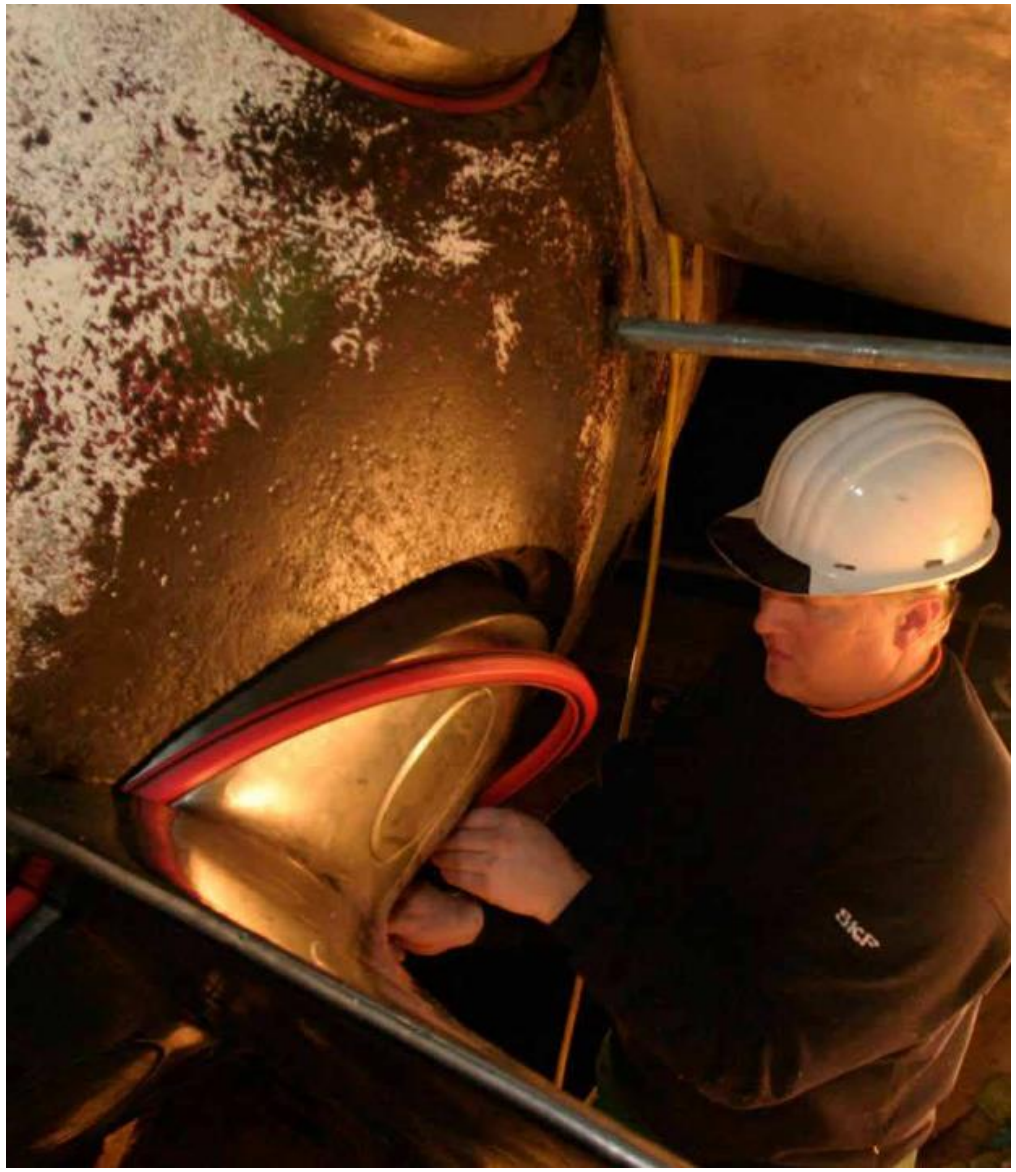
SKF Industrial Seals

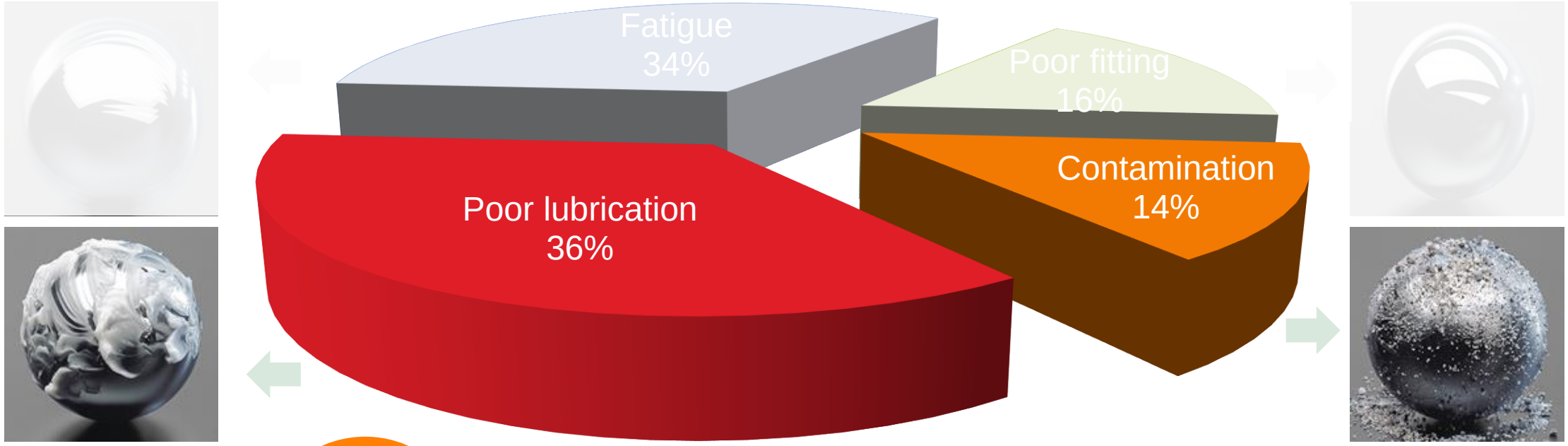
Presented by Philip Ochman
28.03.2019

Content

- Introduction to SKF Industrial Seals
- Our seals offering
- Our capabilities
- SKF – Customized machined seals
- Case study: Mining and Cement
- Case study: Machine tooling



Did you know? – Reasons for premature bearing failure



50%
SEALS

of all bearing failures connected to sealing issues

➔ keep lubricant IN and contaminant OUT

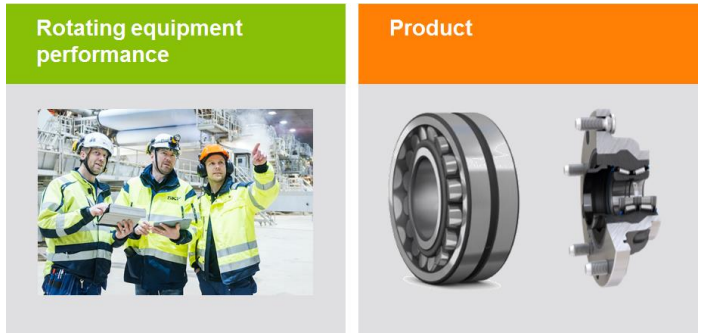
➔ Reliable sealing solutions essential for bearing/system performance

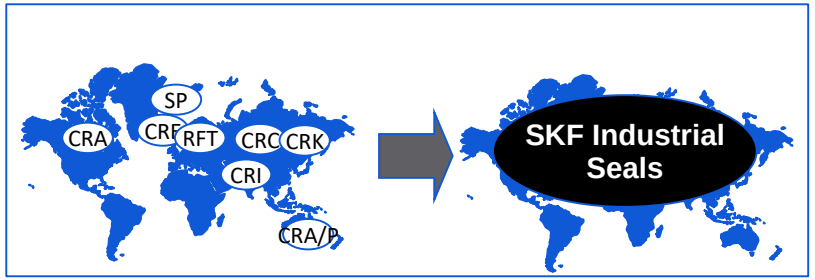
Introduction to SKF Industrial Seals

1

Seals is a “key” platform for SKF

- SKF is committed to the seals business – “One to a Million”
- Many seals companies acquired
  - Plastics and machining technology
  - Reciprocating industrial seals
- Transitioned to one global organization
  - Reflect a common global standard and commitment
- Global seals business
  - Operations in major industrial regions
  - Presence across industry segments





Global SKF seals sites

SKF expanded its global footprint, covering the major regional markets and is also present in best cost countries.

Wide range of industries and applications

Automotive

Industrial

Bearing

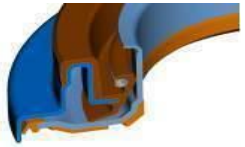
Wide SKF product range for every industry

Automotive

Engine seals

Transmission seals

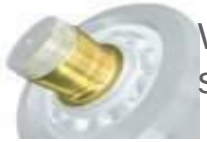
Suspension seals



Wheel seals

Industrial

Radial and axial shaft seals



Wear sleeves

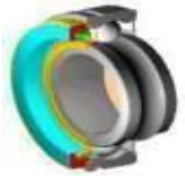
Hydraulic seals

Static seals

Customized machined seals

Bearing

Integrated compact oil sealed unit



Sensor-bearing unit

Washing machine drum bearing unit

R-Safe seal (with tone wheel)

Wide SKF product range for every industry

Cool example:

Our seals offering

2

Our approaches to seals manufacturing

A. SKF Standard Catalogue Seals


- Industrial Shaft Seals
- Hydraulic Seals
- SKF Material

WCL

B. SKF Machined Seals Standard Profiles


- > 170 standard profiles in non-standard sizes and material options
- Prompt manufacturing in local MS location / Solution Factory

EcoCalc DD*

*Seals exceeding the capabilities of SJ DD

C. SKF Customized Seals / Engineered Solutions

Seal design proposal → SKF SEAL JET prototyping → Customer testing field use → Serial production

Seal optimization

Machining | Moulding

M2M Concept

Request for engineered solutions and SKF expertise

SKF Distributors

SKF Authorized Distributors & Specialized Seals Distributors

D. SKF SEAL JET DD

"Low demand, small diameter"

- Increase service offer
- Focus & customer proximity
- Speed & availability
- Door opener for SKF standard assortment

Industrial Market

We will discuss…

Radial shaft seals
- Oil seals
- PTFE Seals
- Heavy industrial seals (HIS)
- Cassette seals

Wear sleeves
- Large diameter sleeves
- SKF SPEEDI-SLEEVES

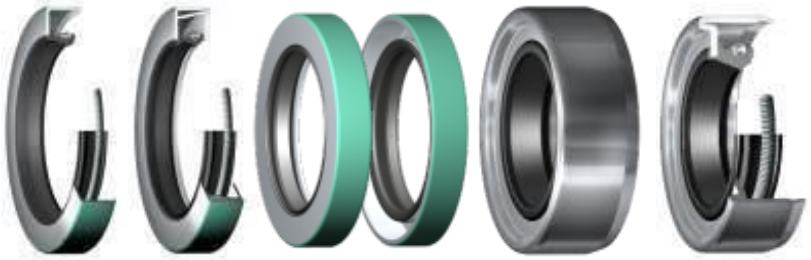
Hydraulic seals
- Piston seals
- Rod seals
- Wipers
- Guide rings

Axial Shaft Seals
- V-rings
- Metal clad V-rings
- Axial clamp seals
- Mechanical seals

Static seals
- O-rings
- Back-up rings

Industrial – Radial shaft seals

WAVE seal type radial shaft seals



Used in general industrial applications with shaft diameters up to 200 mm or 8 inches

Rubber OD metric line

Large diameter shaft seals- optional split

SBF
Metal-reinforced

HSF1
Fabric-reinforced

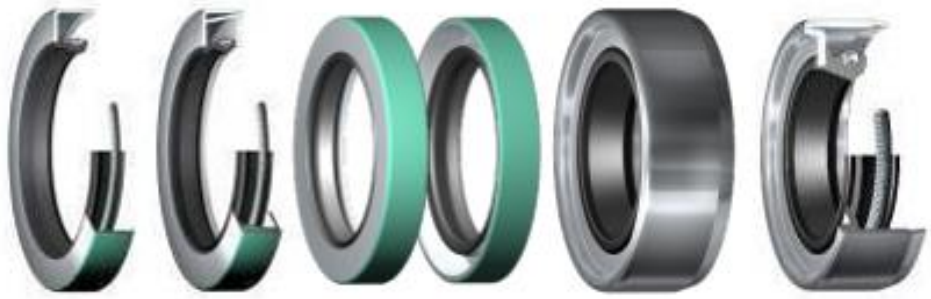
HS8
All-rubber

Cassette seals for oil applications

Robust design able to seal external agriculture environment

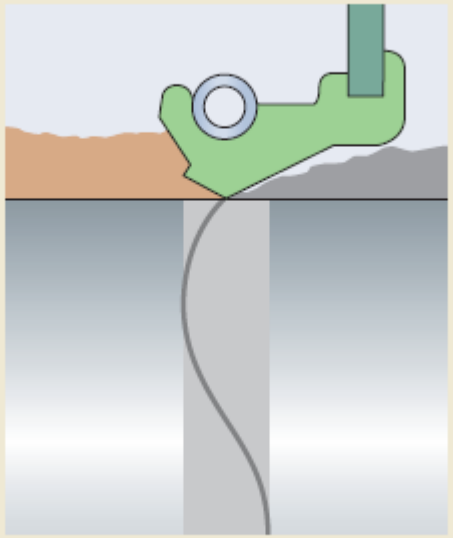
Industrial – Radial shaft seals

WAVE seal type radial shaft seals

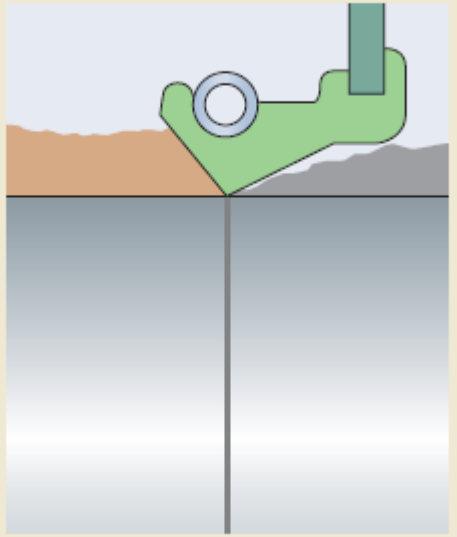


Used in general industrial applications with shaft diameters up to 200 mm or 8 inches

SKF Wave sealing lip with sinusoidal sealing lip edge



Conventional sealing lip with straight edge



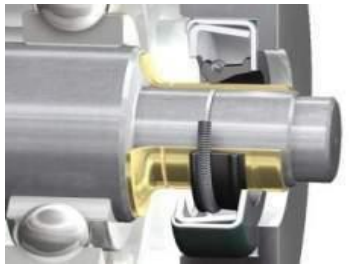
Industrial – Axial shaft seals

V-rings

	VA	VS	VL	VE	VRME
North America:	VR1	VR2	VR3	VR4	VR6

Industrial – Wear sleeves

- SKF Speedi-Sleeves
  - Super hardened surface providing protection against corrosion and abrasion
  - Very thin-walled wear sleeves, allowing same size of seal as the original
  - SKF Speedi-Sleeve for normal operating conditions, SKF Speedi-Sleeve Gold for harsh operating conditions
  - No expensive machining or preparation required before mounting
  - Bridges the gap between a standard sleeve and an expensive custom shaft treatment
  - Available for shaft diameters ranging from 12 up to 200 mm resp. 8 inches



Heavy industrial seals – Large diameter

Metal outer diameter seals

All rubber seals

High performance machined seals

Salt mine

Cement rotary kiln

Hot strip finishing line

Vibrating screens

Heavy industrial seals – Large diameter

Power transmission – large diameter radial shaft seals

Metal-cased
HDS 1,2

HSS SKF DURATEMP
All rubber-reinforced;
HSS 4,5 SOLID
HSS8 SPLIT

All-rubber
HS 4,5 SOLID
HS 8 SPLIT

Machined G-ECOPUR
”high performance
solutions”

HSS reinforced all-rubber seals

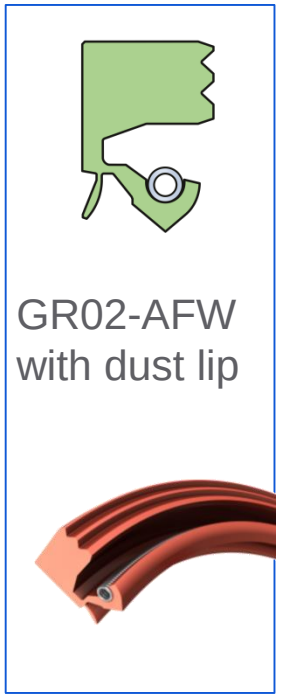
Featuring a new improved reinforcement concept.
Seal body reinforced by a harder grade of
SKF Duratemp, providing strong, but yet smooth and elastic properties.

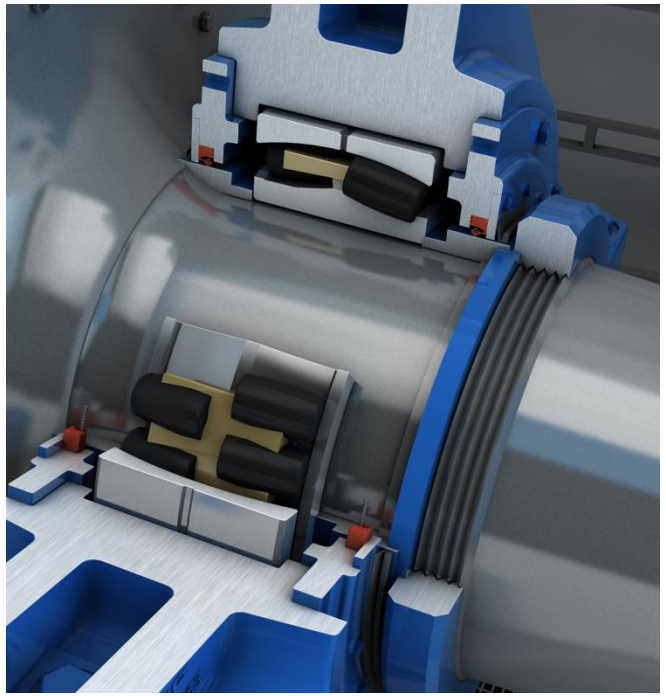
- Benefits
  - No risk of humidity related dimensional changes
  - Compensates for potential imperfections in the housing bore for improved static sealing performance (no bypass leakage)
- New preferred standard solution material
  - SKF Duratemp (HNBR)
  - Wide temperature range (-40 ºC to +150 ºC)
  - Resistant to ozone, UV light and sea water
  - Excellent ageing and wear resistance

Reinforced seal body

G-ECOPUR high performance solutions

With superior abrasion resistance – SOLID and SPLIT versions





Our capabilities

3

Seals manufacturing technology

Compression moulding

Injection moulding

Machining
SKF SEAL JET

“One to a Million” – From machined to moulded seals

Why both – machined and moulded seals?

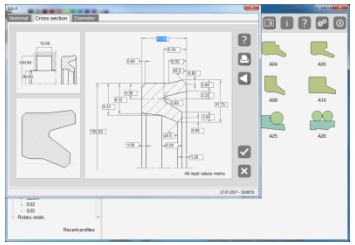
- Flexible production to ensure customer satisfaction across the product life circle
- Infinite size range, even up to 14 000 mm in diameter and larger
- From prototype to serial production
- Customized and standard stocked seals

1. Machined seals

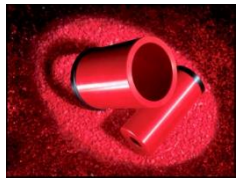
2. Moulded seals

Industrial Market

SKF SEAL JET system – Machined Seals



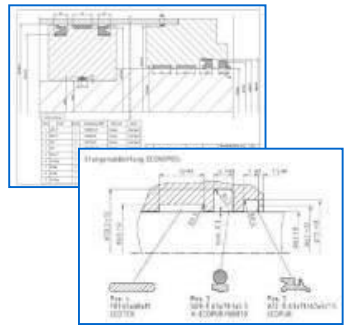
Software
Extensive range of seal profiles and additional features



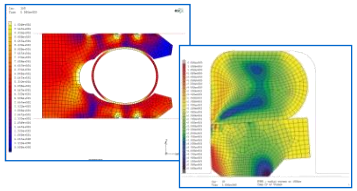
Materials
Top quality materials standard and custom made

Tools
Specialized machining tools

Application Engineering
Technical advise, special solutions



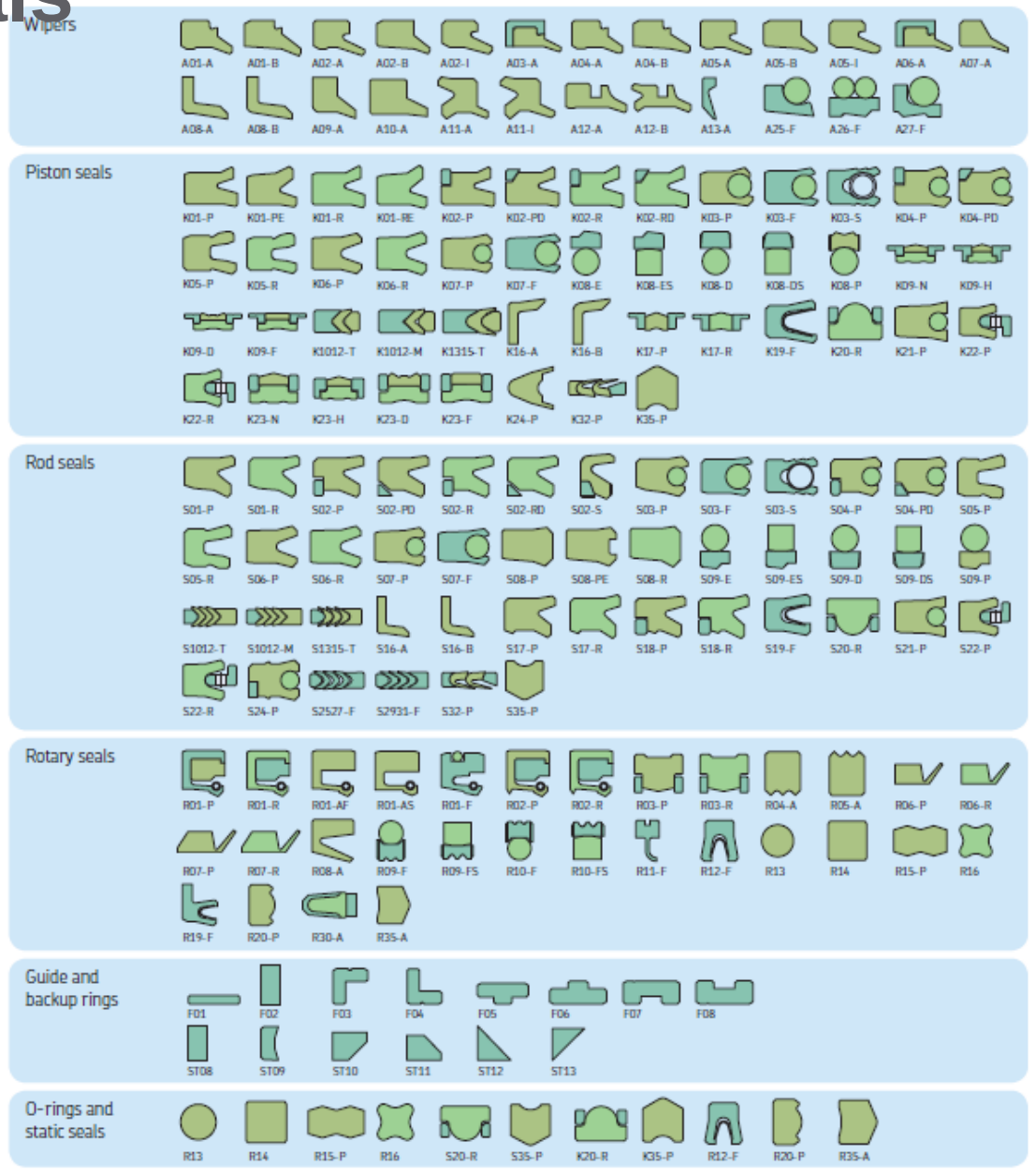
Research and Development
Seals and Materials



Technical and marketing literature
Product range, Industry surveys, etc

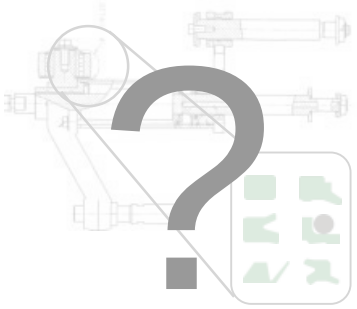
SKF customized machined seals

- Complete range of standard profiles
- Any profile in any material
- Any size from 2 mm to 4 000 mm in one piece and larger using a special welding technique
- Special and standard seals
- From prototype to serial production, using machining and injection moulding techniques
- Additionally, a wide range of moulded standard seals is available

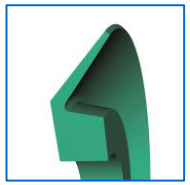


From prototype to serial production

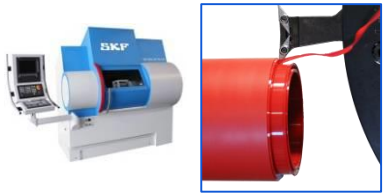
Customer request



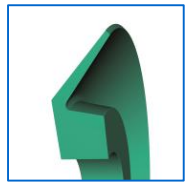
Seal design



Prototyping



On-site testing



Modification

Testing

Serial production

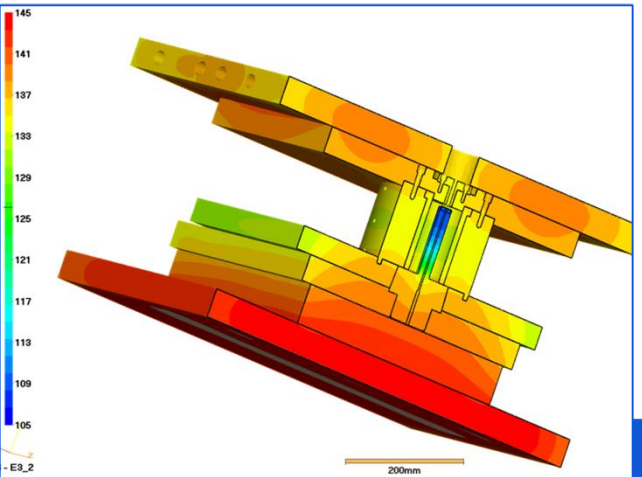
Machining
small to medium
quantities (rod feeder)

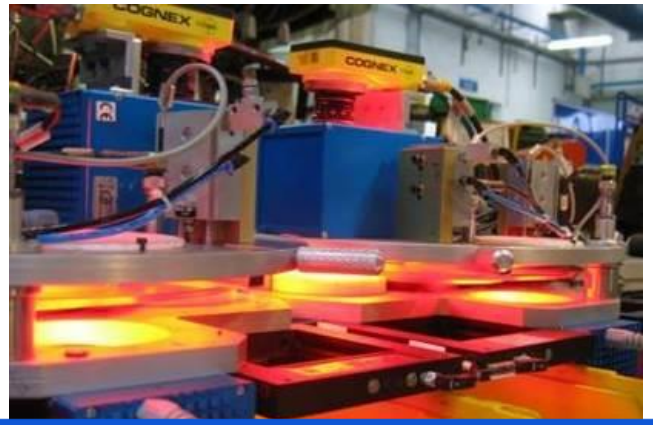
Moulding
medium to large quantities

Satisfied customer

Strong process development capability

- In-house capability to design & develop new processes
- Manufacturing equipment
- Automated processes development
- Visual inspection systems
- Encoders magnetization & control
- Mounting tools development





Material development capabilities

- Development of polymeric materials (elastomers and plastics)
- Application specific compound formulation
- Optimization of the use of materials (including adhesives, metals and phosphating techniques)
- In-house testing equipment for chemical, physical, rheological, low temperature, ageing (air, oils, fluids), corrosion analysis and laboratory mixing room, etc.
- Magnetization development


Elastomers


Polyurethanes


PTFEs

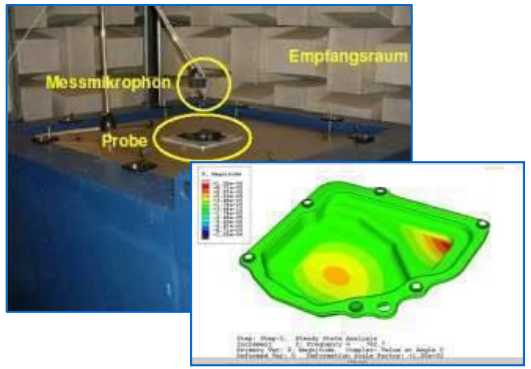
Products and applications testing

Wear test rig

Bench life test for axles

Mud and slurry tests

Structural and acoustical testing

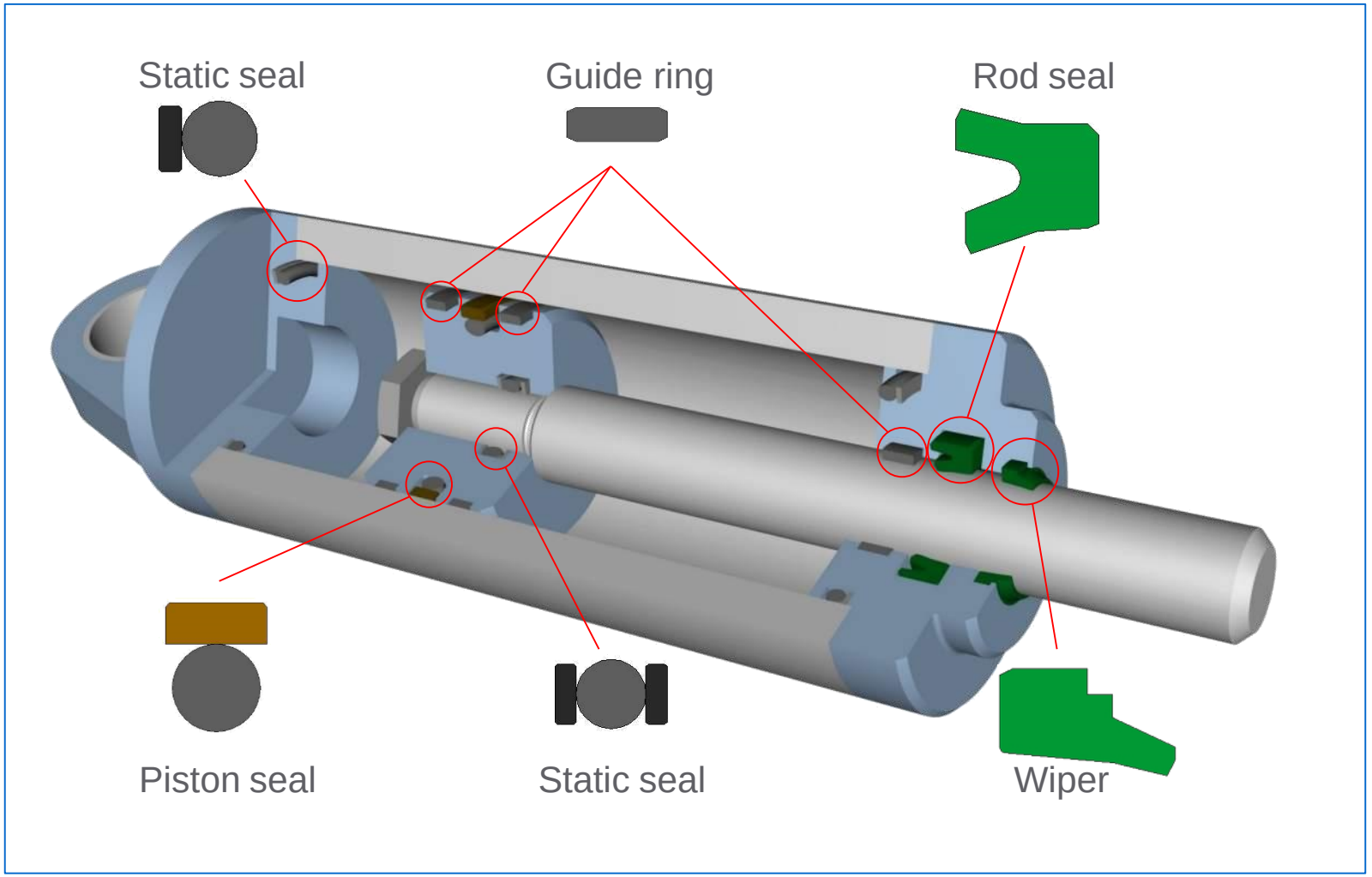


- Dedicated seals testing facilities in USA, Europe and Asia
- Extensive and comprehensive test history database
- Test design and fabrication services
- Tests according to customers' specifications

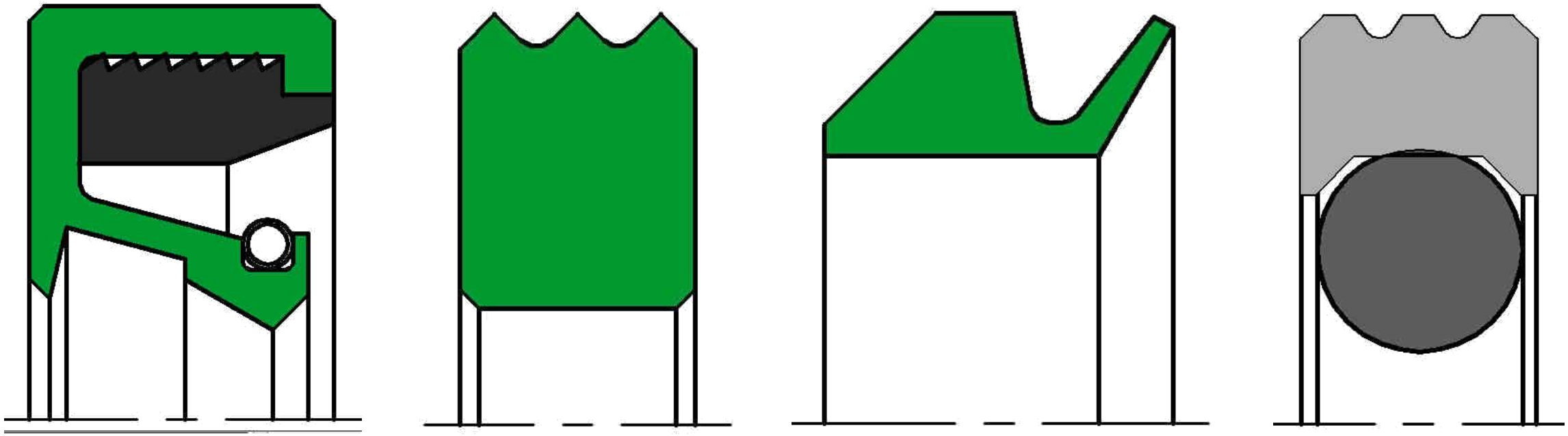
SKF – Customized machined seals

4

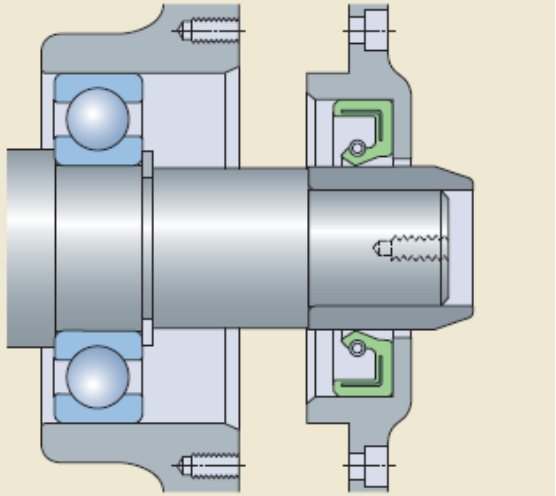
Seals for reciprocating movement



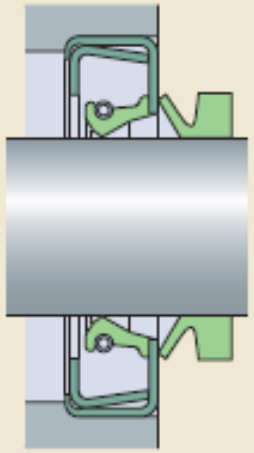
Seals for rotating movement



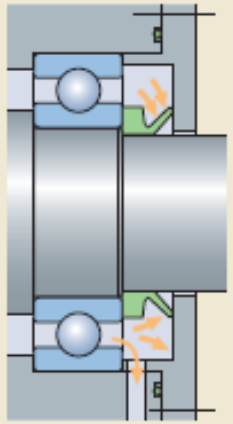
Seals for rotating movement



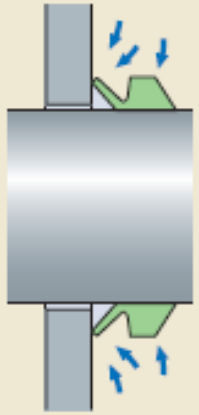
V-ring used as a secondary seal



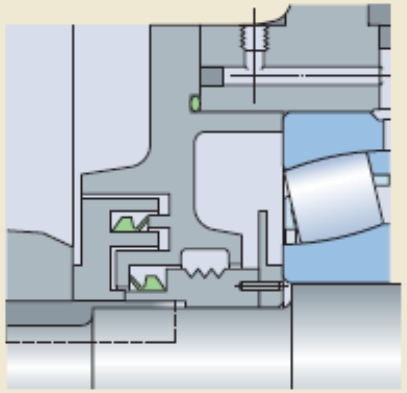
V-ring located axially



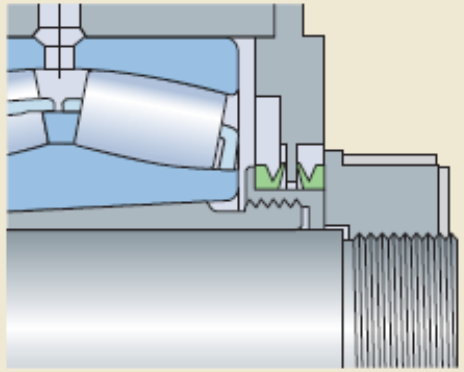
V-ring used as an excluder



V-rings in a labyrinth seal



Two opposing V-rings



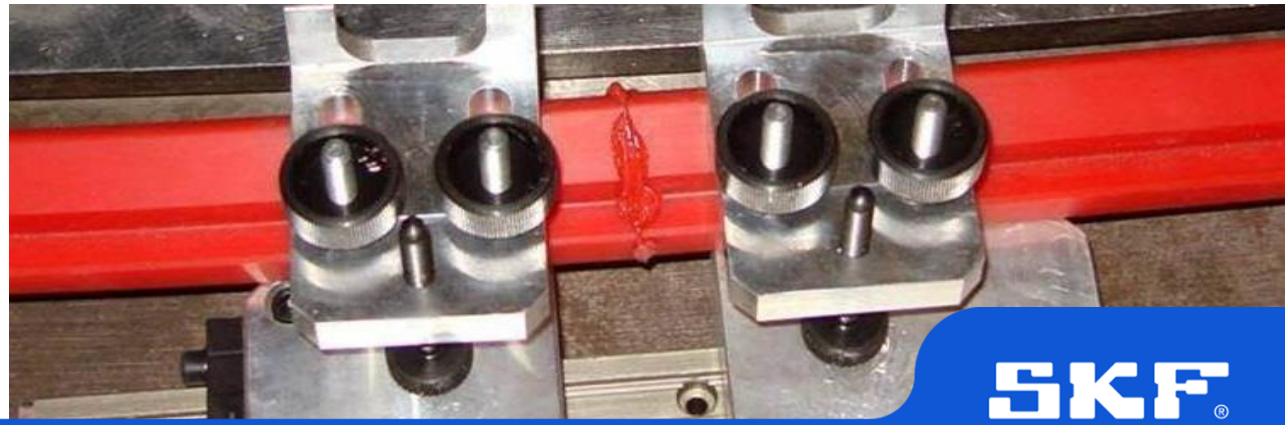
V-ring used as a grease valve



Size range of SKF Industrial Seals

- Ø 2,2 mm: seals for tooth implants, beer tenders or valves
- Ø 14 000 mm and above: seals for hydro power plants – welded

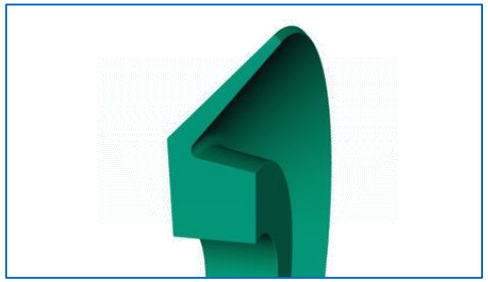




SKF machined seals – The flexible concept

Standard seals

- Seals in standard dimensions
- Machined or injection moulded
- Extensive range of materials
- On-time availability



Customized seals

- Standard seal profiles modified to specific requirements
- Virtually unlimited dimensions
- Extensive range of materials
- On-time availability (approx. 24 hours)

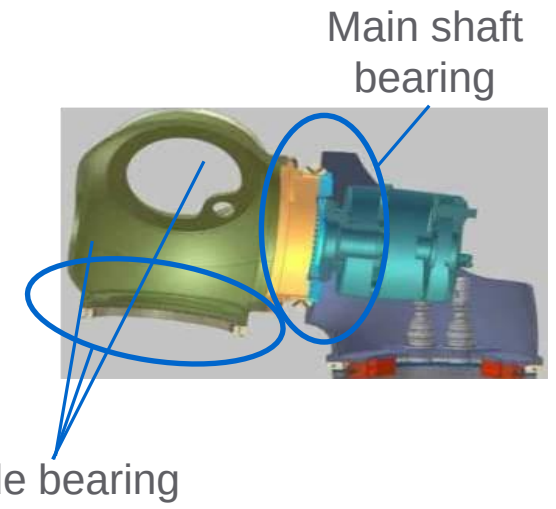
Custom engineered sealing solutions

- Application engineering service
- Customer related designed sealing solutions
- Virtually unlimited dimensions and profiles
- Extensive range of materials
- Short delivery time

SKF machined seals and AEPP solutions, wind power

Large diameter seals for SKF bearings and split rotary seals

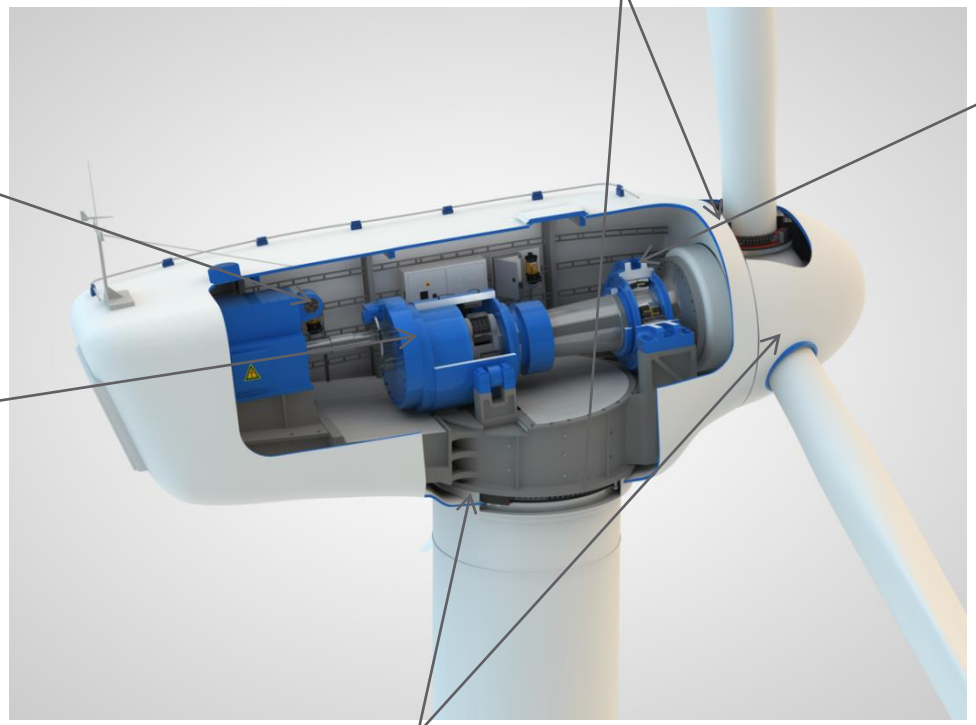
- Current projects for main shaft and blade bearing seals
- Replacement of standard NBR (H-NBR) solutions using special polyurethane seals
- Advantages of polyurethane: wear resistance, friction torque, ozone and UV stability
- Thermal, physical and mechanical properties of polyurethane promote new solutions
- Machined seals for a diverse range of profiles
- Serial production
- Seal replacement on-site (special welding technique)
- Easy installation – no need to dismantle the shaft
- Considerably reduced downtimes
- Reduction of maintenance costs



SKF sealing solutions offers for all applications in wind turbines

Pitch and yaw slewing bearings

Rotor brake (hydraulic)



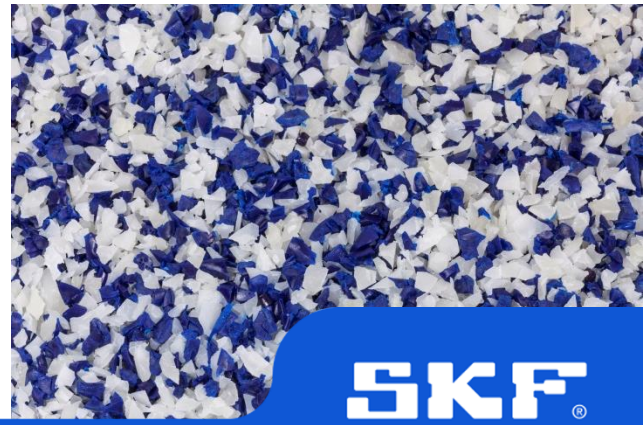
Main shaft

Gearbox

Pitch and yaw drives

Sealing materials – Granules

- Synthesis of high performance thermoplastic polyurethanes with increased sealing and tribological properties
- Production of thermoplastic polyurethanes and cast systems
- 8 standard grades, many special grades in various degrees of hardness
- Supply of granulate, processing of seals and semi-finished material up to 4 000 mm in diameter



Sealing materials – Semi-finished tubes

- Production of semi-finished tubes (more than 20 standard materials and more than 50 special grades)
- Thermoplastic polyurethanes up to a diameter of 610 mm (4 000 mm)
- Standard elastomers (NBR, EPDM, silicone, etc.) and high performance elastomers (H-NBR, FKM, TFE/P, etc.) up to a diameter of 1 600 mm
- Technical thermoplastics (PA, POM, etc.), high performance plastics (PEEK, etc.) and special compounds up to a diameter of 420 mm
- Production of PTFE and special compounds up to a diameter of 2 000 mm

SKF machined seals materials

- Polyurethanes
  - ECOPUR — Standard, general purpose
  - H-ECOPUR — High-performance, hydrolysis resistant, FDA approved
  - G-ECOPUR — Special grade for large diameter; 600 – 4 000 mm
  - S-ECOPUR — Self-lubricating, low friction
  - T-ECOPUR — Low-temperature performance
  - X-ECOPUR — High performance grades
- Elastomers
  - SKF Ecorubber-1 — NBR, general purpose
  - SKF Ecorubber-H — H-NBR, high temperature
  - SKF Ecorubber-2 — FKM, high temperature applications
  - SKF Ecorubber-3 — EPDM, hot water and steam resistant
  - SKF Ecosil — MVQ, extreme temperature resistance
- Thermoplastics
  - SKF Ecotal — POM, general purpose plastic
  - SKF Ecomid — Polyamide, general purpose plastic
  - SKF Ecoflon — PTFE virgin, plus 36 special compounds
  - SKF Ecopaek — PEEK, high-performance thermoplastic for extreme temperatures

Polyurethanes offers outstanding mechanical properties, low compression set, best abrasion resistance and highest strength of the elastomeric sealing materials.

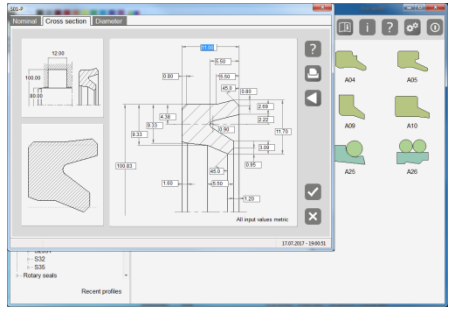
Elastomers or rubbers are the most frequently used materials for seals and gaskets in low to medium pressure applications with good chemical resistance.

Where elastomers do not provide sufficient chemical or temperature resistance, top performance SKF Ecoflon (PTFE) compound materials with high chemical and temperature resistance are suitable.

Sealing materials – Diameter spectrum

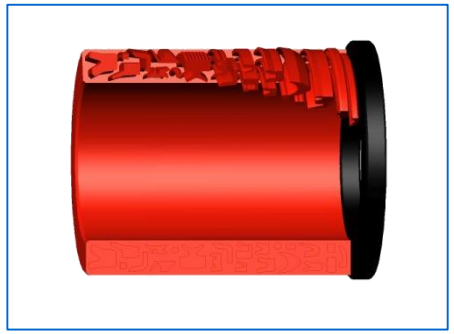
Standard materials	**max. Ø** [mm]
G-ECOPUR	4 000
SKF Ecorubber types	1 500
SKF Ecoflon types	1 500
SKF Ecomid	2 000
SKF Ecowear	990
SKF Ecotex	3 000
SKF Ecoflas	1 500

“Customized machined seals”



“Customized” – to optimize the speed:
SKF engineers adjust the seals locally to fit the customers’ special requirements

“Machined” – SKF’s core production technology, the unique SKF SEAL JET machine system enables fast local seal production with almost any polymeric sealing material



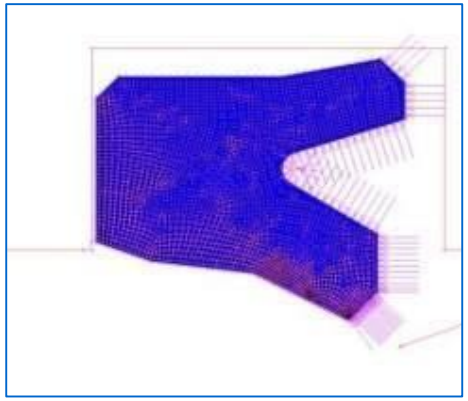
“Seals” – SKF offers “solutions by customizing the seals”, not just “customized sealing solutions”

Finite Element Analysis – FEA

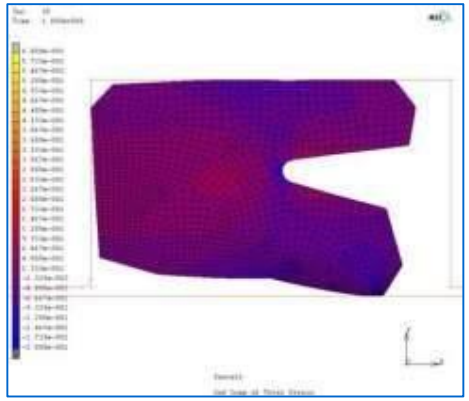
Calculation example

Deformation under pressure

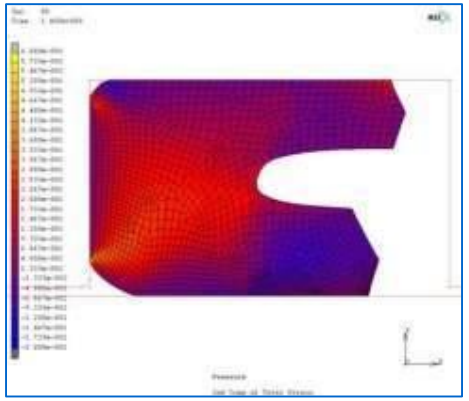
Profile:	S01-P
Material:	H-ECOPUR
Pressure:	0 – 250 bar
Temp.:	20 °C
Speed:	0,1 m/s



Original



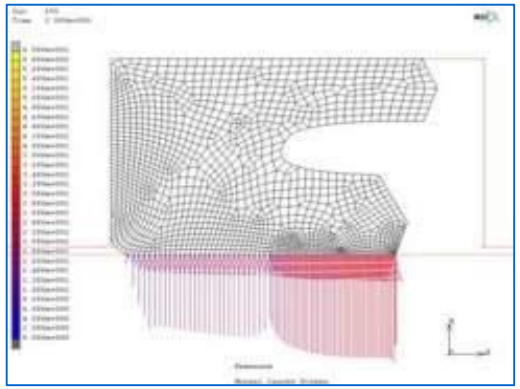
Installed, 0 bar

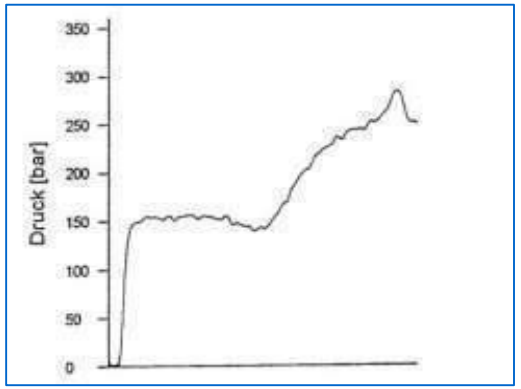


Installed, 250 bar

Finite Element Analysis – FEA

Calculation vs. test rig investigation Contact pressure

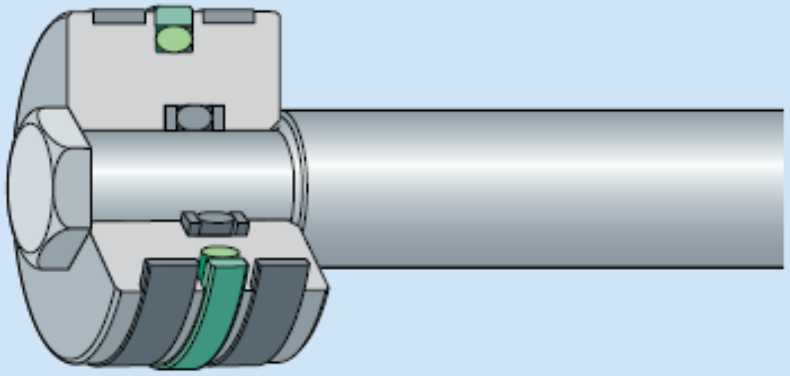


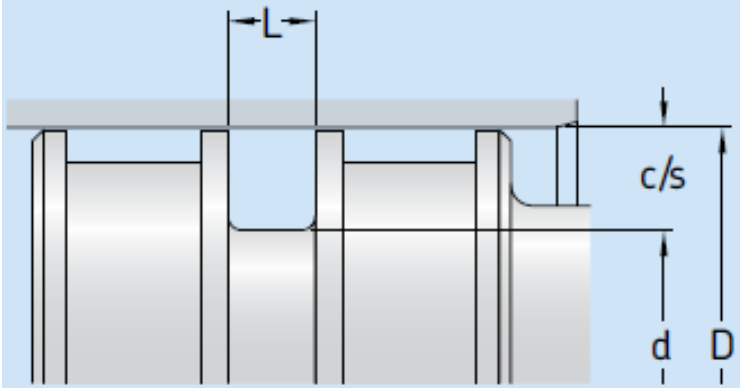


Profile:	S01-P
Material:	H-ECOPUR
Pressure:	0 – 250 bar
Temp.:	20 °C
Speed:	0,1 m/s

Seals test rig

Piston seals applications





K08-D K08-P K08-E

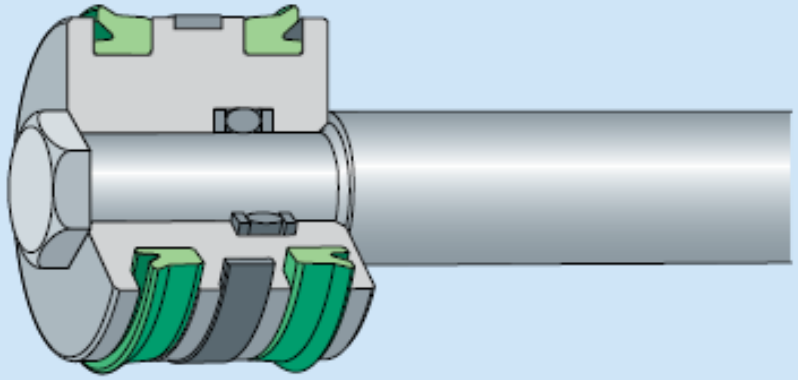
Main function
Single/double-acting piston seals, o-ring activated PTFE (TPU) seals.

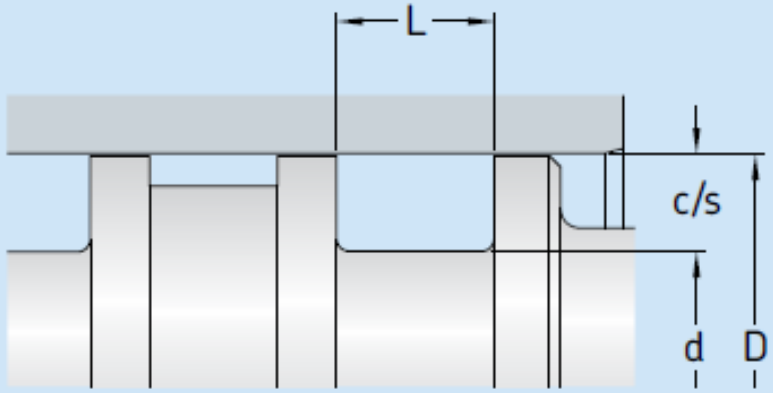
Main applications
Standard cylinders for positioning functions, mobile hydraulics, etc.

Advantages
Low friction, no stick-slip, excellent resistance against pressure shocks.

Standard materials
SKF Ecoflon/NBR
SKF Ecoflon/FKM
X-ECOPUR/NBR.

Piston seals applications





K01 K02 K03 K04

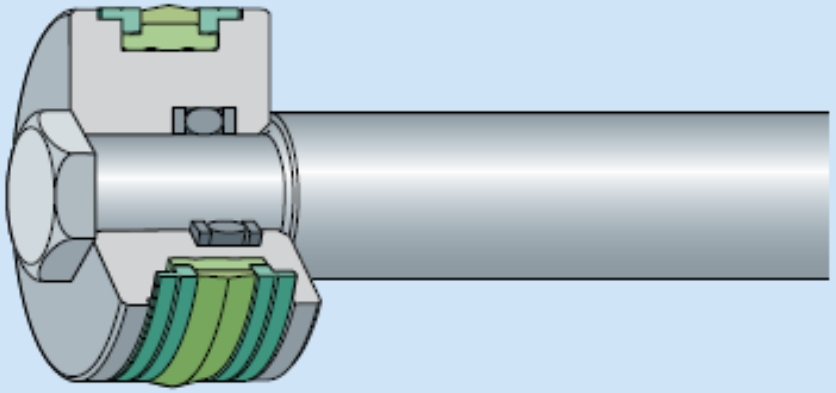
Main function
Single-acting piston seals lip type (U-cup) seals compact seals.

Main applications
Support and retaining cylinders, standard cylinders.

Advantages
Stable fit in the housing, ultimate sealing effect, wide temperature range.

Standard materials
ECOPUR, SKF Ecorubber (all types).

Piston seals applications

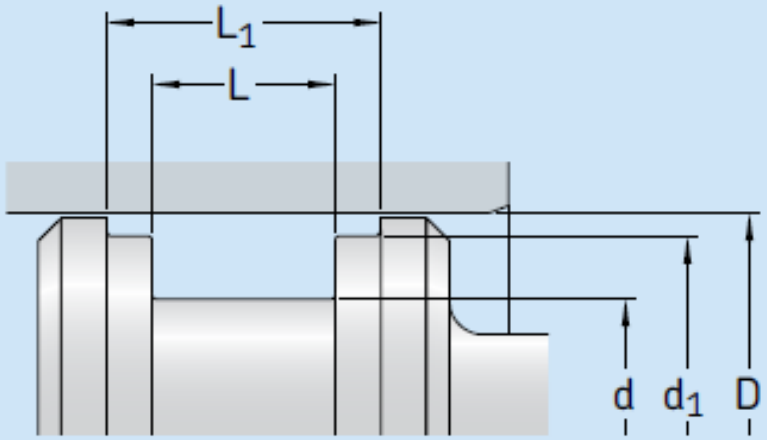


K09-H
Main function
Double-acting piston seal, compact type.

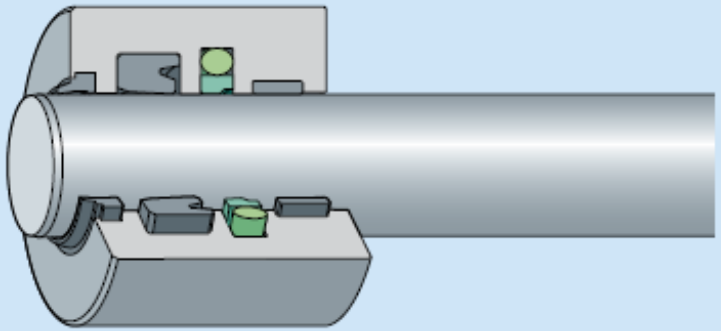
Main applications
Support and retaining cylinders, standard cylinders.

Advantages
Excellent static and dynamic sealing capacity, integrated back-up rings.

Standard materials
ECOPUR / SKF Ecorubber / SKF Ecotal.



Rod seals applications

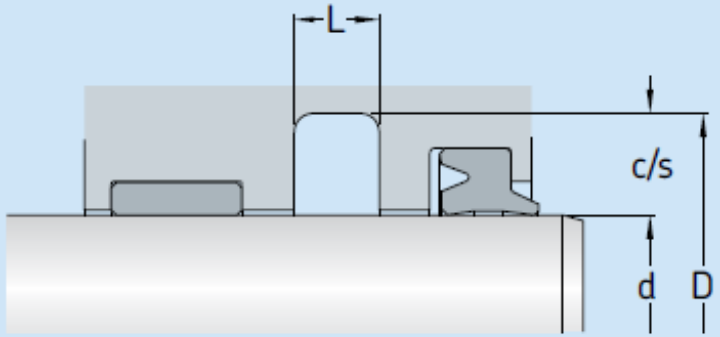


S09-E S09-P S09-D

Main function
Single/double-acting rod seals,
O-ring activated PTFE (TPU) seals.

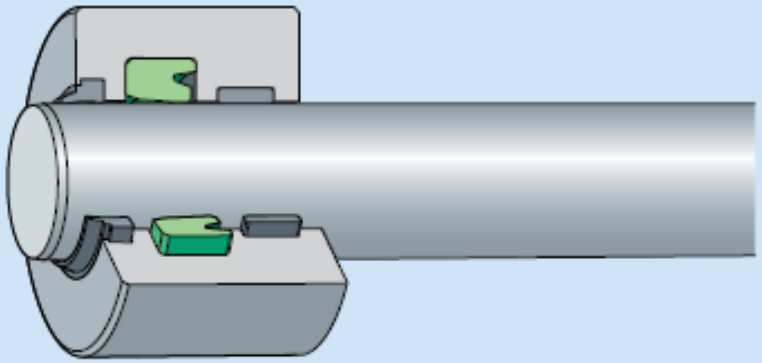
Main applications
Earth moving equipment,
heavy hydraulics.

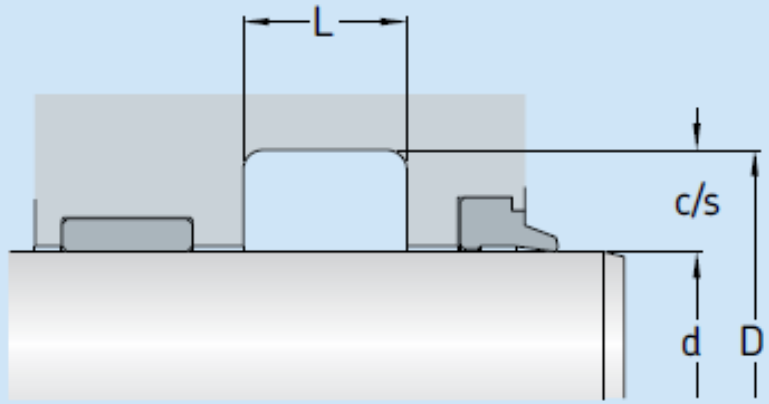
Advantages
Excellent resistance against pressure shocks, long lifetime.



Standard materials
SKF Ecoflon/NBR or SKF Ecoflon/FKM, X-ECOPUR/NBR.

Rod seals applications





S01 S02[1)] S03 S04[1)]

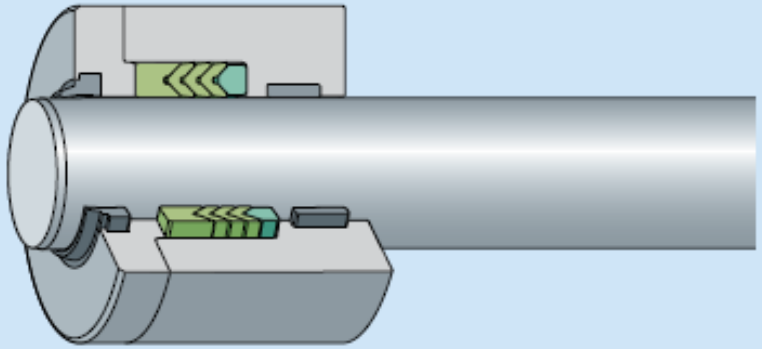
Main function
Single-acting rod seals
lip type (U-cup) seals
compact seals.

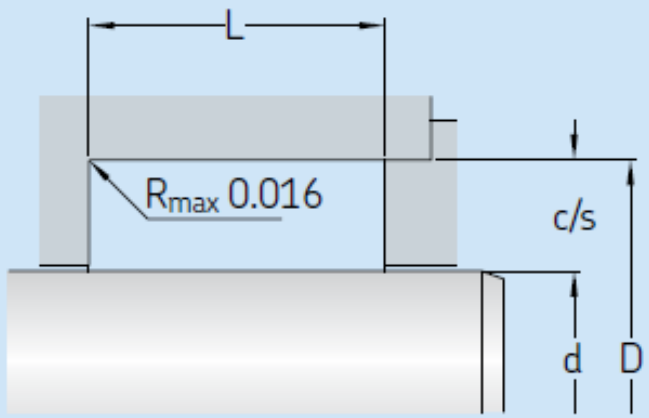
Main applications
Standard cylinders, light and standard hydraulic applications.

Advantages
Stable fit in the housing,
ultimate sealing effect,
wide temperature range,
good backpumping ability.

Standard materials
ECOPUR, SKF Ecorubber (all types)

Rod seals applications





S1012 S1315

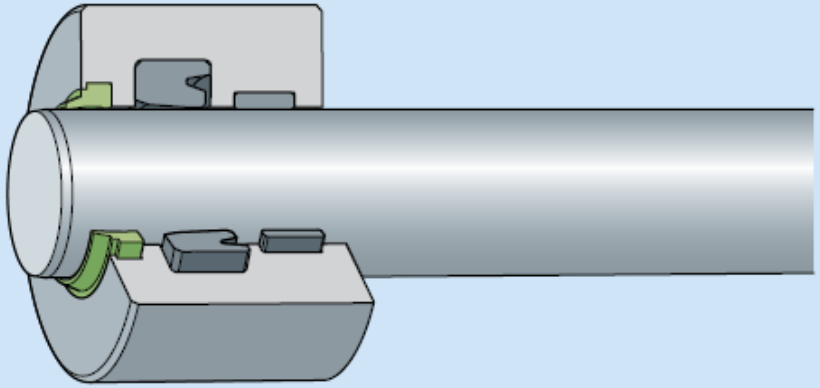
Main function
Single-acting rod seals, chevron packings.

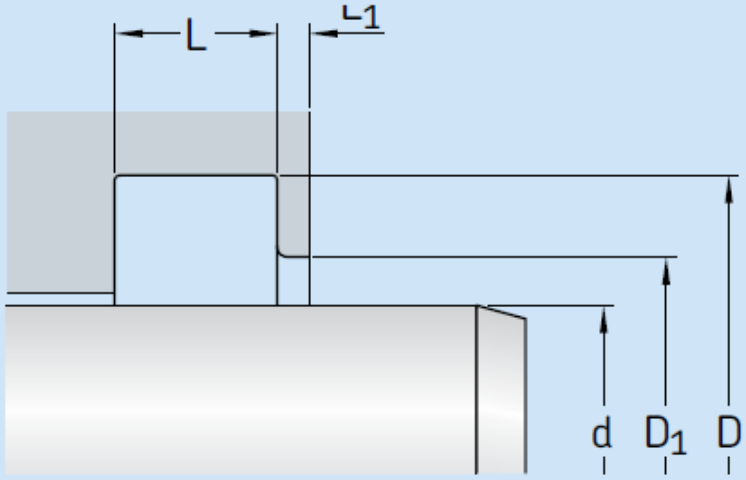
Main applications
Heavy industry hydraulics, presses.

Advantages
Suitable for old, worn rods, split version for easy installation available.

Standard materials
ECOPUR / SKF Ecotal.

Wiper seals applications





A01 A04

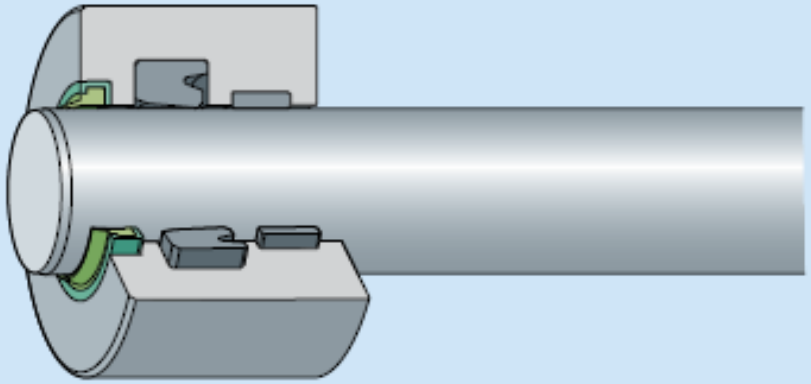
Main function
Single-acting wipers.

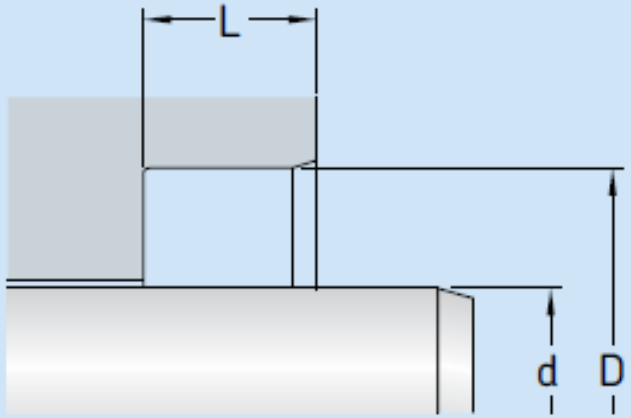
Main applications
Standard wiper for hydraulics.

Advantages
Easy installation (snap-in), excellent wear resistance, technically accurate closure.

Standard materials
ECOPUR (X-ECOPUR) / SKF Ecorubber.

Wiper seals applications





A03 A06

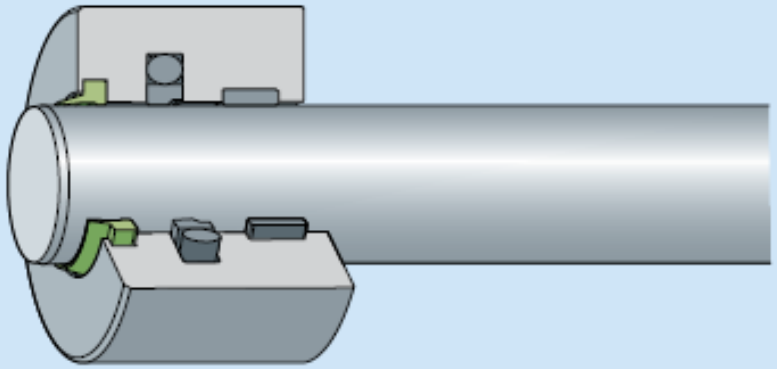
Main function
Single-acting wipers.

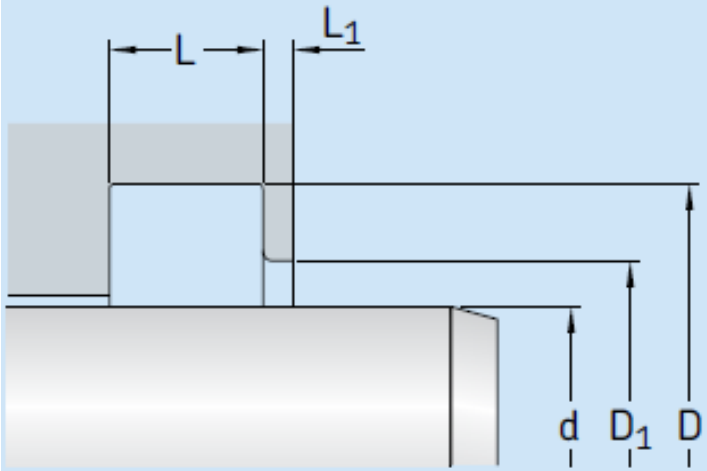
Main applications
Standard hydraulic applications, pressfit for axially open housings.

Advantages
Excellent wear resistance, plastic retainer ring, no oxidation problem between retainer and housing.

Standard materials
ECOPUR (X-ECOPUR) + SKF Ecotal / SKF Ecorubber + SKF Ecotal.

Wiper seals applications





A02 A05 A11

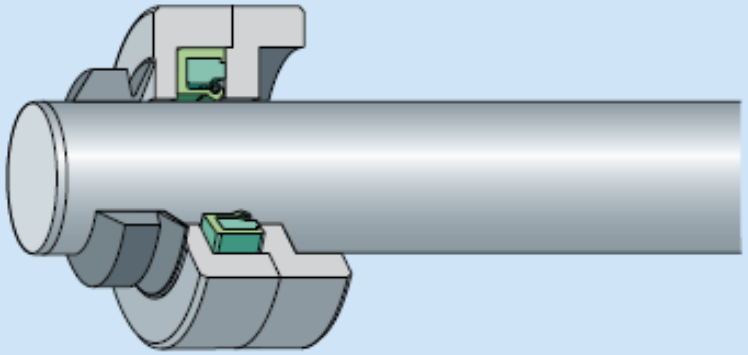
Main function
Single/double-acting wipers.

Main applications
In combination with O-ring activated PTFE rod seals (S09).

Advantages
Excellent wear resistance, double-acting function.

Standard materials
ECOPUR (X-ECOPUR) / SKF Ecorubber.

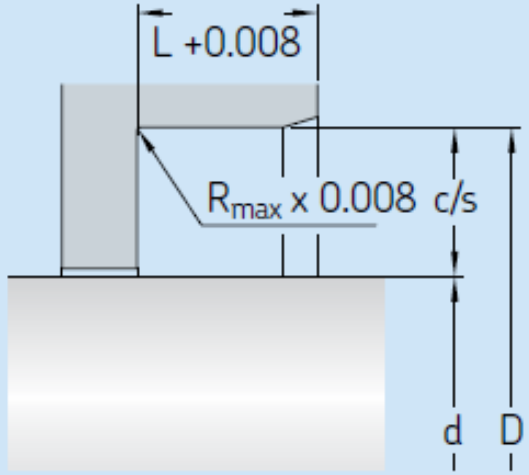
Rotary seals applications



R01 R02

Main function
Single-acting rotary seals,
oil seals,
radial shaft seals.

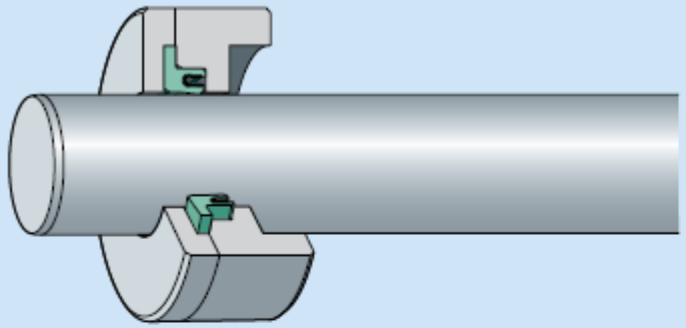
Main applications
Bearing protection.



Advantages
Easily adaptable for diverse temperatures and media.

Standard materials
ECOPUR, SKF Ecorubber/SKF Ecotal, Aluminium.

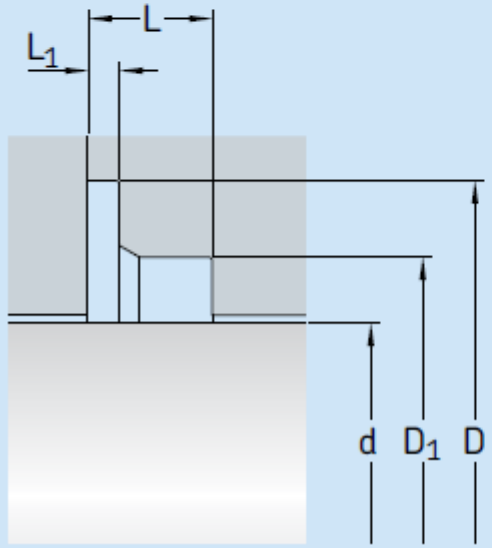
Rotary seals applications



R19

Main function
Single-acting rotary seal, spring activated PTFE seal.

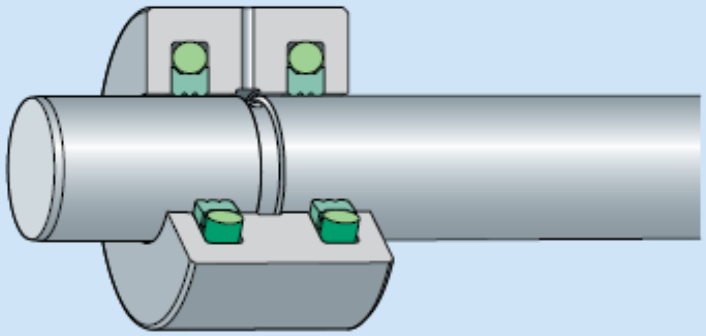
Main applications
Bearing protection for chemical and pharma industries.

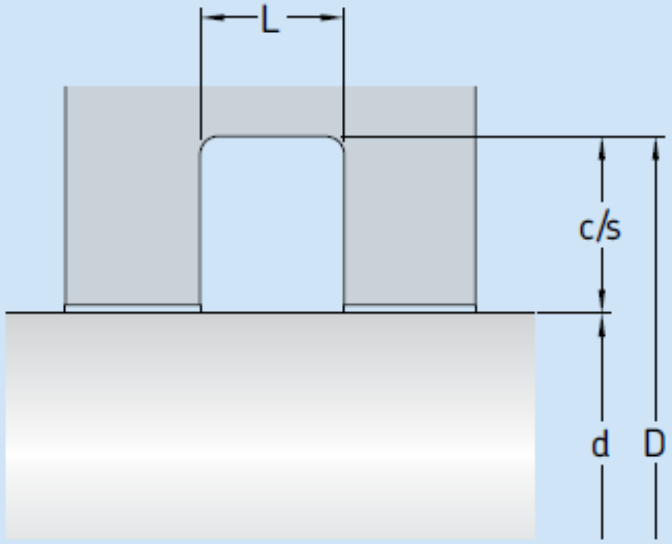


Advantages
Low friction, good chemical and thermal resistance, suitable for high speed.

Standard materials
SKF Ecoflon, stainless steel spring.

Rotary seals applications





R09

Main function
Double-acting rotary seal,
O-ring activated PTFE seal.

Main applications
Rotary pivots.

Advantages
For high pressure.

Standard materials
SKF Ecoflon NBR or FKM.

Case study: Mining and Cement Industry

5

Mining and Cement Industry

Operating environment

The purpose of sealing is to keep operating fluids or lubricants in the system and/or contaminants out.

Aggressive contamination can be a concern. Abrasive particles, cooling fluids and emulsions may affect the sealed machine part.

Fluids

Fluids affect the sealing system in many ways. The sealing material has to be compatible with internal or external fluids. These could be lubricants, coolants, operating media in a hydraulic system, but also auxiliary cleaning or assembly media.

Operating parameters

The impact of type, speed and duration of the motion on the sealing lip is critical. Motion can be linear, rotating or pivoting, continuous or discontinuous. Operating pressures as well as possible system and application related pressure peaks are also to be considered.

Elevated temperatures may also affect the seal and its performance. In most cases, media temperature and motion speed determine the actual temperature at the sealing lip, but an elevated ambient temperature can also affect the performance of the seal.

Mining and Cement Industry

❶ Solutions for hauler strut cylinders

When transporting molten slag, temperatures outside the slag pot can be in excess of 120 °C.

The strut cylinders are located very close to the slag pot and therefore the wiper is exposed to these high temperatures.

The replacement of the split brass wiper, retained with a wave spring, with a one piece PEEK wiper greatly decreased the incidence of ingress as well as simplifies the installation. By introducing the appropriate sealing profile in combination with high performing materials (SKF Ecopaek), SKF achieved a much simpler installation process as well as improved wiping resulting in a significantly extended service life.

❷ Seals for large diameter applications

In mining and mineral processing, dismantling large scale machinery for the replacement of seals is time consuming and related downtime costs are considerable.

Welding large diameter polyurethane seals

SKF has developed a procedure that allows welding of large diameter polyurethane seals on site maintaining the full sealing capacity. For SKF, installing replacement seals is a common process that allows customers to keep production downtime to a minimum.

Split seal assemblies

Access to seals is often limited, especially in gearboxes, as the drive unit and coupling must be removed to facilitate a seal replacement .

By retrofitting with a customized seal made of SKF Ecorubber-2 (FKM), replacements can be completed approximately in an hour. Furthermore, the unique seal design features have extended seal life compared to standard rotary seals.

Mining and Cement Industry

❸ Seals for ball and SAG mills

The harsh working environment of ball and SAG mills and their size provide a challenging dilemma. The seal must provide superior oil inclusion functions as well as being able to exclude foreign materials from the bearing chamber, even during wash-down.

Trunnion seal upgrade

A special engineered double lip seal, also available in triple lip configuration for oil inclusion, is a split seal designed to minimize downtime. G-ECOPUR provides long sealing life as well as reduced wear on the trunnion surface. The purging facility incorporated into the seal allows the removal of contaminants and therefore further increases the seal life.

This seal design has a proven track record in remote mine sites in some of the harshest conditions in the world.

❹ Seals for rear suspension cylinders

The mining industry can provide a wide range of adverse and varied conditions, sometimes unexpected and unforeseen.

Haul truck suspension cylinders are designed to operate at relatively slow speeds and full strokes when carrying a full payload. But when the trucks are empty, the length of the stroke is greatly reduced and the speed greatly increased depending on road surface conditions.

The shorter stroke, combined with faster speed, results in less lubrication, higher friction and, ultimately, failure. By modifying the standard S03-P profile and introducing the S-ECOPUR friction modified polyurethane, SKF was able to significantly extend the service life of the seal.

Mining and Cement Industry

❺ Bearing seal for coal mining conveyor guide wheels

Stock piling and retrieving coal is a necessary function carried out using a stacker/reclaimer. Loading coal onto a conveyor belt requires a scraper to remove the wet coal dust from the belt. The belt scraper is guided by wheels, which are subjected to very aggressive conditions.

The original solution consisting of a labyrinth seal and a rotary shaft seal failed due to coal dust, causing high wear and bearing failures. SKF provides a sealing solution to replace the standard seals arrangement. By using a specially designed seal made of the abrasion resistant H-ECOPUR and including a wear strip made of SKF Ecotex as a counterface for the wiper segment, only minor changes to the existing seal housing were necessary. The bearing life was extended from 6 weeks (worst case) to approximately 2 years with minimal maintenance required. Based on the seal geometry, easy regreasing of the bearings could also be achieved.

❻ Seals for lift and tilt cylinders

The extremely adverse and varied conditions experienced by haul trucks on mine sites all over the world can put standard seals and sealing materials to the test. SKF offers a broad range of sealing materials and profiles that are suitable for the coldest winter conditions, e.g. in Canada, as well as for the high humidity experienced such as in south east Asia.

SKF is able to analyze causes of premature seal failure and design and manufacture a solution with minimal downtime and maximum performance, especially extended service life of the seals.

Case study: Machine Tooling Industry

6

Machine Tooling Industry

Operating environment

The purpose of sealing is to keep operating fluids or lubricants in the system and/or contaminants out.

Aggressive contamination can be a concern. Abrasive particles like chips or material dust, cooling fluids or emulsions may affect the sealed machine part.

Fluids

Fluids affect the sealing system in many ways. The sealing material has to be compatible with internal or external fluids. Those could be lubricants, coolants, operating media in a hydraulic system, but also auxiliary cleaning or assembly media.

Operating parameters

Impact of type, speed and duration of the motion on the sealing lip is critical. Motion can be linear, rotating or pivoting, continuous or discontinuous. Operating pressures as well as possible system and application related pressure peaks are also to be considered.

Elevated temperatures may also affect the seal and its performance. In most cases, media temperature and motion speed determine the actual temperature at the sealing lip, but an elevated ambient temperature can also affect the performance of the seal.

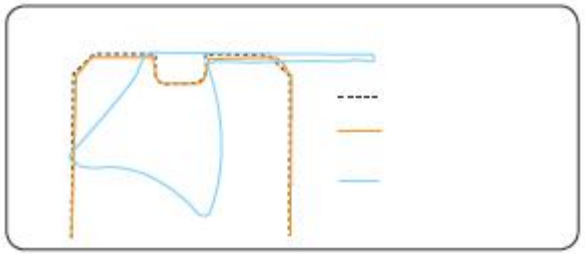
Machine Tooling Industry

Seals for rotary distributors

Rotary distributors or rotary joints regularly rotate at low speeds compared to spindles and have to operate at high pressures (up to 300 bar).

Dynamic seals for applications with rotating or pivoting movements within a rotary distributor have to handle different fluid pressure levels. To ensure positioning accuracy, it is very important to have sealing solutions available with low friction and minimum stick-slip tendency. The seals have to cope with a wide range of media (hydraulic oil, water, air, coolants, lubricants, etc.) and have to provide high wear resistance in order to achieve a long service life.

In one particular case, a modified rotary seal made of hard grade XS-ECOPUR outperformed the previously used PTFE-solution in wear resistance and sealing effectiveness. This resulted in a longer service life (more than 100 000 load cycles, compared to 60 000 previously experienced with a PTFE-solution). As shown below, only a very slight tendency to gap extrusion occurred. The achieved low friction at high pressure level resulted in a low temperature generation. In addition, the material is chemically resistant to all relevant fluids.



Seals for rotary tables

Rotary tables or indexing tables have to offer short cycle times and high precision indexing, even when transporting heavy loads. In that application, the seals have to provide low friction and low wear and have to be available in diameters exceeding 600 mm.

For this application, chemical resistance against coolants and lubricants is a must. SKF's special G-ECOPUR Polyurethane used as a base material for machined large diameter seals (up to 4 000 mm in one piece) provides excellent chemical and wear resistance as well as low friction.

SKF specially designed sealing solutions meet all the customer's requirements of reducing machine downtime and minimizing TCO.

Machine Tooling Industry

Seal for forging presses

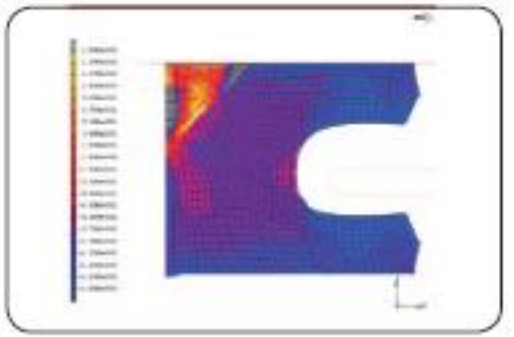
Dismantling large scale machinery for the replacement of seals is time consuming and related downtime costs are considerable.

In one case, a standard rubber fabric seal at the main cylinder had to be replaced. SKF has developed a procedure that allows the welding of large diameter polyurethane seals on site maintaining the full sealing capacity. For SKF, installing replacement seals is a common process that allows customers to keep production downtime to an absolute minimum.

Seals for ceramic powder presses

In the press technology sector, there are presses, which use pressures up to 3 000 bar and more in order to reach necessary forming forces with compact unit dimensions. Hot and cold iso-static presses and presses for sheet metal forming are just two common examples.

In one special case, SKF was challenged with the deflection of the cylinder, combined with the changing properties of the sealing material at ultra high pressure. Based on a Finite Element Analysis (FEA) for design and seal geometry optimisation, a sealing solution for these challenging conditions was introduced, which greatly increased the number of pressing cycles.



Machine Tooling Industry

Seals for wood chipboard presses

To maintain a continuous operating process without unplanned downtimes, each machine component, even a simple seal, has to meet the highest performance expectations.

In this particular case, a customer required a sealing solution for a wood chipboard press. The hydraulic system of the press was operated with a water based fluid (HFA–E), which caused a lack of lubrication at the sealing surface. Combined with heavy loads at the sealing surface, these conditions may have led to extreme wear and reduced lifetime of the seals. By introducing the appropriate sealing profile, together with the high performance, wear resistant sealing material G-ECOPUR, SKF increased the lifespan of the seal from an average of 90 days to more than one year.


SKF