SKF

# SEALS FOR MINING, MINERAL PROCESSING AND CEMENT

Make the difference to business performance



“Maintenance costs can account for 30 to 50% of a mine’s total operating costs”

Source: Mining Digital

“Mining industry employs 1% of world’s workforce, but accounts for 8% of work-place accidents (76% in maintenance operations)”

Source: International Labour Organization

# The harsher the environment, the stronger the seals

Achieving a high Overall Equipment Effectiveness (OEE) and keep maintenance efforts as low as possible is significantly challenging, specially under the very harsh conditions in the mining, mineral processing and cement industry, due to:

- Heavily contaminated environment
- Large sized equipment
- Broad temperature range from very cold to high
- High speeds and torque
- Shock-loads

Not only account maintenance costs a high percentage of the overall mine's costs – unplanned maintenance stops could easily reach 3 to 5 times the cost of planned maintenance.

## A non-functioning seal is, in many cases, the root cause of unplanned stops.

According to our bearing investigation data, circa 20% of bearing failures can be attributed to sealing issues, allowing loss of lubrication or contamination ingress.

Our seals are fighting friction and contamination and make the difference for mining, mineral processing and cement industry since decades – here's how:

- Partners rather than customers
- Outstanding seal quality
- Our knowledge is knowing-why
- The right design for every application
- Broad portfolio from standard seals to higly engineered sealing solutions
- Proprietary skills
- Life span aligned with maintenance cycles





# Trust your machines, they got our seals

**What if you could increase reliability of your operations with better seal choices?**

What are the main issues that may lead to unexpected downtime?

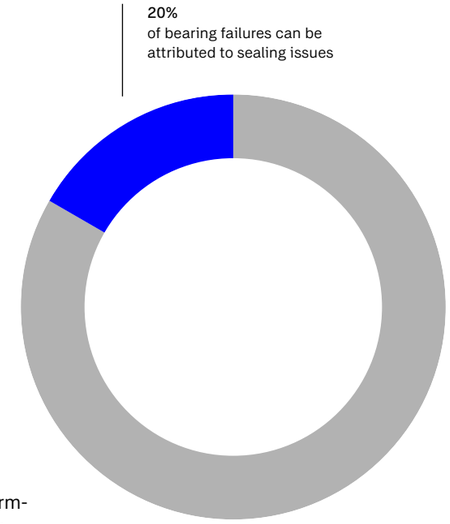
- Ingress of contaminants
- Loss of lubricant
- Unexpected seal aging due to high wear
- In-service bearing or component failures
- Premature maintenance needs

All these issues may lead to increased maintenance efforts and higher maintenance and replacement costs.

Seals are mission critical. The performance and service life of equipment is directly related to the sealing solution.

Life and reliability of what is often considered a simple component, can make all the difference to your operation.

We are committed to enhancing the reliability of processes and reducing maintenance costs to achieve manufacturing excellence and improved Overall Equipment Effectiveness (OEE). Customers looking for cost-effective and reliable machine operation can rely on us.






# Sealing a longer life for your bearings

**What if you could extend maintenance intervals and reduce overall costs with better seal choices?**

This is nothing new: Mining, mineral processing and cement industry is known for its very harsh environmental conditions.

Extreme temperatures, dust, dirt and other contaminants, pressure, friction and more. Not only external factors, but also lubricants to keep firmly inside the components.

All of these elements cause component life to be put to the test and often lead to shorter life cycle and even more maintenance and higher Total Cost of Ownership (TCO).

Our sealing solutions excel in demanding environments, offering outstanding wear and temperature resistance, reduced lubricant consumption and simplified mounting and dismounting procedures – especially in maintenance contexts.

Our seals are made with durable materials and innovative design and processes, allowing our customers to better align their lifespan with maintenance cycles and in many cases increasing time between maintenance.



# Reducing hazard in maintenance operations

**What if you could improve workers safety in your operations?**

The mining, mineral processing and cement industry employs around 1% of the world's workforce[1], but accounts for around 8% of workplace accidents, whereas the vast majority – 76% of those acccidents occur during maintenance operations.

Our sealing solutions can increase maintenance intervalls  therefore reduce the overall maintenance efforts and also can reduce the risk of contamination by lubricants. These aspects lead to reduced exposure to hazardous situations for your employees out there in the field.

[1] Internatioinal Labour Organization




# Let’s seal a better tomorrow

**What if you could make better seal choices to reduce environmental impact?**

If we look deeper into the concept of sustainability, the meaning is more complex than just reducing $CO_2$ emissions and it is based on three pillars:

Environment, Business, and Society or, in other words, The Planet, The Profit, and The People.

Only the integration of actions in each of these dimensions leads us to a holistic approach to globally develop a more sustainable society.

Every small action can have significant effects, particularly when it comes to the environment and sustainability. The use of proper seals not only improves efficiency and productivity, lowering TCO, but also reduces the loss of environmentally harmful lubricants.

By keeping contaminants out, our seals can extend the lifespan of components, reduce waste and make environments safer for the people within them.





# Great variety of sealing applications

SKF provides a large variety of sealing solutions specific to the application needs and customer demands for equipment in the mining, mineral processing and cement industries, covering standard catalogue seals, customized seals based on catalogue products and highly engineered solutions.

## Underground mining

- Continuous miners and longwall shearers
- Roof support systems
- Shuttle cars
- Specialized personnel and service vehicles
- Roof bolting systems
- Drilling units
- Conveyor systems

## Opencast mining

- Dragline hydraulic and mechanical systems
- Power shovel hydraulic and mechanical systems
- Loader hydraulic systems
- Haul vehicles rotary systems
- Haul vehicles hydraulic systems
- Haul and mine roads maintenance units
- Bulldozers
- Bulldozers hydraulic systems and track pin sealing
- Conveyor systems
- Conveyor system drive and tail units
- Belt scraper systems
- Crushers
- Breaker and crushing units
- Workshop and maintenance equipment
- Drills

## Processing

- Wash plant, pumps, gearboxes
- Ball and SAG mill trunnion and gearbox drive systems
- Bulk handling loading and unloading systems
- Bucket wheel hydraulic and drive systems

## SKF offers time-saving retrofit split element sealing solutions for:

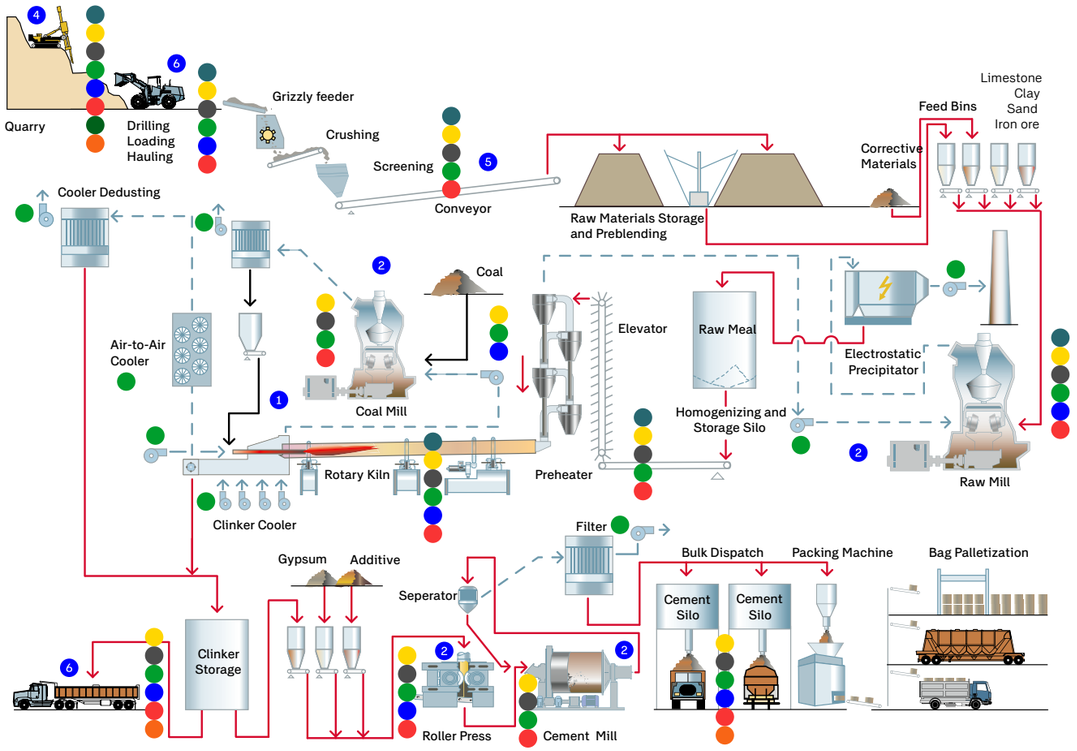
- Gearboxes and drive units
- Pumps
- Difficult access sealing
- Worn shaft/rod sealing
- Ball and SAG mill trunnion and gearbox drive systems (where lengthy strip down is a costly problem)

# Cement and mining process

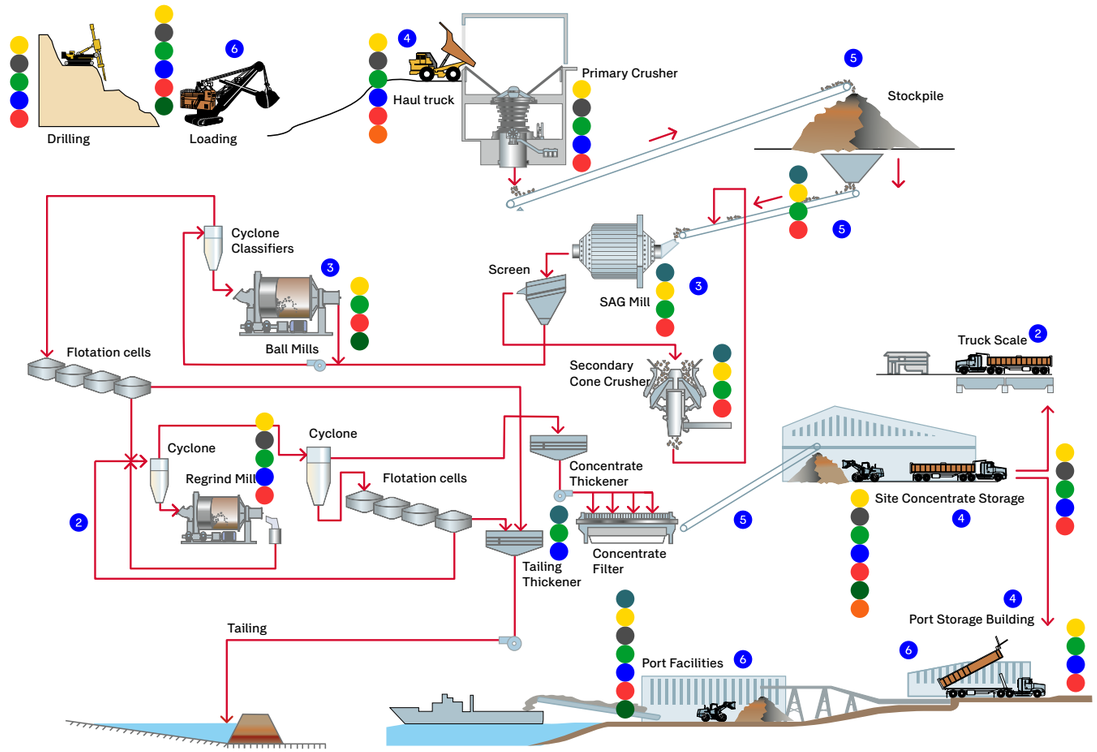
1. High temperature
2. Large diameter seals
3. Wear and reliability
4. Linear and rotary speed
5. Bearing protection
6. Pressure

- SNL housing seals – TXL
- Heavy Industrial Shaft Seals (HIS)
- Metal face seals
- Standard shaft seals (radial, V-rings, Speedi-Sleeves)
- Standard hydraulic seals
- Customized machined seals
- SKF Trackstar seals
- Cassette seals – MUD 11

## Cement process




## Mining process




### 1 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.

### 2 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 .

With customized rubber or rubber-fabric reinforced seals available as split versions, it is also possible to significantly reduce maintenance time keeping the full sealing capability.

### 3 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.

### 4 Seals for haul trucks and mobile equipment

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 trucks are empty, the stroke length is reduced with increased speed. With a modified rod seal using S-ECOPUR self-lubricated polyurethane the service life is significantly increased.

In the heavily contaminated conditions of the driveline metal face seals as well as cassette seals – MUD11 - make a difference in maintenance intervals for rotary applications.

Last, but not least, also metal cased rubber seals with two springs (TR/4/S) are there to provide high contamination as well as increased reliability of electric wheel hub motors.

### 5 Radial shaft seals for conveyors

Stock piling and retrieving minerals via different type of conveyors requires robust rotary sealing solutions to protect all the bearing arrangements used at the conveyor wheels.

All the contaminations present there lead to high wear and reduced life-time.

By using abrasion and wear resistant materials, like the H-ECOPUR polyurethane as well as additional V-rings, the seal life-time as well as the maintenance intervals can be significantly extended.

Furthermore the use of standard radial shaft seals in metric or imperial dimensions combined with appropriate V-rings can provide a robust solution for drives and gearboxes operating the conveyors.

### 6 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.

# SKF’s sealing capabilities

**High level of contamination, temperature and speed extremes; high and constant shock loads; abrasive dust – it’s safe to say that few industries can match the extreme operating conditions in mining, mineral processing and cement industry.**

These conditions degrade equipment, cause unplanned down-time and make effective maintenance difficult at best. Increas-ingly stringent environmental and health-and-safety regulations are also making environmental protection and employee safety top priorities in the industry today.

Nevertheless – as risky, capital-intensive and volatile the industry is – there is still a need to increase productivity and profitability. Being able to stand up against intense global competition calls for flexibility and specialized solutions.

Discover how SKF can help you stay ahead and discover the full range of seals that makes a difference in your equipement performance.

## Standard catalogue seals

- SNL housing seals – TXL
- Heavy Industrial Seals (HIS)
- Metal face seals
- Radial shaft seals
- V-ring seals
- SKF Speedi-Sleeves
- Hydraulic seals
- SKF Trackstar seals
- Cassette seals – MUD 11

## Catalogue seals – Customized size

- No tooling necessary
- Standard seals with non-standard size
- All rubber shaft seals (HIS)
- Metal-cased rubber shaft seals (HIS)
- Customized machined rotary seals
- Customized machined hydraulic seals

## Engineered solutions – Application specific

- Rubber fabric shaft seals (HIS)
- Rubber metal reinforced shaft seals (HIS)
- Custom engineered machined rotary seals
- Custom engineered machined hydraulic seals
- Custom engineered machined sealing solutions according to application demand
- SKF SEAL JET system locally available



# Seal design overview

## Standard catalogue seals

### SNL plummer block housing seals – TXL





### Metal face seals

DO



DF



### Hydraulic seals



### Radial shaft seals

CRW



HMS5 / HMSA10



### SKF Speedi-Sleeve



### IN ROD



### IN PISTON



### V-rings

VA



VL



VE



VRME



### Trackstar seal



### MUD11 cassette seal



### Heavy Industrial Seals (HIS)

TR/3



TR/3/P



TR/3/P/PTV



TR/3/CS



T11



T11/PTV



TR/3/M



TR/3/M/P



TR/3/M/CS



TR/3/M/PTV



T11/M



T11/M/PTV



TR/3/ML



TR/3/ML/P



TR/3/ML/PTV



TR/3/ML/CS



TR/4/PTV



## Catalogue seals – Customized size

HSS



HSSG



R01



GK08



GS09



GR06



HDS



HDSL



HDS7



Machined seals




## Engineered solutions – Application specific

TR/4/S



**APPLICATION:**
Mining truck wheel hub

HDSF2



**APPLICATION:**
Vertical grinding mill rollers

GR08-P



**APPLICATION:**
Horizontal grinding mills, trunnion bearing, replacement of felt seals, additional lip seal for plummer block housings

GR08-A double lip



**APPLICATION:**
Gear garth at drive units

GR08-A single lip



**APPLICATION:**
Gear garth at drive units

GR01 BMS



**APPLICATION:**
Horizontal grinding mill, slide shoe bearing

GR06-P



**APPLICATION:**
Contamination exclusion for various machinery

Machined seals

# Engineering and application support



## Finite Element Analysis (FEA) and seal testing

To understand the detailed seal behaviour under the harsh operating conditions in the field and to support proper seal selection according to the application needs the comprehensive tools of Finite Element Analysis are used together with a broad variety of testing facilities used around the world as well as seal failure analysis. All these aspects combined with application and material knowledge are vital elements for successful seal development to meet the sophisticated application demands.



## On-site welding and installation of seals

One of the biggest advantages of machined seals made of polyurethane is the on-site weldability to specially make replacement and mounting operations much easier, because there's no need to completely demount bulky equipment for a seal replacement. These seals can be welded in any diameter range, directly at large ball or grinding mills.



## Sealing material selection

The proper selection of sealing materials for specific applications is a key factor in relation to asset reliability, lifetime as well as plant safety.

Different types of elastomers or rubbers – as the most common group of sealing materials – offer possibilities of reinforcements (fabric or metal) to combine robust seal bodies with flexible sealing lips as well as a patented process of vulcanized antifriction bands (PCT/EP2006/004962) at the sealing lip to significantly reduce friction and increase lifetime.

Polyurethanes on the other hand offer outstanding mechanical properties, low compression set and excellent abrasion and wear resistance – especially for the harsh environment of mining, mineral processing and/or cement applications.

Last, but not least, there are several PTFE compounds and thermoplastic materials available to provide sufficient resistance against chemicals, high temperatures or heavy wear.



# Pressure fluids and sealing materials

Generally fire-resistant working fluids can greatly affect the integrity of sealing materials. Compared to mineral oils these fluids require a much more careful selection of compatible sealing materials.

SKF has many years of experience in sealing systems for these kinds of critical applications and has extensively investigated the compatibility of seals with these fluids. The results of the investigations and general recommendations for suitable sealing materials are summarized in the table below.

### Fluid compatibility of sealing materials

| Category | Service Temperature (°C) | Resistant elastomers SKF recommendations | Notes |
|---|---|---|---|
| HFA-E | +5 to 60 | H-ECOPUR* (specially formulated polyurethane), NBR, HNBR, specially formulated FPM* | - |
| HFA-S | +5 to 60 | H-ECOPUR* (specially formulated polyurethane), NBR, HNBR, properly formulated FPM and EPDM | Individual tests necessary |
| HFB | +5 to 60 | Specially formulated polyurethanes, NBR, HNBR, specially formulated FPM | - |
| HFC | –20 to 60 | NBR, HNBR, EPDM and MVQ | * Specially formulated polyurethanes and FPM have limited stability |
| HFD-R | >100 | FPM (depending on fluid type), EPDM, MVQ (depending on fluid type) | - |
| HFD-S | >100 | FPM, MVQ | - |
| HFD-T | >100 | FPM, MVQ | - |
| HFD-U | Silicone oils >100 | H-ECOPUR* (specially formulated polyurethane) up to 100 °C max. FPM (plastizer-free) | - |
| | Synthetic esters +80 | H-ECOPUR* (specially formulated polyurethane) , FPM | - |

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