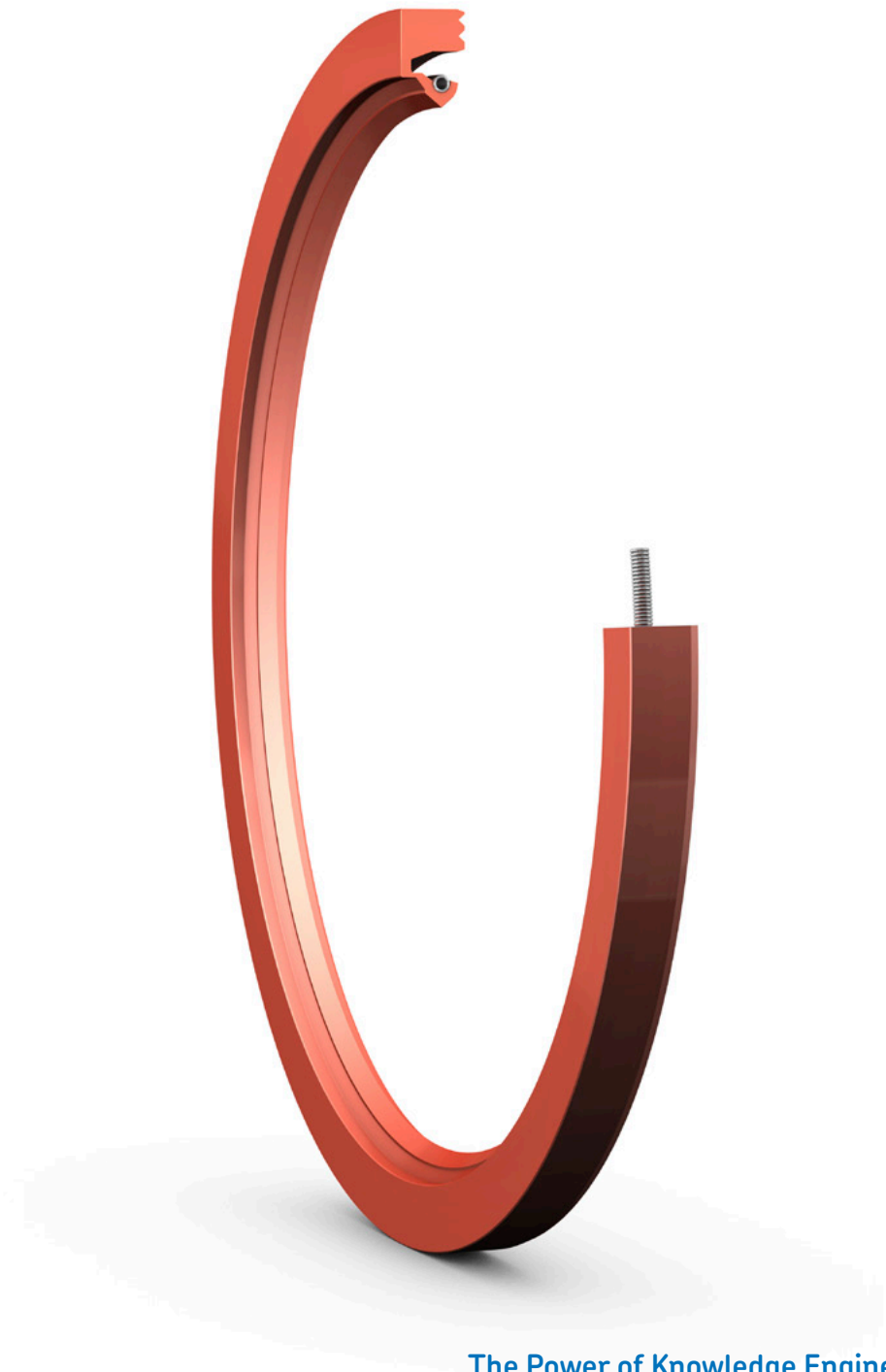


Polyurethane HRS seals

High performance radial shaft seals for wind turbines



High performance solutions for wind turbines

Boosting turbine performance and profitability

SKF designs and develops bearings, seals, condition monitoring systems and lubrication systems that enable more cost-effective wind energy generation.

Working together with original equipment manufacturers and wind farm operators, SKF engineers can provide dedicated solutions to optimize the reliability and performance of new as well as existing wind turbine designs.

HRS seals from SKF are specially designed to cope with the harsh conditions that wind turbine main shafts face. They offer lubricant retention and contamination exclusion to reduce the risks of lubrication or contaminant-related bearings failures and their consequences, such as production downtime and repair costs. These high performance radial shaft seals can deliver significantly extended service life and help wind farm operators to reduce maintenance costs and ultimately increase wind turbine reliability.

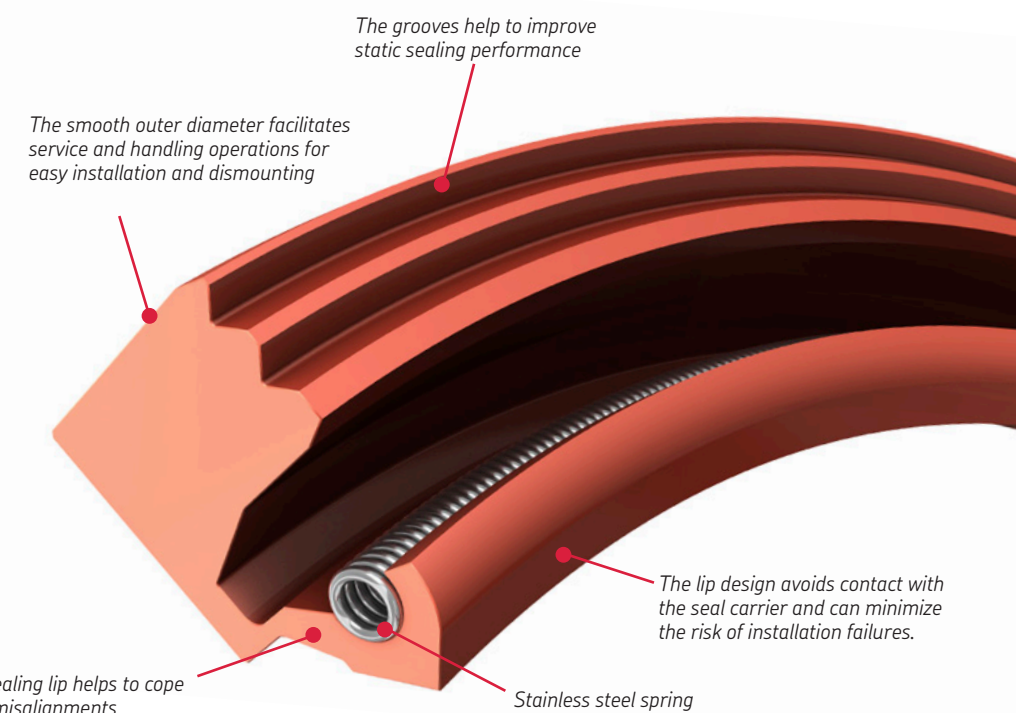
Benefits and features

- Extended service life due to high abrasion resistance material
- Reduced contaminant-related bearing failures
- Hydrolysis resistance, UV radiation and ozone due to G-ECOPUR material
- Increased wind turbine reliability
- Facilitated up-tower retrofits
- Reduced OPEX during turbine life
- Easy installation
- Customization of seal size thanks to flexible manufacturing process

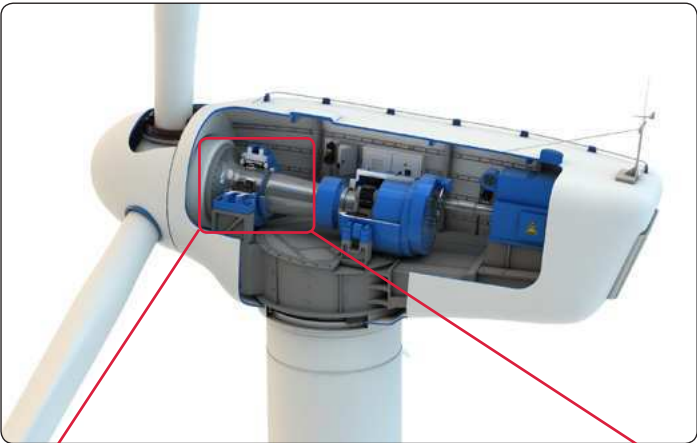
Easy up-tower usage

The split seals are single packed and designed to fulfill the needs in the wind aftermarket. Each package contains a seal with the garter spring and an installation guide. To allow for easy handling and transportation for large diameter seals, these seals are folded.

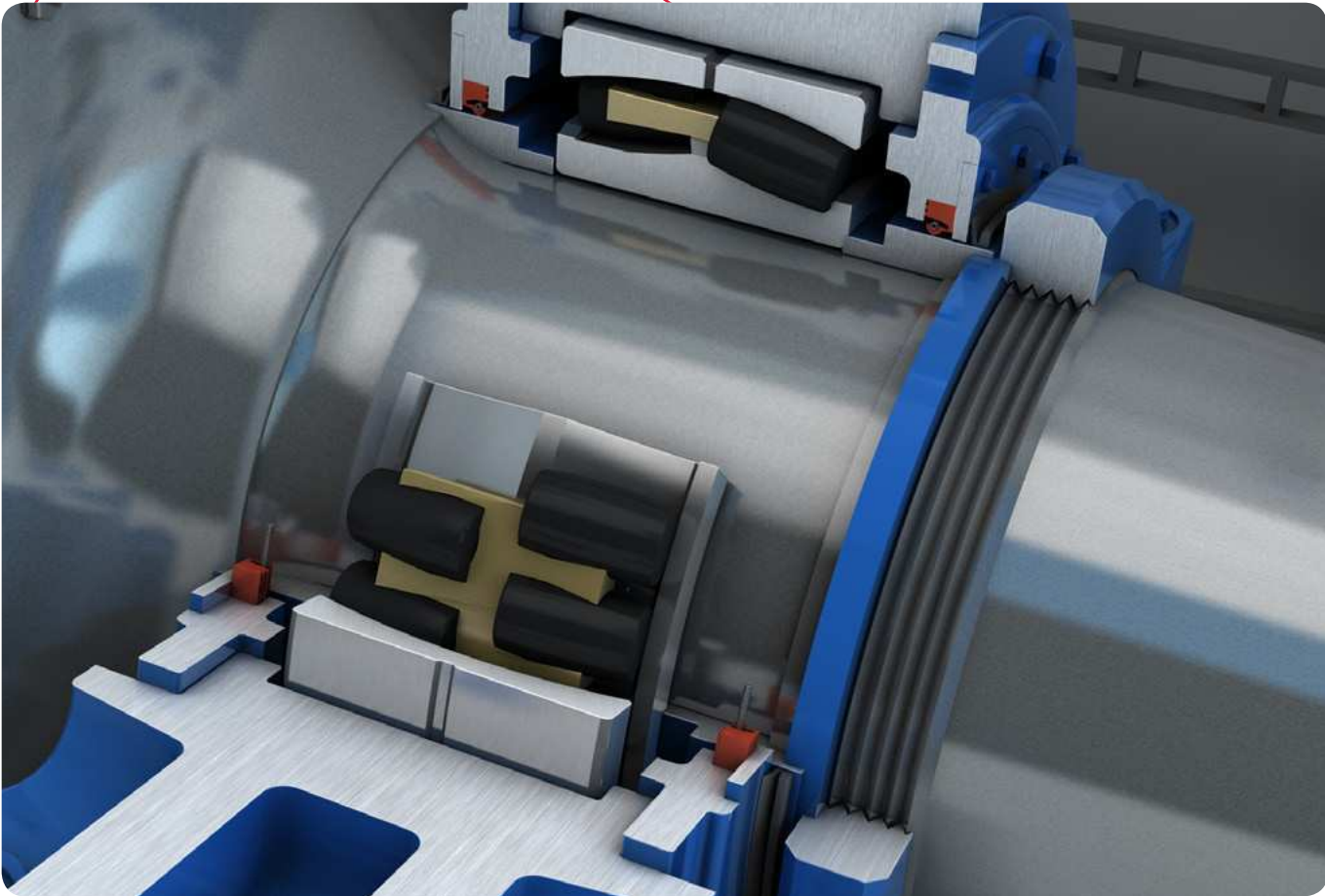
The HRS high performance profile



Main shaft arrangement



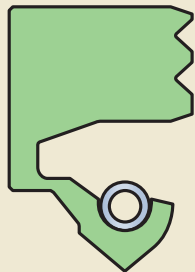
Wind turbine



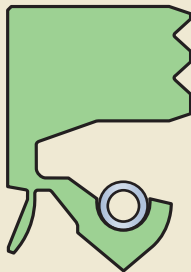
Main shaft arrangement

Seal design overview

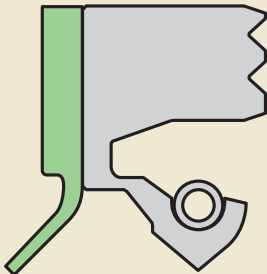
Radial shaft seal, HRS1



Radial shaft seal, HRSA



Radial excluder seal, HRE



| Design | HRS1 | HRSA | HRE |
|----------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description | Radial shaft seal for large diameters and large misalignments. Designed to keep lubricant inside. | Radial shaft seal with additional auxiliary lip for large diameters and large misalignments. Designed to keep lubricant inside while keeping particles out. | Excluder seal to be used in combination with HRS1 design to keep contamination (dust, moisture) out and protect the main sealing lip against abrasive particles. |
| Highlight | Solution for standard use | Compact solution for contaminated environment | Solution for contaminated environment |
| Required space | Narrow seal housing bore depth and counterface | Narrow seal housing bore depth and medium counterface | Wider seal housing bore depth and wider counterface |
| Environment | Standard environment | Contaminated environment | Harsh conditions |

| Designation system | | | |
|------------------------------------------------|-------|-------|-------|
| | HRS1 | HRSA | HRE |
| Solid seal | HRS11 | HRSA1 | HRE11 |
| Split seal | HRS12 | HRSA2 | HRE12 |
| Standard material, G-ECOPUR: GP, H-ECOPUR: HP* | | | |
| Dimensions + seal design + material | | | |
| Example: 920x968x20 HRS11 GP | | | |
| *for seal diameters below 600 mm only | | | |

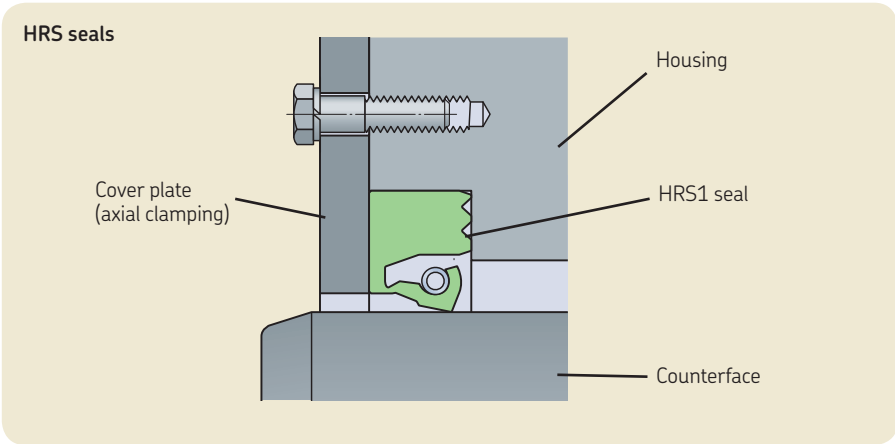
HRS1 and HRSA radial shaft seals

These large diameter radial shaft seals are designed to protect large size bearings in wind turbines with grease lubrication and low pressure differentials. A flexible manufacturing process allows a degree of customization to the seal dimensions to help meet unusual requirements.

HRSA seals feature an additional auxiliary lip to protect the seal and the application against contamination from the environment.

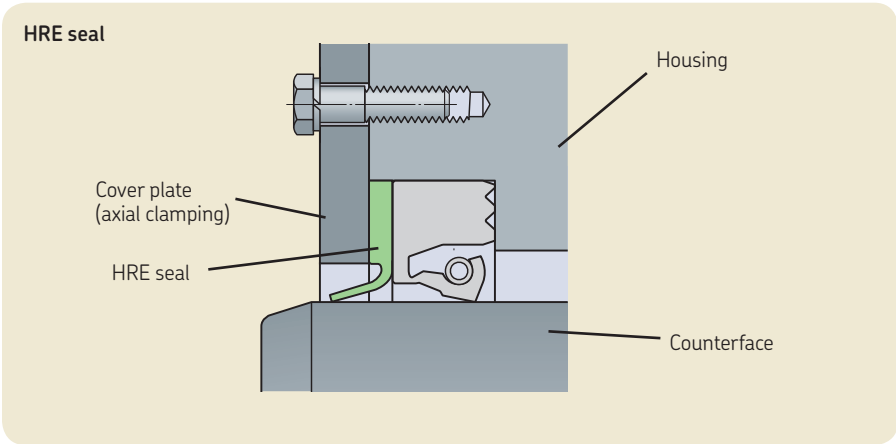
HRS1 and HRSA seals feature a garter spring that stabilizes the sealing lip, increases the lip followability (DRO and STBM) and maintains the sealing function even in alternating operating temperatures. The seals are designed to secure the garter spring inside the spring groove once the seals are installed.

Solid seals feature an endless garter spring, while split seals feature an open connection that is closed during seal installation.

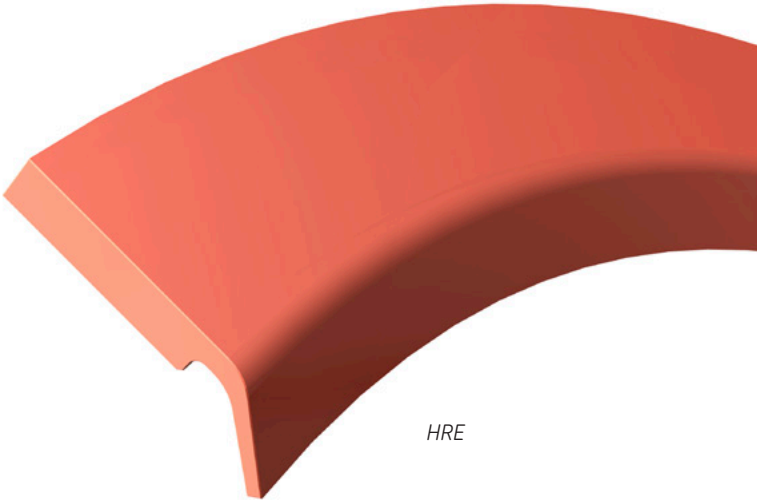


HRE radial excluder seal

HRE is a radial contacting excluder seal, designed to be used in combination with an HRS1 radial shaft seal as additional protection against contamination. A flexible manufacturing process allows a degree of customization to the seal dimensions to help meet unusual requirements.



HRE seals are additional auxiliary lips for contamination protection to be used in combination with HRS1 seals. They are generally used where additional protection from contaminants is needed.



Installation

Seal versions

SKF offers two versions to meet handling and installation requirements.

1 Solid version

Designed and packed for installation in a workshop, solid seal versions are used when it is possible to access the housing bore and shaft axially.

Seal and garter spring are delivered solid and cannot be cut.

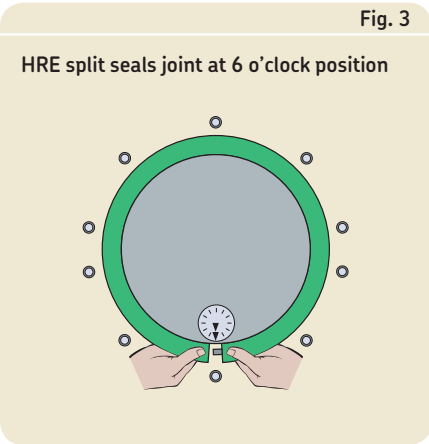
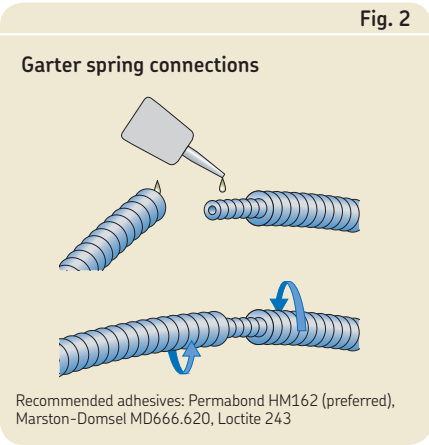
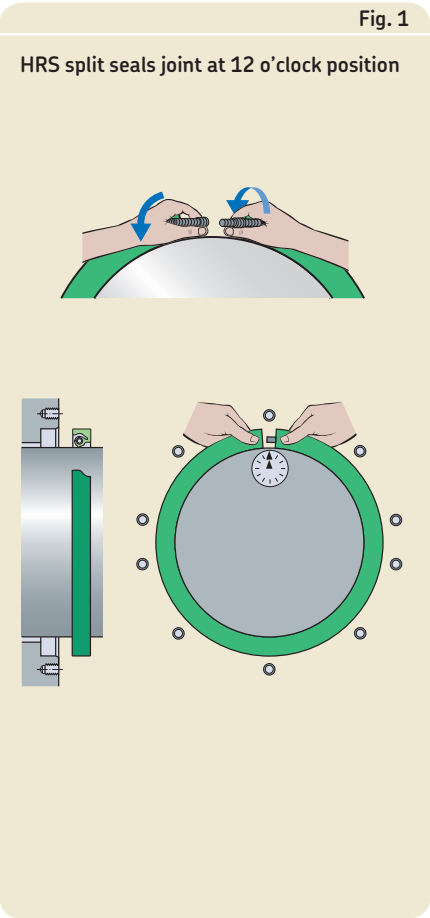
2 Split version

This seal version is used for up-tower replacements or where it is impossible to access the shaft axially.

HRS seals are delivered cut and the garter spring has one connection left open to place them around the shaft. It is recommended that the seal is installed with the ends located in the area of the lowest media pressure. Usually the 12 o'clock position. (→ fig. 1).

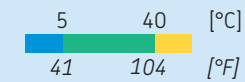
During installation, the garter spring must be connected. Back-wind the spring 7 full turns before the ends are brought together and allowed to thread into each other. To prevent installation failures, SKF recommends additionally securing the connection with an adhesive (→ fig. 2).

HRE split seals can be easily placed around the shaft. Do not position the ends of the HRE seal in the same area as the main seal. Using the 6 o'clock position is recommended (→ fig. 3).



Recommended installation temperature range

Seal installation temperature

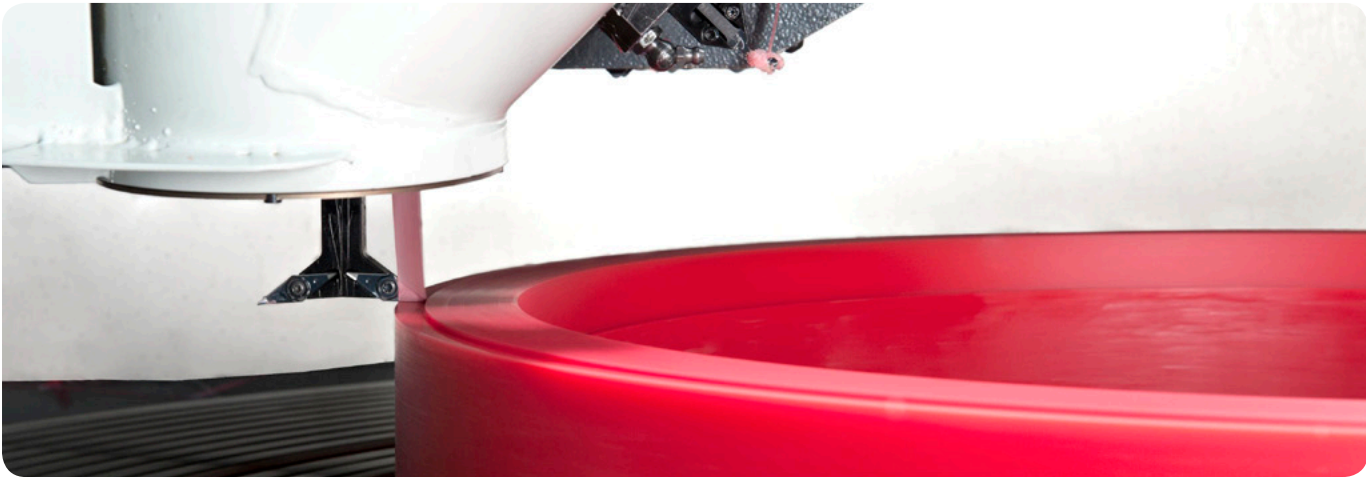


Lower temperature range: Within this range SKF recommends to warm up the seal or the seal housing.

Recommended temperature range for installation

Higher temperature range: Within this range SKF recommends to cool down the seal or the seal housing.

Material and manufacturing



G-ECOPUR

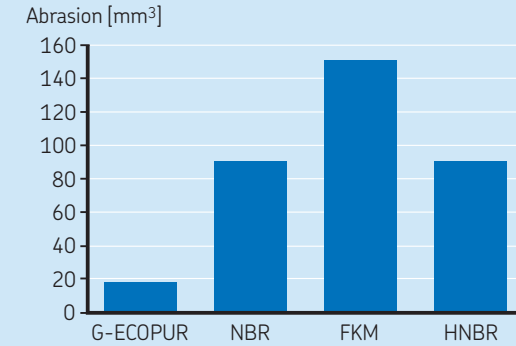
Standard seals are made from G-ECOPUR which is a casted polyurethane elastomer.

This material has outstanding wear resistance and increased stiffness compared to rubber materials. Increased stiffness allows for easier handling and minimizes the risk of installation failures like bending the sealing lip or losing the garter spring.

CNC manufacturing process

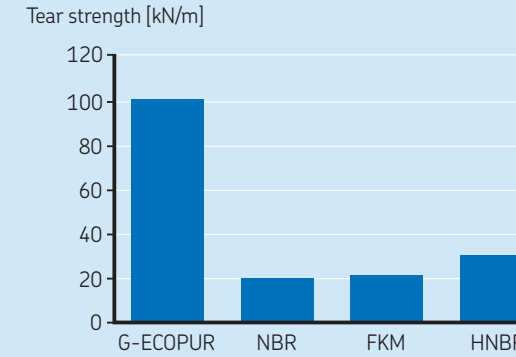
Featuring proprietary software and high-precision cutting tools, the SKF SEAL JET manufacturing system uses Computer Numerical Control (CNC) technology to machine polymer seals quickly. The system machines a seal from a semi-finished tube of the selected material.

Abrasion wear of various sealing materials



G-ECOPUR is 5 times more abrasion-resistant than the next best performing elastomer material.

Tear strength of various sealing materials



G-ECOPUR offers almost 3,5 times greater tear strength than the next best performing elastomer material.

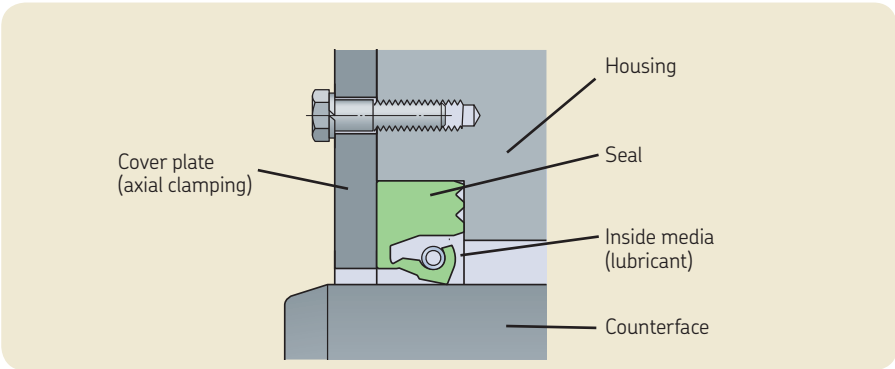
Operating conditions and requirements

Design requirements

- Seal is clamped axially (e.g. with bolted cover plate)
- Rotating applications

Operating conditions

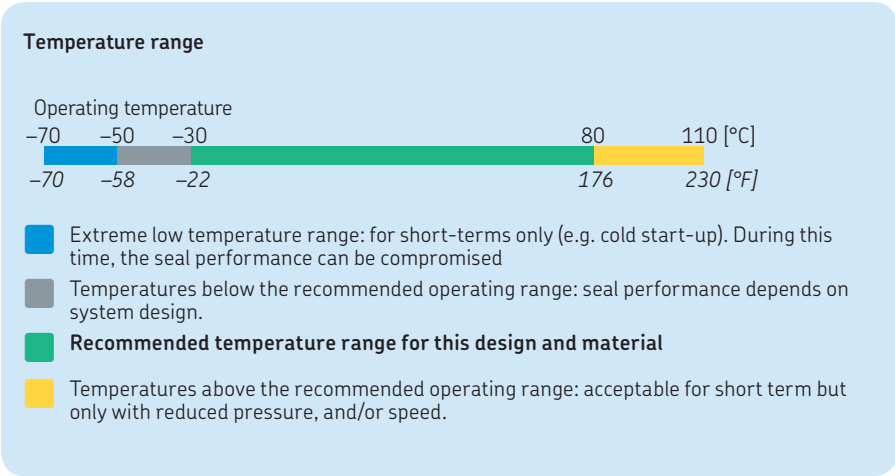
- Permissible misalignments (STBM and DRO) according to **table 1**.
- Pressure differential: 0,5 bar continuously, up to 3 bar short-term
- Counterface surface speed (linear) < 2,5 m/s
- Lubrication: Grease NLGI ≥1
- Temperature range



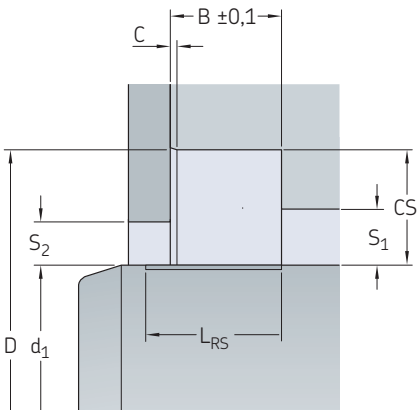
Seal installed with surrounding components

Table 1

| Permissible misalignment | | | | |
|-------------------------------------------|-----------|-----------|-------------|--------|
| Counterface diameter Ød ₁ [mm] | 350 – 500 | 500 – 900 | 900 – 1 800 | >1 800 |
| STBM and DRO (deviation max. [mm]) | 1,5 | 2 | 2,5 | 3 |



Shaft and bore requirements



| d ₁ | D | CS | B | S ₁ | S ₂ | L _{RS} | C |
|----------------|-----|-----|-----------------------|----------------|----------------|-----------------|---------------|
| Range incl. | Tol | Tol | minimum (recommended) | HRS1 HRSA +HRE | HRS1 HRSA HRE | HRS1 HRSA +HRE | HRS1 HRSA HRE |
| mm | | | | | | | |

| | | | | | | | | | | | | | | |
|-------|-------|------|------|-----------|------|------|------|------|------|------|------|----------|------|-------|
| 350 | 900 | –0,4 | +0,4 | ≥ 20 (25) | ≥ 20 | ≥ 25 | ≤ 12 | ≤ 12 | 7-12 | ≥ 15 | ≥ 25 | ≥ B + 10 | ≤ 10 | ≤ 1,5 |
| 900 | 1 800 | –0,5 | +0,5 | ≥ 25 (32) | ≥ 25 | ≥ 30 | ≤ 16 | ≤ 16 | 7-16 | ≥ 15 | ≥ 30 | ≥ B + 10 | ≤ 10 | ≤ 1,5 |
| 1 800 | 3 900 | –0,7 | +0,7 | ≥ 28 (32) | ≥ 25 | ≥ 30 | ≤ 18 | ≤ 18 | 7-18 | ≥ 15 | ≥ 30 | ≥ B + 10 | ≤ 10 | ≤ 1,5 |

Surface roughness

The surface roughness values of the counterface for these radial shaft seals, calculated according to methods described in ISO 4288 (DIN 4768), should be:

$$R_a \leq 0,8 \mu m$$
$$\text{Material ratio: } 50\% \dots 95\% \text{ at } 50\% \text{ of } R_z,$$
$$C_{ref} = 0\%$$

If higher values are used, the seal life may be affected. If the counterface is too rough, there can be excessive sealing lip wear and seal service life might be shortened.

Surface finish

Depending on the direction of rotation, directionality on the seal counterface may cause a seal to leak. Plunge grinding is the preferred machining method to minimize directionality (0±0,05°) on the seal counterface.

The seal counterface surface should be solid, free of any damage, scratches, cracks, rust or burrs and should be properly protected until final installation.

Hardness and surface treatment

The surface hardness of the seal counterface should be at least 45 HRC. Under certain conditions, such as where speeds are low, lubrication is good and contaminants are absent, counterface surfaces having a lower hardness may be suitable. Surfaces that are nitrided, phosphated or have a galvanized coating may also be suitable, but this must be determined for each specific case.

The Power of Knowledge Engineering

Combining products, people, and application-specific knowledge, SKF delivers innovative solutions to equipment manufacturers and production facilities in every major industry worldwide. Having expertise in multiple competence areas supports SKF Life Cycle Management, a proven approach to improving equipment reliability, optimizing operational and energy efficiency and reducing total cost of ownership.

These competence areas include bearings and units, seals, lubrication systems, mechatronics, and a wide range of services, from 3-D computer modelling to cloud-based condition monitoring and asset management services.

SKF's global footprint provides SKF customers with uniform quality standards and worldwide product availability. Our local presence provides direct access to the experience, knowledge and ingenuity of SKF people.



SKF BeyondZero

SKF BeyondZero is more than our climate strategy for a sustainable environment: it is our mantra; a way of thinking, innovating and acting.

For us, SKF BeyondZero means that we will reduce the negative environmental impact from our own operations and at the same time, increase the positive environmental contribution by offering our customers the SKF BeyondZero portfolio of

products and services with enhanced environmental performance characteristics.

For inclusion in the SKF BeyondZero portfolio, a product, service or solution must deliver significant environmental benefits without serious environmental trade-offs.

All our solutions for the renewable energy sector have been selected for inclusion in the SKF BeyondZero portfolio, which includes products and solutions with significant environmental benefits, such as improved energy efficiency and the enabling of increased renewable energy generation.

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