

SKF lubricants

Poor lubrication accounts for over 36% of premature bearing failures



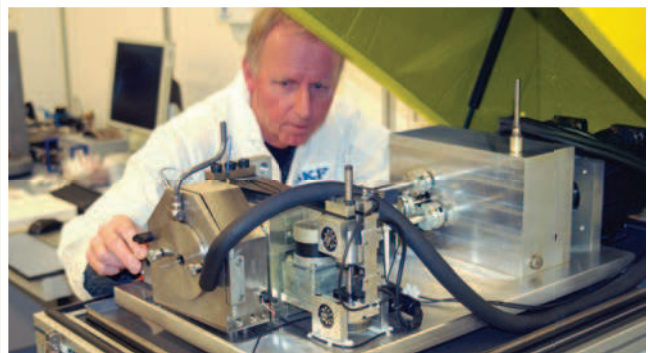
SKF lubricants offer major competitive advantages:

- Designed and tested to perform under real conditions
- Product data include specific test results enabling a better selection
- Strict quality control of every production batch helps ensure consistent performance
- Quality control allows SKF to offer a five-year shelf-life¹⁾ from the date of production

Production processes and raw materials greatly influence grease properties and performance. It is virtually impossible to select or compare greases based only on their composition. Therefore, performance tests are needed to provide crucial information. In over 100 years, SKF has accrued vast knowledge about the interaction of lubricants, materials and surfaces.

This knowledge has led SKF, in many cases, to set industry standards in bearing lubricant testing. Emcor, ROF, ROF+, V2F, R2F and Bequiet are just some of the multiple tests developed by SKF to assess the performance of lubricants under bearing operating conditions. Many of them are widely used by lubricant manufacturers worldwide.

¹⁾ SKF food grade and biodegradable lubricants offer a two-year shelf-life from the date of production.



SKF Engineering and Research Centre in the Netherlands

SKF lubricant selection

Selecting a grease can be a delicate process. SKF has developed several tools in order to facilitate the selection of the most suitable lubricant. The wide range of tools available includes those from easy-to-use application driven tables to advanced software allowing for grease selection based upon detailed working conditions.

The basic bearing grease selection chart provides you with quick suggestions on the most commonly used greases in typical applications.



| Basic bearing grease selection | | |
|--|---------------|----------------------------|
| Generally use if: | | |
| Speed = M, Temperature = M and Load = M | LGMT 2 | General purpose |
| Unless: | | |
| Expected bearing temperature continuously >100 °C (210 °F) | LGHP 2 | High temperature |
| Expected bearing temperature continuously >150 °C (300 °F), demands for radiation resistance | LGET 2 | Extremely high temperature |
| Low ambient -50 °C (-60 °F), expected bearing temperature <50 °C (120 °F) | LGLT 2 | Low temperature |
| Shock loads, heavy loads, frequent start-up / shut-down | LGEP 2 | High load |
| Food processing industry | LGFP 2 | Food processing |
| Biodegradable, demands for low toxicity | LGGB 2 | Biodegradable |

Note: – For areas with relatively high ambient temperatures, use LGMT 3 instead of LGMT 2
– For special operating conditions, refer to the SKF bearing grease selection chart

With additional information like speed, temperature, and load conditions, LubeSelect for SKF greases is the easiest way to select the right grease. For additional information, visit www.apititudeexchange.com. Additionally, the SKF bearing grease selection chart provides you with a complete overview of SKF greases. The chart includes the main selection parameters, such as temperature, speed and load, as well as basic additional performance information.



| Bearing operating parameters | | | |
|------------------------------|--------------------------------|--|--|
| Temperature | | Load | |
| L = Low | <50 °C (120 °F) | VH = Very high | C/P <2 |
| M = Medium | 50 to 100 °C (120 to 230 °F) | H = High | C/P ~4 |
| H = High | >100 °C (210 °F) | M = Medium | C/P ~8 |
| EH = Extremely high | >150 °C (300 °F) | L = Low | C/P ≥15 |
| | | C/P = Load ratio | C = basic dynamic load rating, kN P = equivalent dynamic bearing load, kN |
| Speed | | for roller bearings | |
| for ball bearings | | SRB/TRB/CARB | CRB |
| EH = Extremely high | n d _m over 700 000 | H = High | n d _m over 210 000 |
| VH = Very high | n d _m up to 700 000 | M = Medium | n d _m up to 210 000 |
| H = High | n d _m up to 500 000 | L = Low | n d _m up to 75 000 |
| M = Medium | n d _m up to 300 000 | VL = Very low | n d _m below 30 000 |
| L = Low | n d _m below 100 000 | n d _m = rotational speed, r/min x 0,5 (D+d), mm | |

SKF bearing grease selection chart

| Grease | Description | Application examples | Temperature range ¹⁾ | | Temp. | Speed |
|---------------|--|--|---------------------------------|--------------------|--------|---------|
| | | | LTL | HTPL | | |
| LGMT 2 | General purpose industrial and automotive | Automotive wheel bearings Conveyors and fans Small electric motors | -30 °C (-20 °F) | 120 °C (250 °F) | M | M |
| LGMT 3 | General purpose industrial and automotive | Bearings with d>100 mm Vertical shaft or outer bearing ring rotation Car, truck and trailer wheel bearings | -30 °C (-20 °F) | 120 °C (250 °F) | M | M |
| LGEP 2 | Extreme pressure | Forming and press section of paper mills Work roll bearings in steel industry Heavy machinery, vibrating screens | -20 °C (-5 °F) | 110 °C (230 °F) | M | L to M |
| LGWA 2 | Wide temperature ⁴⁾ , extreme pressure | Wheel bearings in cars, trailers and trucks Washing machines Electric motors | -30 °C (-20 °F) | 140 °C (285 °F) | M to H | L to M |
| LGGB 2 | Biodegradable, low toxicity ³⁾ | Agricultural and forestry equipment Construction and earthmoving equipment Water treatment and irrigation | -40 °C (-40 °F) | 90 °C (195 °F) | L to M | L to M |
| LGFP 2 | Food compatible | Food processing equipment Wrapping machines Bottling machines | -20 °C (-5 °F) | 110 °C (230 °F) | M | M |
| LGFP 2 | Food compatible | Food processing equipment Wrapping machines Bottling machines | -20 °C (-5 °F) | 110 °C (230 °F) | M | M |
| LGQ 2 | Food compatible High load | Pellet presses Mills Mixers | -40 °C (-40 °F) | 140 °C (285 °F) | L to H | VL to M |
| LGED 2 | Food compatible High temperature Harsh environment | Bakery/brick oven equipment Glass industry Vacuum pumps | -30 °C (-20 °F) | 240 °C (464 °F) | VH | L to M |
| LGBB 2 | Wind turbine blade and yaw bearing grease | Wind turbine blade and yaw slewing bearings | -40 °C (-40 °F) | 120 °C (250 °F) | L to M | VL |
| LGLT 2 | Low temperature, extremely high speed | Textile and machine tool spindles Small electric motors and robots Printing cylinders | -50 °C (-60 °F) | 110 °C (230 °F) | L to M | M to EH |
| LGWM 1 | Extreme pressure, low temperature | Main shaft of wind turbines Centralised lubrication systems Spherical roller thrust bearing applications | -30 °C (-20 °F) | 110 °C (230 °F) | L to M | L to M |
| LGWM 2 | High load, wide temperature | Main shaft of wind turbines Heavy duty off road or marine applications Snow exposed applications | -40 °C (-40 °F) | 110 °C (230 °F) | L to M | L to M |
| LGEM 2 | High viscosity plus solid lubricants | Jaw crushers Construction machinery Vibrating machinery | -20 °C (-5 °F) | 120 °C (250 °F) | M | VL |
| LGEV 2 | Extremely high viscosity with solid lubricants | Trunnion bearings Support and thrust rollers on rotary kilns and dryers Slewing ring bearings | -10 °C (15 °F) | 120 °C (250 °F) | M | VL |
| LGHB 2 | EP high viscosity, high temperature ⁵⁾ | Steel on steel plain bearings Dryer section of paper mills Work roll bearings and continuous casting in steel industry | -20 °C (-5 °F) | 150 °C (300 °F) | M to H | VL to M |
| LGHP 2 | High performance polyurea grease | Electric motors Fans, even at high speed High speed ball bearings at medium and high temperatures | -40 °C (-40 °F) | 150 °C (300 °F) | M to H | M to H |
| LGET 2 | Extreme temperature | Bakery equipment (ovens) Wafer baking machines Textile dryers | -40 °C (-40 °F) | 260 °C (500 °F) | VH | L to M |

¹⁾ LTL = Low Temperature Limit
HTPL = High Temperature Performance Limit
²⁾ mm²/s at 40 °C (105 °F) = cSt.

³⁾ LGGB 2 can withstand peak temperatures of 120 °C (250 °F)
⁴⁾ LGWA 2 can withstand peak temperatures of 220 °C (430 °F)
⁵⁾ LGHB 2 can withstand peak temperatures of 200 °C (390 °F)

| Load | Thickener / Base Oil | NLGI | Base oil viscosity ²⁾ | Vertical shaft | Fast outer ring rotation | Oscillating movements | Severe Vibrations | Shock load or frequent start up | Rust inhibiting properties | |
|---------|--|------|----------------------------------|----------------|--------------------------|-----------------------|-------------------|---------------------------------|----------------------------|---------------------------|
| L to M | Lithium soap / mineral oil | 2 | 110 | ● | | | + | | + | Wide applications greases |
| L to M | Lithium soap / mineral oil | 3 | 125 | + | ● | | + | | ● | |
| H | Lithium soap / mineral oil | 2 | 200 | ● | | ● | + | + | + | |
| L to H | Lithium complex soap / mineral oil | 2 | 185 | ● | ● | ● | ● | + | + | |
| M to H | Lithium-calcium soap / synthetic ester oil | 2 | 110 | ● | | + | + | + | ● | Special requirements |
| L to M | Aluminium complex / medical white oil | 2 | 150 | ● | | | | | + | |
| L to VH | Complex calcium sulphate/PAO | 1-2 | 320 | ● | ● | + | + | + | + | |
| H to VH | PTFE / synthetic fluorinated polyether oil | 2 | 460 | ● | ● | + | ● | ● | ● | Low temperatures |
| M to H | Lithium complex soap / synthetic PAO oil | 2 | 68 | | | + | + | + | + | |
| L | Lithium soap / synthetic PAO oil | 2 | 18 | ● | | | | ● | ● | |
| H | Lithium soap / mineral oil | 1 | 200 | | | + | | + | + | |
| L to H | Complex calcium sulphate / synthetic PAO oil / mineral oil | 1-2 | 80 | ● | ● | + | + | + | + | High loads |
| H to VH | Lithium soap / mineral oil | 2 | 500 | ● | | + | + | + | + | |
| H to VH | Lithium-calcium soap / mineral oil | 2 | 1020 | ● | | + | + | + | + | |
| L to VH | Complex calcium sulphate / mineral oil | 2 | 425 | ● | + | + | + | + | + | High temperatures |
| L to M | Di-urea / mineral oil | 2-3 | 96 | + | | | ● | ● | + | |
| H to VH | PTFE / synthetic fluorinated polyether oil | 2 | 400 | ● | + | + | ● | ● | ● | |

● = Suitable + = Recommended

| | LGMT 2 | LGMT 3 | LGEP 2 | LGWA 2 | LGGB 2 | LGFP 2 | LGFO 2 |
|---|--|---|--|--|--|---|--|
| DIN 51825 code | K2K-30 | K3K-30 | KP2G-20 | KP2N-30 | KPE 2K-40 | K2G-20 | KP1/2N-40 |
| NLGI consistency class | 2 | 3 | 2 | 2 | 2 | 2 | 1-2 |
| Thickener | Lithium | Lithium | Lithium | Lithium complex | Lithium/calcium | Aluminium complex | Complex calcium sulphonate |
| Colour | Red brown | Amber | Light brown | Amber | Off white | Transparent | Brown |
| Base oil type | Mineral | Mineral | Mineral | Mineral | Synthetic (Ester) | Medical white oil | Synthetic (PAO) |
| Operating temperature range | -30 to +120 °C (-20 to +250 °F) | -30 to +120 °C (-20 to +250 °F) | -20 to +110 °C (-5 to +230 °F) | -30 to +140 °C (-20 to +285 °F) | -40 to +90 °C (-40 to +195 °F) | -20 to +110 °C (-5 to +230 °F) | -40 to +140 °C (-40 to +284 °F) |
| Dropping point DIN ISO 2176 | >180 °C (>355 °F) | >180 °C (>355 °F) | >180 °C (>355 °F) | >250 °C (>480 °F) | >170 °C (>340 °F) | >250 °C (>480 °F) | >300 °C (>570 °F) |
| Base oil viscosity 40 °C, mm ² /s 100 °C, mm ² /s | 110 11 | 125 12 | 200 16 | 185 15 | 110 13 | 150 15,3 | 320 30 |
| Penetration DIN ISO 2137 60 strokes, 10 ⁻¹ mm 100 000 strokes, 10 ⁻¹ mm | 265-295 +50 max. (325 max.) | 220-250 280 max. | 265-295 +50 max. (325 max.) | 265-295 +50 max. (325 max.) | 265-295 +50 max. (325 max.) | 265-295 +30 max. | 280-310 +30 max. |
| Mechanical stability Roll stability, 50 hrs at 80 °C, 10 ⁻¹ mm V2F test | +50 max. 'M' | 295 max. 'M' | +50 max. 'M' | +50 max. change 'M' | +70 max. (350 max.) | | -20 to +30 max. |
| Corrosion protection Emcor: - standard ISO 11007 - water washout test - salt water test (100% seawater) | 0-0 0-0 0-1 ¹⁾ | 0-0 0-0 | 0-0 0-0 1-1 ¹⁾ | 0-0 0-0 ¹⁾ | 0-0 | 0-0 ¹⁾ | 0-0 0-0 |
| Water resistance DIN 51 807/1, 3 hrs at 90 °C | 1 max. | 1 max. ¹⁾ | 1 max. | 1 max. | 0 max. | 1 max. | 1 max. |
| Oil separation DIN 51 817, 7 days at 40 °C, static, % | 1-6 | 1-3 | 2-5 | 1-5 | 0,8-3 | 1-5 | 3 max. |
| Lubrication ability R2F, running test B at 120 °C R2F, cold chamber test, -30 °C, +20 °C | Pass | Pass | Pass | Pass, 100 °C (210 °F) | Pass, 100 °C (210 °F) ¹⁾ | | Pass |
| Copper corrosion DIN 51 811 | 2 max. 110 °C (230 °F) | 2 max. 130 °C (265 °F) | 2 max. 110 °C (230 °F) | 2 max. 100 °C (210 °F) | | 1 max. 120 °C (250 °F) | 1b max. 100 °C (210 °F) |
| Rolling bearing grease life ROF test L ₅₀ life at 10 000 r/min., hrs | | 1 000 min., 130 °C (265 °F) | | | >300, 120 °C (250 °F) | 1 000, 110 °C (230 °F) ¹⁾ | |
| EP performance Wear scar DIN 51350/5, 1 400 N, mm 4-ball test, welding load DIN 51350/4, N | | | 1,4 max. 2 800 min. | 1,6 max. 2 600 min. | 1,8 max. 2 600 min. | 1 100 min. | 1 max. >4 000 |
| Fretting corrosion ASTM D4170 FAFNIR test at +25 °C mg | | | 5,7 ¹⁾ | | | | 0,8 ¹⁾ |
| Low temperature torque IP186, starting torque, m Nm ¹⁾ IP186, running torque, m Nm ¹⁾ | 98, -30 °C (-20 °F) 58, -30 °C (-20 °F) | 145, -30 °C (-20 °F) 95, -30 °C (-20 °F) | 70, -20 °C (-5 °F) 45, -20 °C (-5 °F) | 40, -30 °C (-20 °F) 30, -30 °C (-20 °F) | | 137, -30 °C (-20 °F) 51, -30 °C (-20 °F) | 369, -40 °C (-40 °F) 223, -40 °C (-40 °F) |

¹⁾ Typical value

Special requirements

Wide applications greases

| LGED 2 | LGBB 2 | LGLT 2 | LGWM 1 | LGWM 2 | LGEM 2 | LGEV 2 | LGHB 2 | LGHP 2 | LGET 2 |
|---|---|--|--|--|---|--|--|--|--|
| KFK2U-30 | KP2G-40 | K2G-50 | KP1G-30 | KP2G-40 | KPF2K-20 | KPF2K-10 | KP2N-20 | K2N-40 | KFK2U-40 |
| 2 | 2 | 2 | 1 | 1-2 | 2 | 2 | 2 | 2-3 | 2 |
| PTFE | Lithium complex | Lithium | Lithium | Complex calcium sulphonate | Lithium | Lithium/calcium | Complex calcium sulphonate | Di-urea | PTFE |
| Off white | Yellow | Beige | Brown | Yellow | Black | Black | Brown | Blue | Off white |
| Synthetic (fluorinated polyether) | Synthetic (PAO) | Synthetic (PAO) | Mineral | Synthetic (PAO)/Mineral | Mineral | Mineral | Mineral | Mineral | Synthetic (fluorinated polyether) |
| -30 to +240 °C (-22 to +464 °F) | -40 to +120 °C (-40 to +250 °F) | -50 to +110 °C (-60 to +230 °F) | -30 to +110 °C (-20 to +230 °F) | -40 to +110 °C (-40 to +230 °F) | -20 to +120 °C (-5 to +250 °F) | -10 to +120 °C (15 to 250 °F) | -20 to +150 °C (-5 to +300 °F) | -40 to +150 °C (-40 to +300 °F) | -40 to +260 °C (-40 to +500 °F) |
| >300 °C (>570 °F) | >200 °C (390 °F) | >180 °C (>355 °F) | >170 °C (>340 °F) | >300 °C (>570 °F) | >180 °C (>355 °F) | >180 °C (>355 °F) | >220 °C (>430 °F) | >240 °C (>465 °F) | >300 °C (>570 °F) |
| 460 42 | 68 | 18 4,5 | 200 16 | 80 8,6 | 500 32 | 1 020 58 | 425 26,5 | 96 10,5 | 400 38 |
| 265-295 271 ¹⁾ | 265-295 +50 max. | 265-295 +50 max. | 310-340 +50 max. | 280-310 +30 max. | 265-295 325 max. | 265-295 325 max. | 265-295 -20 to +50 (325 max.) | 245-275 365 max. | 265-295 - |
| | +50 max. | | | +50 max. | 345 max. 'M' | +50 max. 'M' | -20 to +50 change 'M' | 365 max. | ±30 max. 130 °C (265 °F) |
| 0-0 ¹⁾ | 0-0 0-1 ¹⁾ | 0-1 | 0-0 0-0 | 0-0 0-0 0-0 ¹⁾ | 0-0 0-0 | 0-0 0-0 ¹⁾ 0-0 ¹⁾ | 0-0 0-0 0-0 ¹⁾ | 0-0 0-0 0-0 | 1-1 max. |
| 1 max. | 1 max. 4 max, 2.5 ¹⁾ | 1 max. | 1 max. | 1 max. | 1 max. | 1 max. | 1 max. | 1 max. | 0 max. |
| | | <4 | 8-13 | 3 max. | 1-5 | 1-5 | 1-3, 60 °C (140 °F) | 1-5 ¹⁾ | 13 max. 30 hrs 200 °C (390 °F) |
| | | | | Pass, 140 °C (285 °F) Pass, Pass | Pass, 100 °C (210 °F) | | Pass, 140 °C (285 °F) | Pass | |
| 1 max. 100 °C (210 °F) ¹⁾ | 1 max. 120 °C (250 °F) | 1 max. 100 °C (210 °F) | 2 max. 90 °C (>195 °F) | 2 max. 100 °C (210 °F) | 2 max. 100 °C (210 °F) | 1 max. 100 °C (210 °F) | 2 max. 150 °C (300 °F) | 1 max. 150 °C (300 °F) | 1 max. 150 °C (300 °F) |
| >700 at 220 °C (430 °F) | | >1 000, 20 000 r/min. 100 °C (210 °F) | | 1 824 ¹⁾ , 110 °C (230 °F) | | | >1 000, 130 °C (265 °F) | 1 000 min. 150 °C (300 °F) | >1 000 ¹⁾ at 220 °C (428 °F) |
| 8 000 min. | 0,4 ¹⁾ 5 500 ¹⁾ | 2 000 min. | 1,8 max. 3 200 min. ¹⁾ | 1,5 max. ¹⁾ 4 000 min. ¹⁾ | 1,4 max. 3 000 min. | 1,2 max. 3 000 min. | 0,86 ¹⁾ 4 000 min. | | 8 000 min. |
| | 0-1 ¹⁾ | | 5,5 ¹⁾ | 5,2 / 1,1 at -20 °C (-5 °F) ¹⁾ | | | 0 ¹⁾ | 7 ¹⁾ | |
| | 313, -40 °C (-40 °F) 75, -40 °C (-40 °F) | 32, -50 °C (-60 °F) 21, -50 °C (-60 °F) | 178, 0 °C (32 °F) 103, 0 °C (32 °F) | 249, -40 °C (-40 °F) 184, -40 °C (-40 °F) | 160, -20 °C (-5 °F) 98, -20 °C (-5 °F) | 96, -10 °C (14 °F) 66, -10 °C (14 °F) | 250, -20 °C (-5 °F) 133, -20 °C (-5 °F) | 1 000, -40 °C (-40 °F) 280, -40 °C (-40 °F) | |

High loads

Low temperatures

High temperatures

SKF oils for food processing industry

| Grease | Description | Application examples | Base oil | Temperature range ¹⁾ | |
|-----------------|-------------------------------|--|---------------|---------------------------------|--------------------|
| | | | | LTL | HTPL |
| LFFH 46 | Food grade hydraulic oil | Presses and oil circulating systems | PAO | -60 °C (-76 °F) | 140 °C (284 °F) |
| LFFH 68 | Food grade hydraulic oil | Presses and oil circulating systems | PAO | -50 °C (-58 °F) | 140 °C (284 °F) |
| LFFG 220 | Food grade gear oil | Enclosed gear boxes as in filling machines or conveyor lines | PAO | -40 °C (-40 °F) | 140 °C (284 °F) |
| LFFG 320 | Food grade gear oil | Enclosed gear boxes as in filling machines or conveyor lines | PAO | -35 °C (-31 °F) | 140 °C (284 °F) |
| LFFM 80 | Food grade chain oil | High humidity applications as proof ovens and pasta driers | Mineral/ester | -30 °C (-22 °F) | 120 °C (248 °F) |
| LHFP 150 | Food grade chain oil | General chain lubrication as in confectionery industries and fruit and vegetable processing. | PAO/ester | -30 °C (-22 °F) | 120 °C (248 °F) |
| LFFT 220 | Food grade chain oil | High temperature applications as bakery ovens | Ester | 0 °C (32 °F) | 250 °C (482 °F) |
| LDS 1 | Food grade dry film lubricant | Conveyors in bottling lines using PET, carton, glass or can packages | Mineral/PTFE | -5 °C (25 °F) | 60 °C (140 °F) |

SKF lubricants for non bearing applications

| Grease | Description | Application examples | Thickener/Base Oil | Temperature range ¹⁾ | |
|-----------------|--------------------------------|---|-----------------------------|---------------------------------|--------------------|
| | | | | LTL | HTPL |
| LMCG 1 | Grid and gear coupling grease | Grid and gear couplings Flexible heavy duty grid and gear coupling | Polyethylene / mineral | 0 °C (32 °F) | 120 °C (248 °F) |
| LGLS 0 | Low temperature chassis grease | Plain bearings and chassis sliding surfaces. Centralized lubrication systems | Anhydrous calcium / mineral | -40 °C (-40 °F) | 100 °C (212 °F) |
| LHMT 68 | SKF Chain Oil | ideal for medium temperatures and dusty environments | Mineral | -15 °C (5 °F) | 90 °C (194 °F) |
| LHHT 265 | SKF Chain Oil | ideal for high load and/or high temperature conditions | PAO/ester | -15 °C (5 °F) | 250 °C (482 °F) |

¹⁾ LTL = Low Temperature Limit
HTPL = High Temperature Performance Limit

Understanding grease technical data

Some basic knowledge is required to understand the technical data so that you can select the proper grease. This is an excerpt of the main terms mentioned in SKF grease technical data.

Consistency

A measure of the stiffness of a grease. A proper consistency must ensure that the grease stays in the bearing without generating too much friction. It is classified according to a scale developed by the NLGI (National Lubricating Grease Institute). The softer the grease, the lower the number. Grease for bearings are typically NLGI 1, 2 or 3. The test measures how deep a cone falls into a grease sample in tenths of mm.

| Classification of greases by NLGI consistency number | | |
|--|---|--------------------------------|
| NLGI number | ASTM worked penetration (10 ⁻¹ mm) | Appearance at room temperature |
| 000 | 445–475 | very fluid |
| 00 | 400–430 | fluid |
| 0 | 355–385 | semi-fluid |
| 1 | 310–340 | very soft |
| 2 | 265–295 | soft |
| 3 | 220–250 | medium hard |
| 4 | 175–205 | hard |
| 5 | 130–160 | very hard |
| 6 | 85–115 | extremely hard |

Temperature range

Comprehends the suitable working range of the grease. It goes between the low temperature limit (LTL) and the high temperature performance limit (HTPL). LTL is defined as the lowest temperature at which the grease will allow the bearing to be started up without difficulty. Below this limit, starvation will occur and cause a failure. Above HTPL, the grease will degrade in an uncontrolled way so that grease life cannot be determined accurately.

Dropping point

Temperature at which a grease sample, when heated, will begin to flow through an opening according to DIN ISO 2176. It is important to understand that this point is considered to have limited significance for performance of the grease as it is always far above HTPL.

Viscosity

A measure of a fluid's resistance to flow. For lubricants, a proper viscosity must guarantee an adequate separation between surfaces without causing too much friction. According to ISO standards, it is measured at 40 °C (105 °F), as viscosity changes with temperature. Values at 100 °C (210 °F) allow calculation of the viscosity index, e.g. how much the viscosity will decrease when temperature rises.

Mechanical stability

The consistency of bearing greases should not significantly change during its working life. Three main tests are normally used to analyse this behaviour:

- **Prolonged penetration**

The grease sample is subjected to 100 000 strokes in a device called a grease worker. Then, the penetration is measured. The difference against penetration at 60 strokes is reported as the change in 10⁻¹ mm.

- **Roll stability**

A grease sample is placed in a cylinder with a roller inside. The cylinder is then rotated for 72 or 100 hours at 80 or 100 °C (175 or 210 °F) (the standard test demands just 2 hours at room temperature). At the end of the test period, once the cylinder has cooled to room temperature, the penetration of the grease is measured and the change in consistency is reported in 10⁻¹ mm.

- **V2F test**

A railway axlebox is subjected to vibration shocks of 1 Hz from a bouncing hammer producing an acceleration level between 12–15 g. After 72 hours at 500 r/min., the grease leaked from the housing through the labyrinth seal is collected in a tray. If it weighs less than 50 g, a rating of 'm' is granted, otherwise it is rated as 'fail'. Afterwards, the test is continued for another 72 hours at 1 000 r/min. If less than 150 grams of grease leaked after completion of both tests, then a rating of 'M' is given.

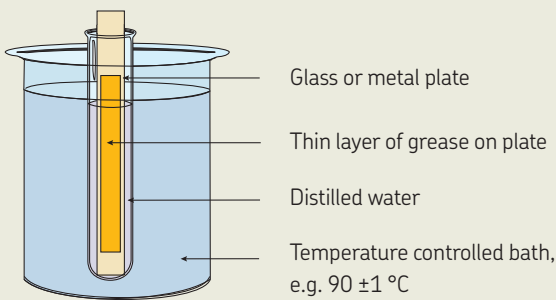
Corrosion protection

Corrosive environments demand special properties for rolling bearing greases. During the Emcor test, bearings are lubricated with a mixture of grease and distilled water. At the end of the test, a value between 0 (no corrosion) and 5 (very severe corrosion) is given. Salt water, instead of distilled water or continuous water flow (washout test), can be used to make the test more severe.

Water resistance

A glass strip is coated with the candidate grease, which is placed into a water-filled test tube. The test tube is immersed in a water bath for three hours at a specified test temperature. The change in the grease is visually evaluated and reported as a value between 0 (no change) and 3 (major change) along with the test temperature.

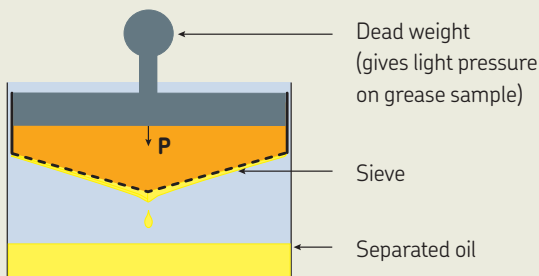
Water resistance test



Oil separation

Lubricating greases release oil when stored for long periods of time or when used in bearings as a function of temperature. The degree of oil separation will depend upon the thickener, base oil and manufacturing method. In the test, a cup is filled with a given quantity of grease (and is weighed before the test) and a 100 gram weight is placed on top of the grease. The complete unit is placed into an oven at 40 °C (105 °F) for one week. At the end of the week, the amount of oil which has leaked through the sieve, is weighed and reported as a percentage of weight loss.

Oil separation test



Lubrication ability

The R2F test assesses the high temperature performance and lubricating ability of a grease. A shaft with two spherical roller bearings in their respective housings is driven by an electric motor. The bearings are run under load, the speed may be varied and heat can be applied. The test method is carried out under two different conditions after which the wear of the rollers and the cage is measured. Test A is conducted at ambient temperature and a “pass” rating means that the grease can be used to lubricate large bearings at normal operating temperatures and also in low vibrating applications. Test B runs at 120 °C (250 °F) and a “pass” rating indicates suitability for large bearings at high temperatures.

Copper corrosion

Lubricating greases should protect copper alloys used in bearings from corrosive attack while in service. To assess these properties, a copper strip is immersed in the grease sample and placed in an oven. The strip is then cleaned and the degradation is observed. The result is rated by a numerical system and a rating above 2 indicates poor protection.

Rolling bearing grease life

The ROF and ROF+ tests determine the grease life and its high temperature performance limit (HTPL). Ten deep groove ball bearings are fitted into five housings and filled with a given quantity of grease. The test is undertaken at a pre-determined speed and temperature. Axial and radial loads are applied and the bearings run to failure. The time to failure is recorded in hours and a Weibull life calculation is made to establish the grease life. This information can then be used to determine re-lubrication intervals in an application.

Extreme pressure (EP) performance

The 4-ball weld load test rig uses three steel balls held in a cup. A fourth ball is rotated against the three balls at a given speed. A starting load is applied and increased at pre-determined intervals until the rotating ball seizes and welds to the stationary balls. Values above 2 600 N are typically expected in EP grease. Under the 4-ball wear scar test, SKF applies 1 400 N (standard test uses 400 N) on the fourth ball during 1 minute. The wear on the three balls is measured and values below 2 mm are considered as appropriate values for EP greases.

Fretting corrosion

Vibrating or oscillating conditions are typical causes for fretting corrosion. Under the FAFNIR test, two thrust ball bearings are loaded and subjected to oscillation. The wear on each bearing is then measured. A wear below 7 mg indicates good fretting protection.

| Thickener compatibility chart | | | | | | | | | | | |
|-------------------------------|---------|---------|--------|-----------------|-----------------|----------------|----------------|-------------------|------------------|-------------------------------|----------------------------|
| | Lithium | Calcium | Sodium | Lithium complex | Calcium complex | Sodium complex | Barium complex | Aluminium complex | Clay (Bentonite) | Common polyurea ¹⁾ | Calcium sulphonate complex |
| Lithium | + | ● | - | + | - | ● | ● | - | ● | ● | + |
| Calcium | ● | + | ● | + | - | ● | ● | - | ● | ● | + |
| Sodium | - | ● | + | ● | ● | + | + | - | ● | ● | - |
| Lithium complex | + | + | ● | + | + | ● | ● | + | - | - | + |
| Calcium complex | - | - | ● | + | + | ● | - | ● | ● | + | + |
| Sodium complex | ● | ● | + | ● | ● | + | + | - | - | ● | ● |
| Barium complex | ● | ● | + | ● | - | + | + | + | ● | ● | ● |
| Aluminium complex | - | - | - | + | ● | - | + | + | - | ● | - |
| Clay (Bentonite) | ● | ● | ● | - | ● | - | ● | - | + | ● | - |
| Common polyurea ¹⁾ | ● | ● | ● | - | + | ● | ● | ● | ● | + | + |
| Calcium sulphonate complex | + | + | - | + | + | ● | ● | - | - | + | + |

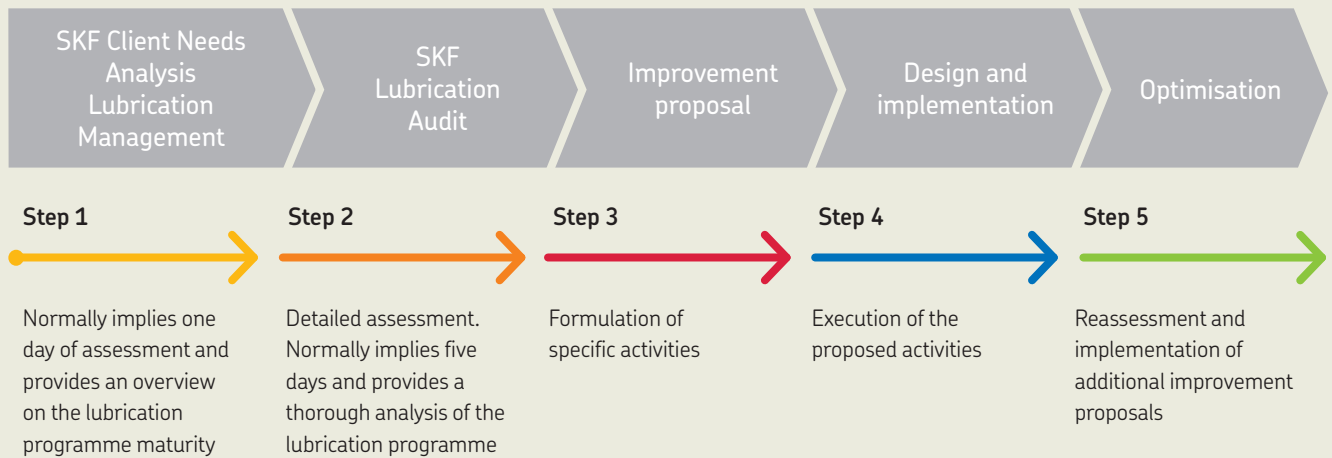
| Base oil compatibility chart | | | | | | | |
|------------------------------|-------------|-------|------------|------------------|------------------|-----------------|------|
| | Mineral/PAO | Ester | Polyglycol | Silicone: Methyl | Silicone: Phenyl | Polyphenylether | PFPE |
| Mineral/PAO | + | + | - | - | + | ● | - |
| Ester | + | + | + | - | + | ● | - |
| Polyglycol | - | + | + | - | - | - | - |
| Silicone: Methyl | - | - | - | + | + | - | - |
| Silicone: Phenyl | + | + | - | + | + | + | - |
| Polyphenyl-ether | ● | ● | - | - | + | + | - |
| PFPE | - | - | - | - | - | - | + |

+ = Compatible
 ● = Test required
 - = Incompatible

¹⁾ SKF high performance, high temperature bearing grease LGHP 2 is not a common polyurea type grease. It is a di-urea bearing grease, which has successfully been tested for compatibility with lithium and lithium complex thickened greases i.e. LGHP 2 is compatible with such greases.

Lubrication management

Just as asset management takes maintenance to a higher level, a lubrication management approach allows lubrication to be seen from a wider point of view. This approach helps to effectively increase machine reliability at a lower overall cost.



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