Guide for Choosing Lubricants

General

Information about the manual

Important

This manual contains very important information concerning safety and equipment protection for maintenance and operating workers.

Carefully read the entire manual before working (maintenance or operating) on any component or subcomponent.

Manual structure

To allow quick access to information, the manual is divided into sheets.

Each sheet covers a specific procedure or information and is identified by the module letter, followed by numerical digits displayed in the upper right corner.

However, the present manual only contains modules and sheets concerning the specific task or ropeway this manual is designed for.

Code		Information
A	A0	Information about the manual
	A1	Description
	A2	Technical data
C	C0	Checklist for assembly
	C1	Instructions for a prolonged shutdown and storage
	C2	Preparation and installation
	C3	Adjustments
D	D1	Checklist for commissioning
	D3	Instructions in case of failure
	D4	Use and operation
E	E1	Maintenance table
	E2	Preventive maintenance tasks
F	F1	Troubleshooting table
G	G1	Cleaning, protection and lubrication
	G2	Replacement work
H	H2-H9	Spare parts

Equipment information

Our company cannot be held responsible if the component is used outside the terms defined in this manual.

Reservations concerning modifications and copies

This manual is the property of our company which reserves the right to modify the contents herein without prior notice.

Indications and symbols

The following table shows the symbols and signal words used in this manual.

These conventional symbols mark important messages relating mainly to worker safety as well as component integrity.

Safety message information type

DANGER

Indicates an immediate danger for workers, which could cause death or serious injury, should the safety regulations be ignored.

WARNING

Indicates a potential danger for workers, which could cause death or serious injury, should the safety regulations be ignored.

CAUTION

Indicates a potential danger for workers, which could cause light or moderate injury, should the safety regulations be ignored.

NOTICE

Indicates a danger for component integrity, which could lead to danger for workers and passengers.

Safety message information content

The information content of a safety message is explained below (example with CAUTION level). A safety message could include the following information:

CAUTION

Type and source of hazard

Consequences

► Remedy action

Method of lubricant selection

The quality concept

The quality of the lubrication is one of the most important factors for the life time of each mechanical system. Our design department has developed precise recommendations for users in close collaboration with our suppliers in terms of:

- types of lubricants
- required viscosities
- required specifications for each use
- maintenance intervals

In these recommendations, the design and functioning of the various components as well as the operating conditions to which the ropeway is exposed were fully taken into account:

- high speed and high throughput,
- load variations,
- heat and cold,
- great variations in temperature,
- moisture, frost
- long standstill periods between the single seasons.

Selected products

First filling and customer service

For the first filling and customer service, we have selected products:

- which are ideally suited for use in alpine, arctic and tropical conditions
- whose life time corresponds to the specified lubrication intervals
- offering an excellent price-performance ratio

These products are available as spare parts at our customer service department.

Selection of the products by the operator

It is the responsibility of the operator to select products whose quality and properties are suitable for the conditions under which the ropeway is operated.

If the operator purchases lubricants directly from a manufacturer or a trading company, he/she should ensure that the properties of each delivered charge of products are unchanged or remain within the limits of the corresponding specification.

Furthermore, the operator should ensure that the properties and characteristics of the selected product remain within the required specification until the next oil change.

Products with secondary raffinates are not permitted.

Our society and our suppliers assume no liability if an operator selects unsuitable lubricants or lubricants which are not contained in this manual.

General information regarding lubricants

Properties of an oil

Among other things, an oil can have the following properties:

- Viscosity
- Viscosity index
- Pour point
- Flash point
- Oxidation resistance

Viscosity

The viscosity of the oil is a measure of its natural flow velocity.

The unit of the dynamic viscosity is mPa.s. The old unit is "centipoise".
The unit of the kinematic viscosity is mm^2/s. The old unit is "centistoke" (cSt).

A higher number indicates a higher viscosity (flow time).

There are two classifications for oil, based on its viscosity:

- The ISO classification is generally used for industrial oils and is based on the kinematic viscosity at 40 ºC – Example: ISO 220 = Viscosity of 220 mm^2/s ± 10 %.
- The SAE classification for motor and gear oils (standard of US automobile industry) indicates the viscosity at low temperature (a number followed by the letter "W") and at high temperature (only one number). Example: 80W–90.

The viscosity is chosen according to the operating conditions under which the oil will be used within a range of operating temperatures:

- In cold conditions, the viscosity must be sufficiently low for the oil to ensure efficient lubrication as soon as the ropeway is started.
- In warm conditions, the viscosity must be sufficiently high to maintain a permanent oil film.

Viscosity index

The temperature of the oil has a strong influence on its viscosity. The viscosity index is a conventional number indicating the degree in which the viscosity varies according to the temperature.

The higher the viscosity index, the smaller the viscosity variations.

As an example, the viscosities (in mm^2/s) of two oils with an original viscosity of **$22mm^2/s$** at **40 °C**, but with different viscosity index, are shown in the following table:

Temperature	Index of 100	Index of 160
40°C	**$22mm^2/s$**	**$22mm^2/s$**
-10°C	**$350mm^2/s$**	**$270mm^2/s$**
80°C	**$6.8mm^2/s$**	**$7.3mm^2/s$**

Pour point The pour point of the oil is the temperature at which the oil flows under a certain set of conditions.

In general, the pour point is at **3 °C** over the solidification point, at which the oil stops flowing.

Flash point The flash point of a material is the lowest temperature at which a flammable vapour/air mixture may be produced above a material. If the volume of the mixture is large enough, this may lead to an explosion. Below the flash point, the flame front cannot spread away from the ignition source, as the heat coming from the oxidation is not sufficient to heat the mixture up to the temperature required for combustion.

Oxidation resistance The oxidation resistance specifies the ageing resistance of the oil. This is an important characteristic, as it defines the interval between the oil changes.

Properties of a grease

A grease has the following properties:

- Composition
- Viscosity of the base oil
- EP properties
- Behaviour in the presence of water

Composition A grease consists of:

- a lubrication base, in synthetic or mineral oil (base oil)
- a thickening agent, normally a metal soap (lithium, calcium etc.)
- additions, for example extreme pressure additives (EP additives) or corrosion inhibitors

Greases with different thickening agents cannot necessarily be mixed. The same rule shall apply, if the base oils are different.

The NLGI class specifies the consistency of the grease.

The lower the class, the softer the grease.

Consistency classification for lubricants according to DIN 51 818

The classification of the lubricants is carried out in NLGI classes after the worked penetration and is used to differentiate the lubricants according to their consistency (mouldability) and their structure.

NLGI: National Lubricating Grease Institute

NLGI consistency class no.	Worked penetration according to DIN ISO 2137 units*)	Visual assessment of the mouldability	Use
000 00	445-475 400-430	similar to very thick oil, very soft	gear grease
0 1	355-385 310-340	soft	

NLGI consistency class no.	Worked penetration according to DIN ISO 2137 units*)	Visual assessment of the mouldability	Use
2 3 4	265-295 220-250 175-205	ointment-like almost solid solid	roller bearing grease sliding bearing grease
5 6	130-160 85-115	very solid	block grease

Viscosity of the base oil

The viscosity of the oil contained in the grease is used for calculating the specified life time of the bearings.

The viscosity of the base oil must be chosen according to the circumferential speed and load acting on the bearing:

- Low viscosity is required for high speeds and low loads.
- High viscosity is required for low speeds and high loads.

EP properties

To determine the ability of the lubricant to maintain the lubrication under high loads, a standard test called Shell four-ball test (ASTM D2596) is used. The results indicate the seizure loads and weld loads the grease is able to tolerate under test conditions.

A lubricating grease that is used for highly stressed bearings for low rotational speeds must generally contain EP additives. The grease must be subjected to this test and on the data sheet at least the weld load should be indicated.

Behaviour in the presence of water

To measure the ability of the grease to protect bearings against corrosion in the presence of water, a standard test called SKF Emcor or Emcor test (IP 220-Standard) is used.

The first part of the test is carried out on bearings containing grease that is contaminated with water. The results indicate the corrosion on a scale of **0** to **5**, whereby:

- **0** = no corrosion
- **5** = strong corrosion on more than **10%** of the surface.

Good lubricating grease should have the value **0**.

In the second part of the test, the washing effect of the water is measured. This test is carried out by letting water flow through lubricated bearings. The results are evaluated the same way as for the first part of the test.

In an additional washout test with water (ASTM D1264), a lubricated bearing is subjected to a jet of water. After the end of the test, the percentage loss of grease is measured. This percentage should be as low as possible.

Information about the miscibility of oils

Base oil

Modern lubricants are produced from numerous "ingredients". The basis for this is a base oil that is contained in the end product by more than 50%. Most often, paraffin-based and mineral-based oils are used, which are produced in a lubricating oil refinery from crude oil distillates. In particular, if characteristics such as biodegradability, high ageing stability or improved viscosity temperature behaviour are required, synthetic base liquids are used.

Overview of base oils

Base oils	Description
Mineral oil raffinate	Vacuum distillate of raw oil
Hydrocrack oil	"Heat-treated" mineral oil with optimised molecular structure
Poly-α-olefin (PAO) Polyisobutene (PIB)	Synthetic base oil with paraffinic basic structure
Ester	Synthetic and natural liquid produced from alcohol or acid
Glycols	Polyvalent alcohol produced synthetically from mineral oil or carbon
Silicone oil	Synthetic liquid (polydimethylsiloxane PDMS)
Perfluorinated hydrocarbons	Synthetic oil on the basis of perfluorinated polyether oils (PFPE, fluorpolymers)
Alkylbenzene	Synthetic oil on the basis of aromatic hydrocarbons
Bone oil	Lubricating oil produced from bones for precision drive systems

Additives

In most instances, the base oil alone is not sufficient to cover the wide range of tasks which an oil must fulfil for the respective use. For reliable lubrication and in order to ensure long-term and smooth operation, single additions or also complex combinations of substances, the so-called additives, are added. This oil "alloy" can reinforce existing characteristics of the base oil or provide the end product with completely new characteristics. The list of the various additive components is long.

The single additive components are mostly combined into an additive package, depending on requirement. When mixing, the substances and additive packages are added to the base oil that has been heated to **40°C - 60°C** and stirred or swirled intensively, until they are fully dissolved in the oil. For motor oils, the content of additives can be up to **20%**, for hydraulic oils it can be less than **1%**.

Overview of additives

Additive	Description
Corrosion protection additives	Protection of the metallic surfaces against attack by moisture and acid or alkali
Wear protection additives	Avoid the direct contact of the metallic surfaces in the mixed area and the boundary friction area
Oxidation protection additives	Prevent or slow down the oil oxidation. Thus, they delay oil ageing and extend the duration of the oil.
Detergents / dispersants	Reach soil dissolving and soil suspending properties (e.g. soot, mud, water)
VI improvers	Optimisation of the viscosity-temperature dependence
Anti-foam addition	Improvement of the foaming characteristics
Swell agents	The behaviour of the oil towards sealing materials is set precisely.
Friction coefficient changer	Specific setting of a required friction coefficient characteristic

Mixing of different oils

The mixing of different oil types such as motor oil with hydraulic oil or compressor oil with gear oil, also if the base oil basis is the same and the viscosity is similar, is not permitted. In the industry sector, mixing of the same oil types such as CLP gear oils of different oil manufacturers should be avoided, if the additives or the base oil basis of these oils is unknown.

The mixing or contamination of a lubricant by the oil of a different manufacturer or by a different oil type is one of the main reasons for ropeway problems. A clear distinction is to be made between miscibility and compatibility. Oil with the same base oil basis, similar viscosity, comparable density can in fact be mixed. However, their compatibility with each other mainly depends on their additive.

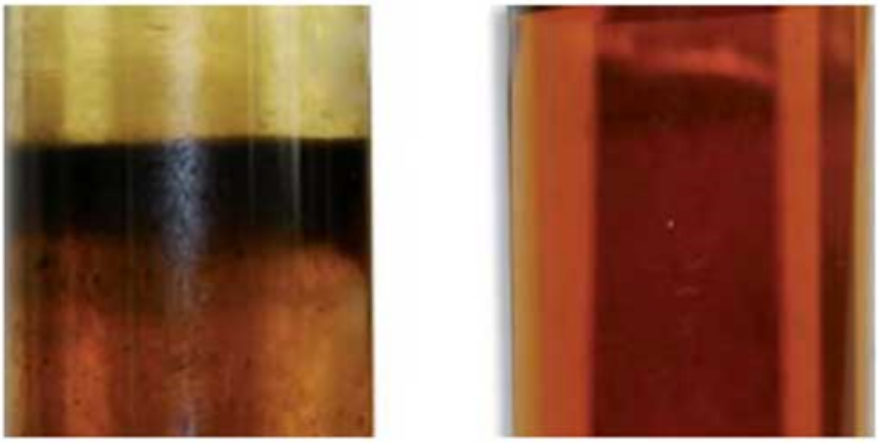


Illustration 1: Comparison between non-miscible and miscible oils

There are some general notes, e.g. in product information, that can be used for a preliminary assessment:

- Are the markings comparable according to DIN or ASTM standards, are the same requirement standards (HLP, CLP, TD-L, SAE, API, ACEA) met?
- Do the oils meet the same general specifications, have they been released by the same ropeway manufacturers?
- Are the same mechanical test procedures (carrier test, VKA, Brugger, FE8, foam test) fulfilled?
- Are parameters such as viscosity, viscosity index, density, ash content or flash point comparable?

The following oils should not be mixed:

- Zinc-free and zinc-containing hydraulic oils and circulating oils
- Oils with deterging and non-deterging characteristics
- Glycol-based synthetic oils with all other synthetic oils

Miscibility The miscibility describes a chemical characteristic. Two liquids are truly miscible if they are completely and easily soluble in one another.

Compatibility Compatibility means that two oils can be mixed, but that they still keep their individual properties.

Miscibility is usually the characteristic which the supplier is willing to confirm and which is quite easy to fulfil as a main requirement. Information on the compatibility of lubricants is not so easily accessible. Before mixing oils with different designations, it is necessary to clarify if also the same or similar additive packages are used beside the same base oil basis. For example, HLP hydraulic oils whose formulation can contain zinc-containing or zinc-free additive combinations are always miscible according to DIN 51524, but are only very seldom compatible with one another.

If incompatible oils are mixed, e.g. during incomplete oil change, the following problems may occur:

- Increased formation of surface foam
- Deteriorated air release properties
- Increased risk of cavitation
- Seal wear
- Changed behaviour towards water
- Affected demulsifying and emulsifying properties
- Changed friction characteristic
- Changed wear protection behaviour
- Increased system contamination due to dissolved deposits
- Degradation of filterability or reduced filter life
- Increased formation of deposits due to additive reactions

Avoidance of mixing

It is possible to reduce the risk for unintended mixing during the daily contact with oils:

- Carry out an exact incoming goods inspection.
- In the oil storage, identify the storage locations for the single lubricant types.
- For each oil type, use a separate oil refill can, marked with a different colour. Use the same colour for the oil filler neck.
- Report the lubricated area in a lubrication plan together with the denomination of the oil.

Information about the miscibility of greases

Base grease

Lubricating greases are composites; i.e. they are composed of several components. The base of lubricating greases is a lubricating oil with a portion of approx. 75%. A102

Additional 15% are thickeners (also called soap) and the remaining 10% are composed of additives. A102

Metal soap thickener

■ **Basic soaps**

Basic soaps	Description
Lithium soap	Mixtures of lithium salts of several fatty acids
Aluminium soap	Mixtures of aluminium salts of several fatty acids
Barium soap	Mixtures of barium salts of several fatty acids
Calcium soap	Calcium salts or magnesium salts
Sodium soap	Mixtures of sodium salts of several fatty acids

■ **Complex soaps**

Basic soaps	Description
Lithium complex soap	Mixtures saponified with lithium hydroxide
Aluminium complex soap	Mixtures saponified with aluminium hydroxide
Barium complex soap	Mixtures saponified with barium hydroxide
Calcium complex soap	Mixtures saponified with calcium hydroxide
Sodium complex soap	Mixtures saponified with sodium hydroxide

Soap-free thickener

Soap-free thickener	Description
Inorganic thickener (bentonite)	Mixtures of various clay minerals
Silica	Fireproof ceramic material

Soap-free thickener	Description
Polyurea	Polyaddition of isocyanates and amines
Polytetrafluorethylene (PTFE)	Teflon

Mixing various types of grease

When mixing greases, the thickeners and base oils used in the corresponding greases must be compatible. Certain base oils cannot be mixed. *A102*

Avoidance of mixing

It is possible to reduce the risk for unintended mixing during the daily contact with greases:

- Carry out an exact incoming goods inspection.
- In the grease storage, identify the storage locations for the single lubricant types.
- Report the lubricated area in a lubrication plan together with the denomination of the grease.

If a change or replacement of a lubricant is requested, always check with the producer first, if the two products are compatible. If they are not compatible, the old lubricant must be completely removed by dismantling and cleaning the single parts of the components and a new lubricant must be applied.

General information for lubricant analysis

01 Analysis of a lubricant

NOTICE

Possible damage to the product!

- In general, the results of the lubricant condition analysis and any further use of the lubricant must be discussed with the supplier of the lubricant. The lubricant condition analysis is not an alternative to a regular lubricant change, but can only postpone a lubricant change.

Information

The kit needed to perform a lubricant condition analysis can be ordered from any supplier of the specific lubricant.

Information

In case of a regular lubricant condition analysis:

- always use the same sampling point (for optimal comparability).
- the results of the lubricant condition analysis must be stored in any case, at least until the next oil change.

The life time of a lubricant depends very strongly on the actual operating conditions.

With the lubricant condition analysis, the actual general condition of the lubricant can be determined. When analysing the condition of a lubricant, appearance, viscosity, deterioration, water content and, if required, solid foreign objects, are checked. Depending on the analysis result, the lubricant can continue to be used or must be replaced.

An oil change planned in the maintenance lists can be postponed if the result is positive. The oil change can be postponed until the maximum deterioration of the lubricant.

A lubricant condition analysis is recommended annually or every 2,000-3,000 operating hours.

Oil sampling

1. Ensure that the oil is well mixed.
   ⇒ **Assistance**
   The sampling should be performed shortly after operation stop.
2. Ensure that the sample cannot be contaminated.
   ⇒ **Recommendation**
   Clean the sampling point and use rubber gloves.
3. Guide the disposable tube included in the set into the opening.

4. Remove the lid of the vacuum bottle included in the set.
5. Connect the vacuum bottle to the disposable tube.
   ⇒ **Important**
   The connection must be leaktight.
6. Open the valve of the vacuum bottle.
   ⇒ **Detail**
   The position of the vacuum bottle is not important.
7. Wait until the vacuum bottle is filled by approx. 80%.
8. Close the valve and fit the lid.
9. Send the filled vacuum bottle to the oil condition analysis.
   ⇒ If oil is sampled for the first time, the initial sampling form must be filled out.

Grease sampling

1. Ensure that the grease is well mixed.
   ⇒ **Assistance**
   The sampling should be performed shortly after operation stop.
2. Ensure that the sample cannot be contaminated.
   ⇒ **Recommendation**
   Clean the sampling point and use rubber gloves.
3. Sample the grease using the spatula included in the set.
4. Wipe off the grease into the bottle included in the set.
   ⇒ **Detail**
   Fill the bottle by approx. 80%.
5. Send the filled vacuum bottle to the grease condition analysis.
   ⇒ If grease is sampled for the first time, the initial sampling form must be filled out.

Rules for the use and storage of lubricants

Rules for use and storage

The quality of the lubricants chosen by our company for the use of assemblies is an important factor for the correct operation and stability of these assemblies.

The rules for the storage and handling listed below must be respected in order to maintain the original characteristics of the products.

Quality of the storage

The lubricants must be stored as follows:

- protected from extreme atmospheric conditions
- protected from any significant variations in temperature
- on a base by means of which they are insulated from the ground

Water should not accumulate on the lids or around the caps.

It is important that the product labels are kept in a good condition, as they are the only way to clearly recognise the stored products.

Partial use of a product

After opening, the product containers must be securely closed. The product must not be contaminated by water, dust, metal chips etc.

Stock turnover

When using the products, the "FIFO" system must be applied.

When opening a product, the date should be marked on the label in order to ensure efficient stock turnover.

Storage periods

Respect the following storage periods. After this period, a visual inspection of the lubricant must be carried out. In case of doubt, please contact the supplier.

Product type	Storage period
Unopened product in case of proper storage	3 years
Opened product in case of proper storage	6 months

01 Using the lubricants

General use of the lubricants

In general, there are some things to consider when using lubricants.

Basic corrosion protection

Illustration 1: Apply sufficient lubricant for basic corrosion protection

In general, corrosion must be avoided in all components; this applies in particular to bearing seats of bushings and the associated pins. Thus, if components are stored unprotected for a longer period of time (for example outside), these bearing seats and pins must be provided with a protective lubricating film as basic corrosion protection. *Application and insertion of the lubricant*

Illustration 2: Insufficient lubricant applied for basic corrosion protection

If the bearing seats of bushings or the associated pins have not been protected or not sufficiently protected with lubricant, a layer of corrosion has formed which must be removed in any case (before inserting the bushings if they are not already pre-assembled)!

NOTICE

Sandpaper that is too coarse to remove the corrosion layer can cause damage to the product.

NOTICE

Corrosion may be too advanced (for example, if the bushing has too much play in the bearing seat after removal of the corrosion layer).

► The component must not be used and must be replaced.

Illustration 3: Corrosion layer or protective lubricating film layer removed without residue

When the corrosion layer or the protective lubricating film layer has been removed without residue, the assembly of the bushings and the bolts can begin. The intended lubricant must be applied to the walls of the bearing seat of the bushings (provided the bushing is not yet fitted), to the bushing itself and to the associated pin! *Application and insertion of the lubricant*

Renewal of the lubricating film

For upcoming maintenance

If a component is dismantled, for example, for upcoming maintenance, it is recommended to renew the lubricating film. This requires first of all mechanical cleaning of the dismantled part with a cloth. After the coarsest grease residues have been removed, the last lubricant residues must be removed, ideally with cold cleaner, so that the new lubricant also adheres. If the part has to wait longer for reassembly, it must be cleaned during assembly. The new lubricant must already be applied to the lubricating surfaces of the parts to be lubricated before assembly in order to obtain basic corrosion protection. After assembly of the component, relubrication can be carried out via the grease nipples; this is ideally done when the pin is in motion. *Application and insertion of the lubricant*

When maintenance is not upcoming

If the lubricant changes and the component is not due for maintenance, the old lubricant must be pressed out with the new lubricant. To ensure that the new lubricant completely replaces the old one, this process must be repeated a week later. If there are still traces of the old lubricant in the new one, repeat this process every week until the old lubricant has been completely removed. *Application and insertion of the lubricant*

Application and insertion of the lubricant

When applying the basic corrosion protection and when pressing in lubricant via the lubrication points, make sure that not too much lubricant is applied/pressed in. More lubricant than necessary is not (necessarily) better - neither in terms of cost nor sustainability.

NOTICE

Inserting grease too quickly.

This can lead to damage to the product.

- ► Electric or pneumatic grease guns with flow rates of more than 30ml/min must generally not be used when lubricating small sliding bearing bushings. Here the use of a hand grease gun or a mechanical grease pump with similar delivery rates is mandatory.

Using the lubricants

Pin-bore and pin-bushing connections

When fitting the pins, it is necessary to carry out the following operations:

1. Clean the pin.
2. Clean the bore.
3. Lubricate the pin with a thin lubricant layer.
4. Lubricate the bore with a thin lubricant layer.
5. Insert the pin into the bore.
6. Wipe off any escaping excess lubricant on the sides.

Splined shaft connections

Illustration 4: Correctly lubricated splined shaft connection

Illustration 5: Incorrectly lubricated splined shaft connection

1. Clean the splined shaft connection to remove dirt and residues of old lubricant.
2. Apply a thin lubricating film to the toothing.
   ⇒ **IMPORTANT**
   A too thick lubricating film is removed during assembly.

Open roller bearings

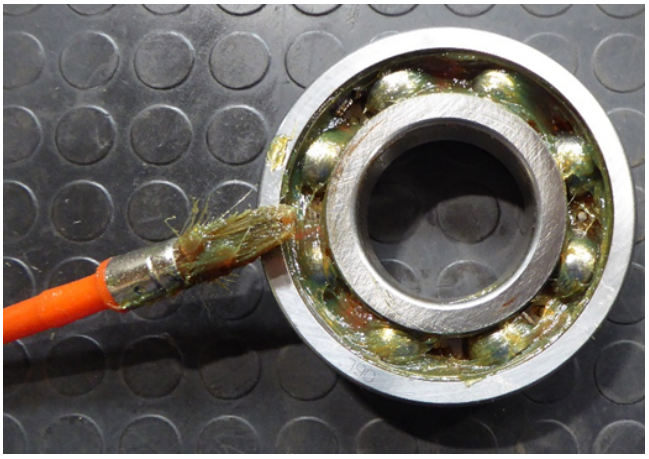


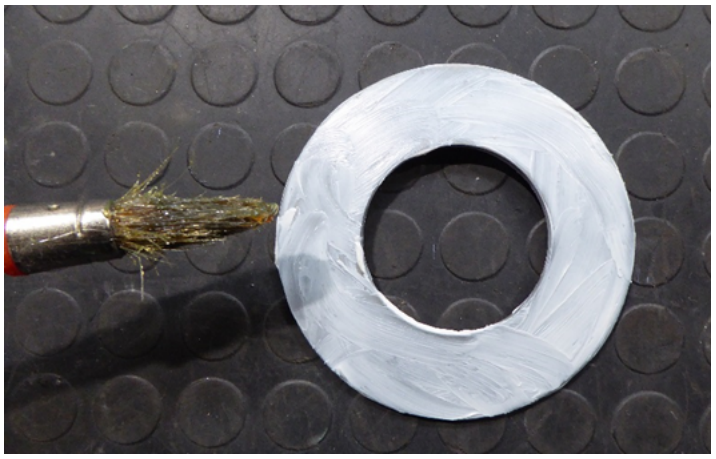
Illustration 6: Example: ball bearings

Prior to assembly, open roller bearings must be greased completely with the corresponding lubricant. Greasing can be performed using a brush or using the finger (gloves).

Seals (o-rings, radial sealing rings)

Prior to assembly, the seals must be greased completely with the corresponding lubricant. Greasing can be performed using a brush or using the finger (gloves).

Spring washers



Prior to assembly, the spring washers must be greased completely with the corresponding lubricant. Greasing can be performed using a brush or using the finger (gloves).

Lubricants overview

Lubricants overview

Intended purpose - lubricating greases / lubricating sprays

Type	Intended use	Lubricant
100	**Bearings and hinges**	
101	Sliding bearings and rolling bearings	Klübersynth EM 94-102
102	Rolling bearings in e-motors	Klübersynth BEM 41-132
103	Hinges	Klüberfluid NH1 CM 4-100
200	**Spring washers**	
201	Springs washers in a protected environment	Klübersynth EM 94-102
202	Spring washers in an unprotected environment	ALTEMP Q NB 50
300	**Pin-bushing connections**	
301	Static loads (pin-bushing, pin-bore)	ALTEMP Q NB 50
400	**Toothings**	
401	Open toothings LP	Klüberplex AG 11-462
402	Splined shaft connections LP	STABURAGS NBU 30 PTM
500	**Guides**	
501	Cabin guides	Klüberfluid NH1 CM 4-100 spray
600	**Electrical contacts**	
601	Electrical contacts	ISOFLEX TOPAS NB52
700	**Chains and conveying systems**	
701	Chains	STRUCTOVIS GHD
800	**Rails**	
801	Funicular rails	Klüberrail LEA 62-2000
802	Guide rails	Klüberfluid NH1 CM 4-100
900	**Rollers**	
901	Running rollers, guiding rollers and coupling rollers	Silicone 1-2
1000	**Ropes**	

Type	Intended use	Lubricant
1001	Carrying ropes with lifting from the rope saddle	STABURAGS NBU 12 AL-TEMP
1100	**Seals**	
1101	Seals	PETAMO GHY 133 N

Intended purpose - oils

Type	Intended use	Lubricant
5000	**Hydraulic oils**	
5001	Hydraulic systems (brakes - tensioning devices)	NILS TTO 970 PAO ISO VG 22
5002	Brake hydraulics (L>6m)	NILS TTO 971 PAO ISO VG 15
5003	Hydraulic systems (emergency drive)	NILS ATF DEXRON III H
5100	**Motors**	
5101	Diesel motors	NILS BORA 10W40
5200	**Bearings**	
5201	Sheave bearings	Klübersynth 4-GEM N
5300	**Gearboxes**	
5301	Planetary gearboxes (main drive)	Klübersynth GEM 4-150
5302	Helical gearboxes	Klübersynth GEM 4-220N
5303	Worm gearboxes	Klübersynth GH 6-220
5304	Helical gearbox (main drive)	Klübersynth EG 4-150
5400	**Ropes**	
5421	Hauling ropes	Redaelli 9 R100
5422	Carrying ropes	Redaelli 9 R100