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4. Railway Bearings in General
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6. Control Arm Housing for LHB Coaches

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SKF railway product offers



Condition monitoring:

- Temperature monitoring
- Sensors
- On-line Condition Monitoring
- Hand held equipment

Bogie solutions:

- Axleboxes
- Wheelset bearings
- AXLETRONIC sensors
- Slewing bearings
- Suspension tubes

Drive solutions:

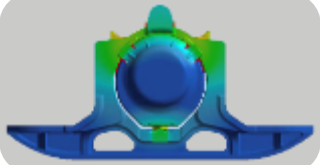
- Gearbox bearings
- Traction motor bearings and units

- AMPEP – High performance plain bearings

- Wheel flange lubrication systems

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Key applications, products and solutions

Applications		Solutions
High speed 		Axleboxes Wheelset bearings AXLETRONIC sensors Condition Monitoring Wheel flange lubrication
Passenger and locos 		
Freight cars 		Axleboxes Wheelset bearings
Drive system 		Traction motor and gearbox bearings Traction motor bearing units (TMBU) – speed and positioning sensors INSOCOAT and hybrid bearings
Aftermarket		Replacement bearings Remanufacturing Condition Monitoring

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Innovative and value added bearing solutions

- New material
- Sensorization
- Integrated functions for longer life
- Bearing health and reliability

Wheelset bearings & axleboxes



Traction motor & gearbox



© SKF Group

4

Railway bearings in general

Bearings for railway industry

1. Journal bearings
2. Traction motor bearings
3. Gearbox bearings
4. Plain bearings

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4.1

Railway Journal Bearings

Railway Journal Bearings

TBU



CRB (CRU)



SRB (Open Bearing)



TRB



© SKF Group

Bearing capabilities

The reason for the choice of a specific bearing design can be quite different and depends on various criteria:

- specific area/country/railway operator's standards that have to be considered
- field experience
- established maintenance routines in the maintenance workshops
- new vehicles equipped with existing bogie and bearing designs

Axlebox bearing unit design benefits

- ready-to-mount unit
- easy handling and installation
- factory greased and sealed solution
- higher reliability and safety

© SKF Group

TBU bearing capabilities

Bearing capabilities

	Very high-speed trains	High-speed trains and locomotives	Diesel and electrical locomotives		Multiple units (EMU[1] and DMU[2]), passenger coaches		Metro cars, light rail and tramways	Freight cars with closed axlebox	Freight cars with adapter design
Max. speed km/h	301 to 400	201 to 300	121 to 200	up to 120	161 to 200	up to 160	up to 120	up to 120	up to 120
TBU Tapered roller bearing units	■	■	■	■	■	■	■	■	■
CRU Cylindrical roller bearing units	■	■	■	■	■	■	■	■	
Cylindrical roller bearings				■			■	■	
Spherical roller bearings								■	

1) Electrical multiple unit
2) Diesel multiple unit

© SKF Group

Cylindrical roller bearings

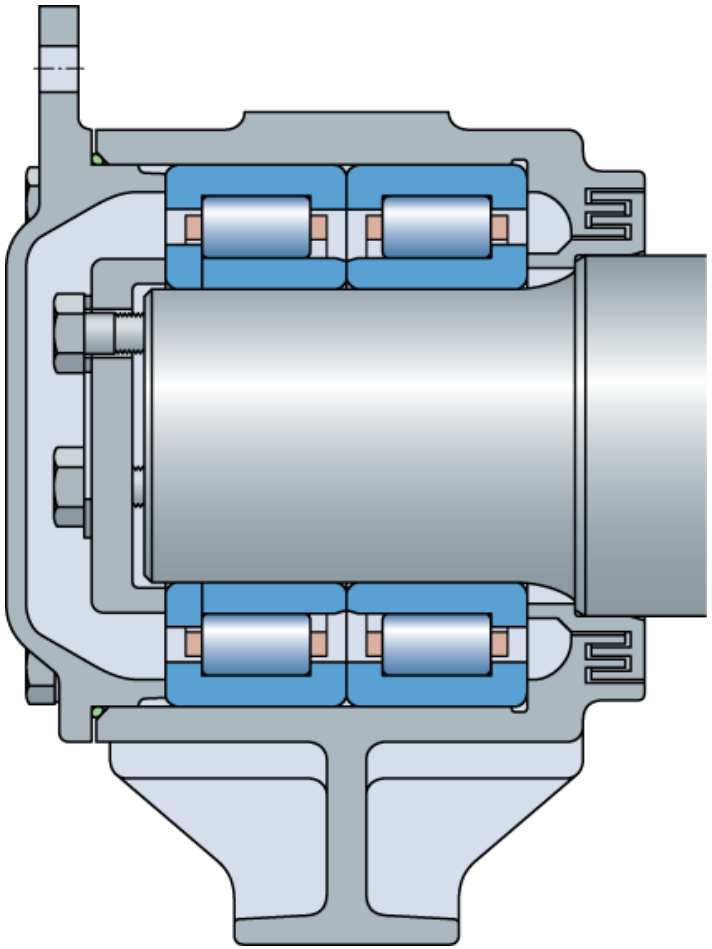




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Cylindrical roller bearings

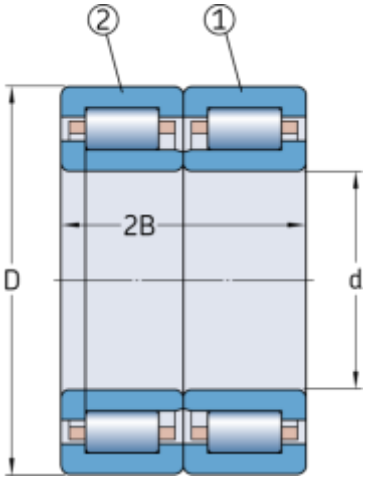
Typical axlebox assembly equipped with a set of NJ / NJP cylindrical roller bearings also called WJ / WJP cylindrical roller bearings



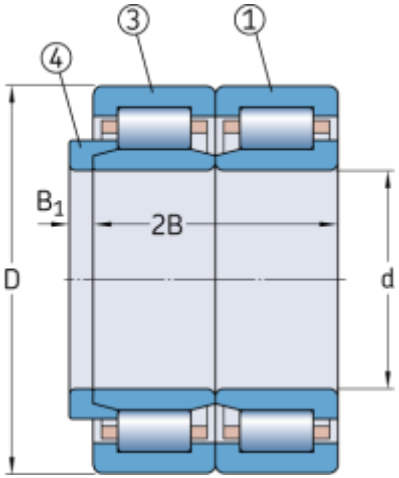
© SKF Group

CRB cylindrical roller bearings

Size	Principal dimensions				Basic designation
	d	D	2B	B_1	
–	mm				–
CRB 90 x 160	90	160	104,8	–	WJ / WJP 90 x 160P[1)]
CRB 100 x 180	100	180	120,6	–	WJ / WJP 100 x 180P[1)]
CRB 120 x 215	120	215	146	–	WJ / WJP 120 x 215P[1)]
CRB 120 x 240	120	240	160	–	WJ / WJP 120 x 240P[1)]
CRB 130 x 220	130	220	122	–	WJ / WJP 130 x 220P[1)]
CRB 130 x 240	130	240	160	–	WJ / WJP 130 x 240P[1)]
CRB 130 x 250	130	250	160	–	WJ / WJP 130 x 250P
CRB 150 x 270	150	270	146	12	NJ 2230 EC / NU 2230 EC / HJ 2230 EC
CRB 180 x 320	180	320	172	–	NJ 2236 EC / NJP 2236 EC



Type WJ + WJP or NJ + NJP



Type NJ + NU + HJ angle ring

1 WJ and NJ design
2 WJP and NJP design
3 NU design
4 HJ angle ring

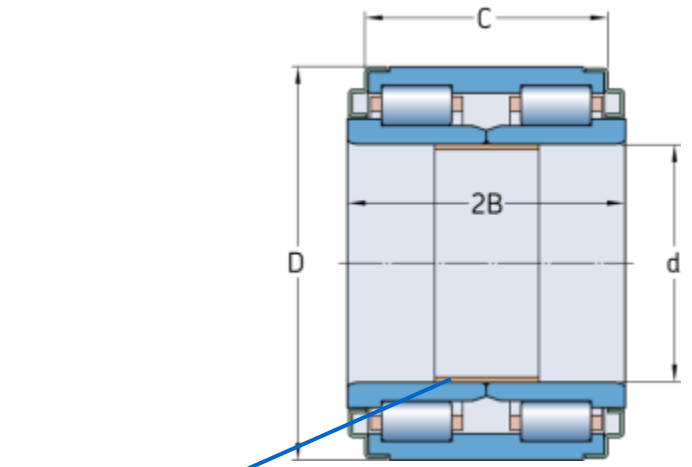
These figures are for information only. Contact SKF for detailed product specifications.

[1)] *In accordance with the German standard DIN 5412-11*

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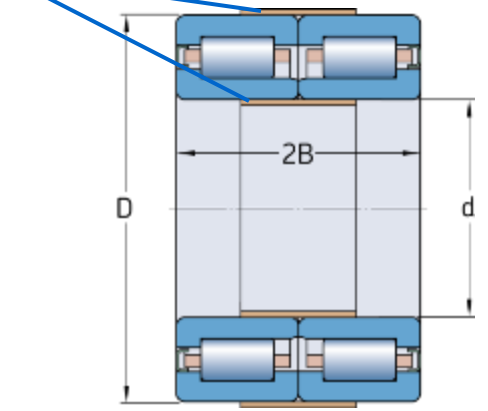
CRU cylindrical roller bearing units

Size	Principal dimensions				Type
	d	D	C	2B	
–	mm				–
CRU 100 x 180	100	180	–	120,6	1
CRU 120 x 200	120	200	–	112	1
CRU 120 x 215	120	215	–	146	1
CRU 130 x 220	130	220	–	160	1
CRU 130 x 240	130	240	–	160	1
CRU 130 x 240	130	240	164	160	2
CRU 150 x 250	150	250	160	180	2
CRU 160 x 270	160	270	150	170	2



Mounting sleeves

Type 1



Type 2

These figures are for information only. Contact SKF for detailed product specifications.

© SKF Group

Spherical roller bearings

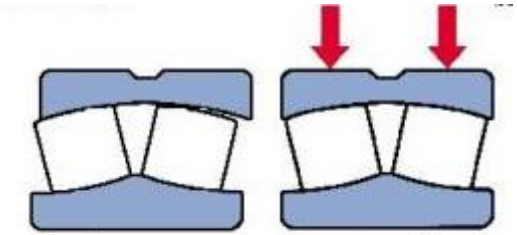


Figure 1

Figure 2

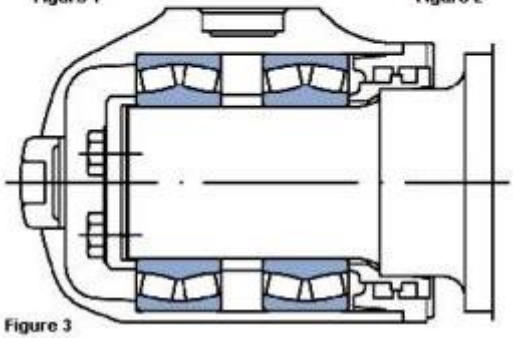
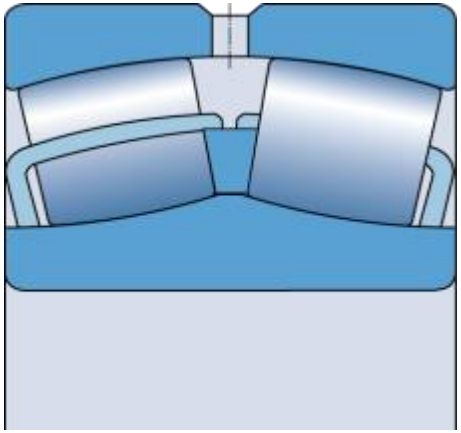


Figure 3

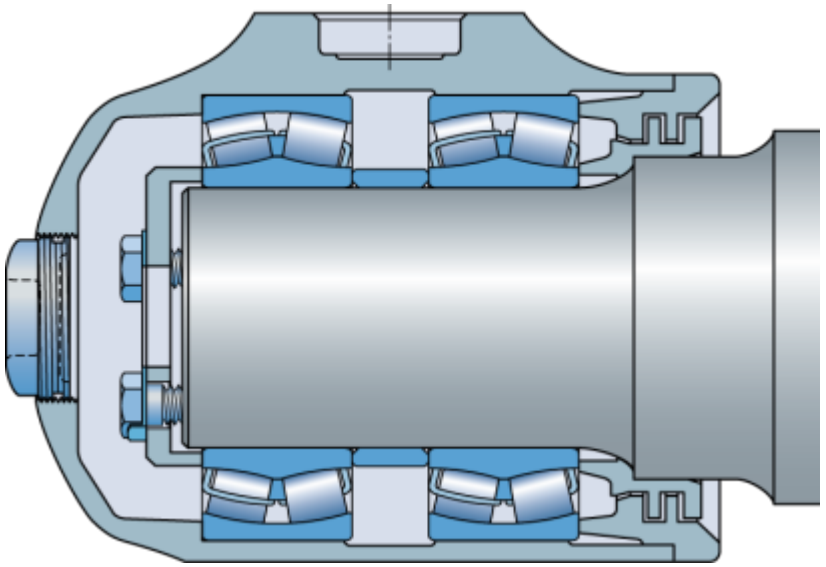


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Spherical roller bearings



Spherical roller bearing design

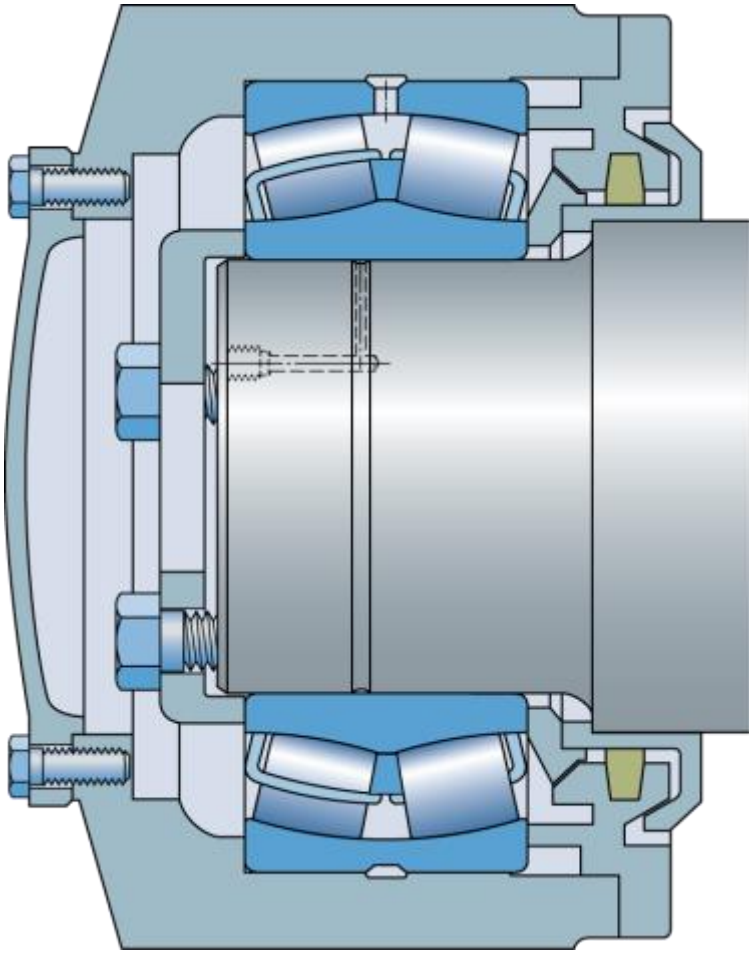


Typical application of an axlebox assembly fitted with a set of two spherical roller bearings 229750 separated by an inner ring spacer

© SKF Group

Spherical roller bearings

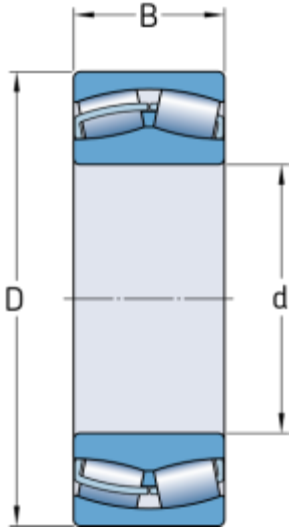
Axlebox fitted with a single spherical roller bearing



© SKF Group

SRB spherical roller bearing

Size	Principal dimensions			Basic designation
	d	D	B	
–	mm			–
SRB 130 x 220	130	220	73	229750

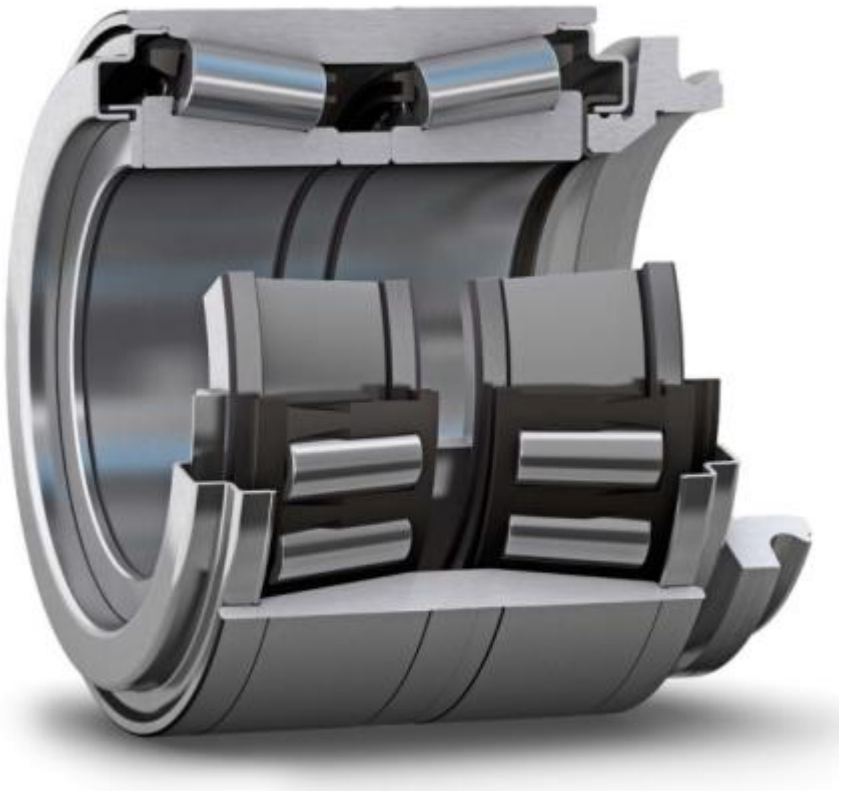


These figures are for information only. Contact SKF for detailed product specifications.

Dimensions of standard spherical roller bearings can be found in the SKF General Catalogue.

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TBU and CTBU



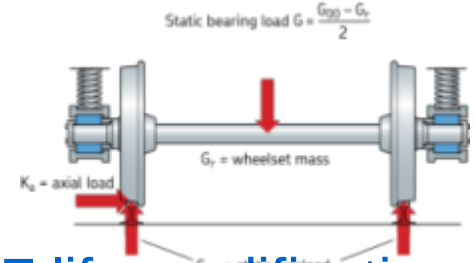


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Bearing life calculation approach

1. Basic rating life – still the standard in railway industry

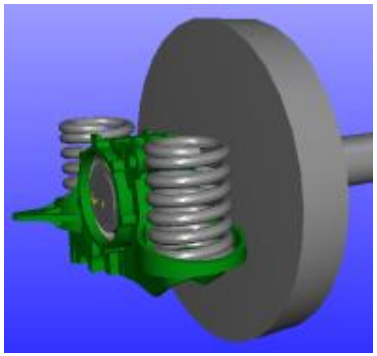
$$L_{10} = \left(\frac{C}{P}\right)^p$$



2. More advanced - SKF life modification factor a_{SKF}

$$L_{nm} = a_1\, a_{SKF}\, L_{10} = a_1\, a_{SKF} \left(\frac{C}{P}\right)^p$$

3. Very advanced calculation - SKF Bearing Beacon



lubrication, contamination,
clearance, bearing internal geometry,
temperature, flexibility of components, …

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SKF Handbook method – example of combined life

Curve = 30%
(based on track data received from customer)

Straight = 70%
(based on track data received from customer)

Standard Handbook Method (fad = 1,2)

Equivalent Axial Axlebox Load Calculation	
Ka = fo * fad * 2G/g * v^2/r =	15,45 kN
fad = dynamic axial factor:	1,20

Modified Handbook Method (fad = 0)

Equivalent Axial Axlebox Load Calculation	
Ka = fo * fad * 2G/g * v^2/r =	15,45 kN
fad = dynamic axial factor:	0



Combined life L10 = 1,5MKm

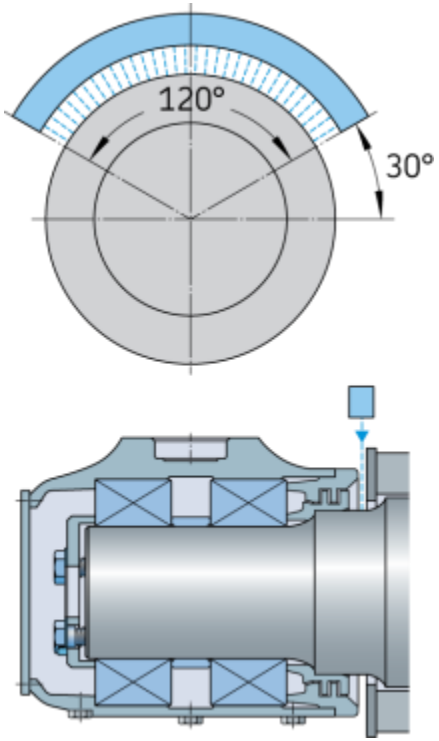
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Bearing testing

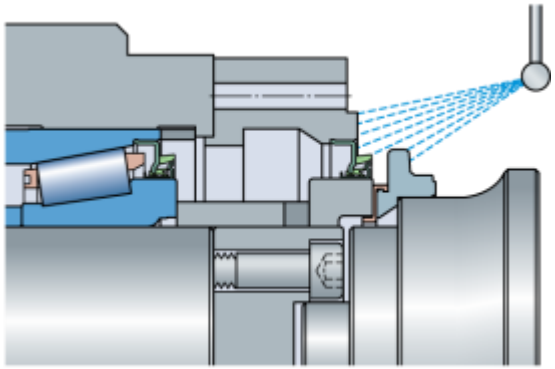


R3 endurance test rigs for quasi-static performance testing

Seal testing



European Standard EN 12082
watertightness test



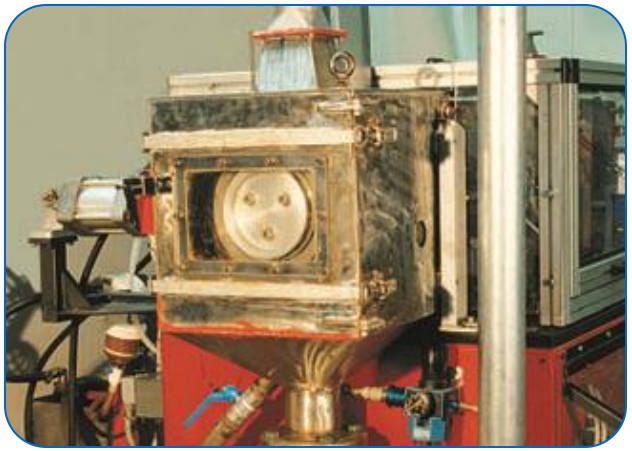
Water spray test principle

© SKF Group

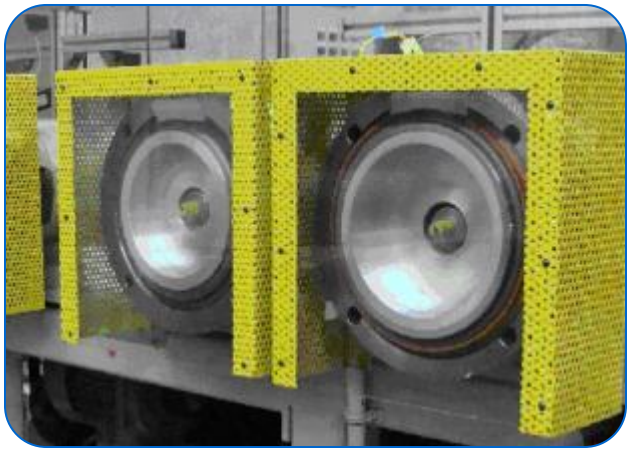
Seal testing



Watertightness test in operation



SKF environmental seal test rig for simulating contaminated conditions such as dust and water



Seal friction, wear and torque test rig battery

© SKF Group

Grease testing

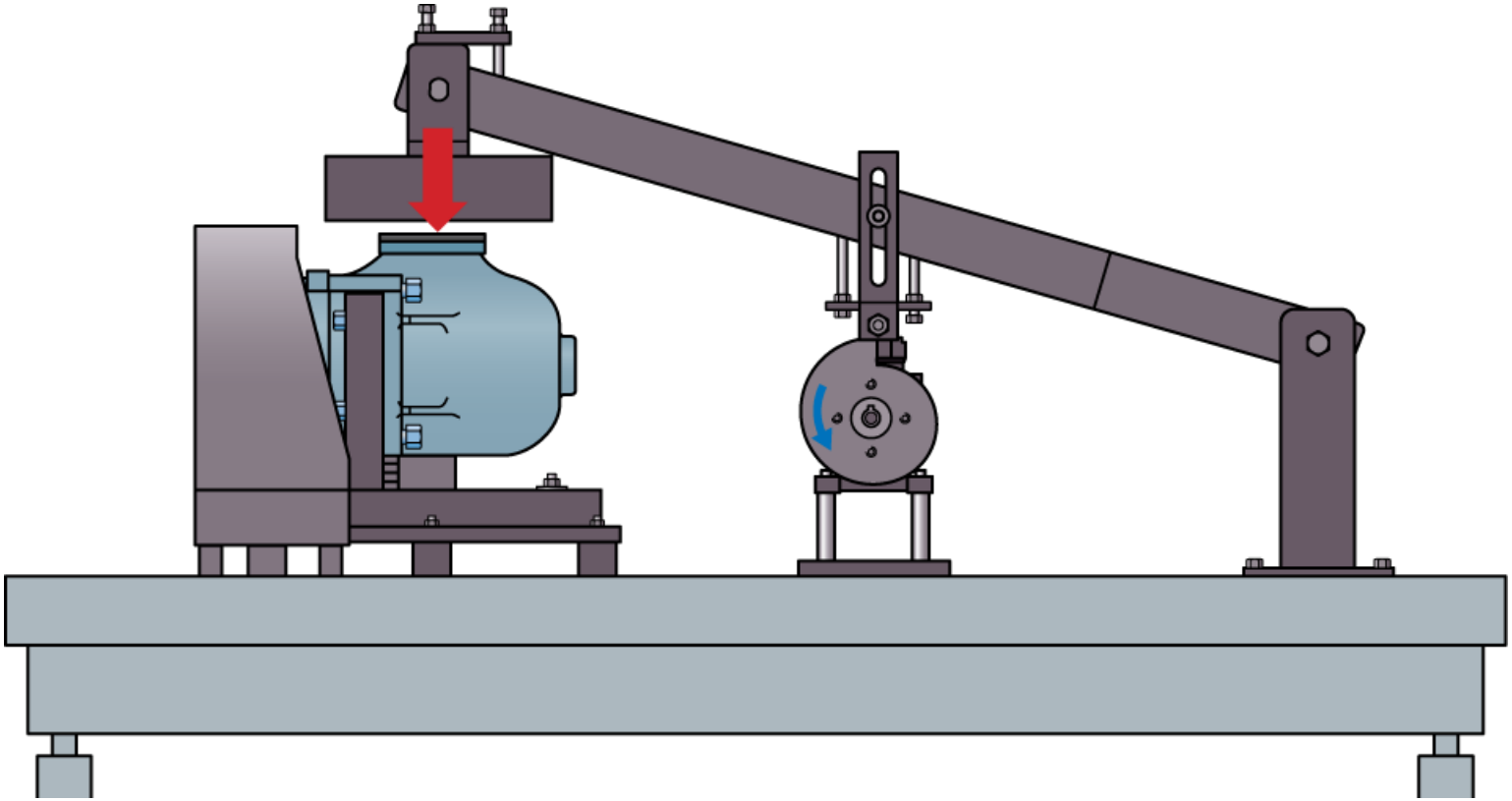
SKF V2F mechanical grease stability test rig



© SKF Group

Grease testing

SKF V2F testing principle



© SKF Group

Quasi-static performance testing



SKF R3 test rig arrangement in accordance with EN 12082

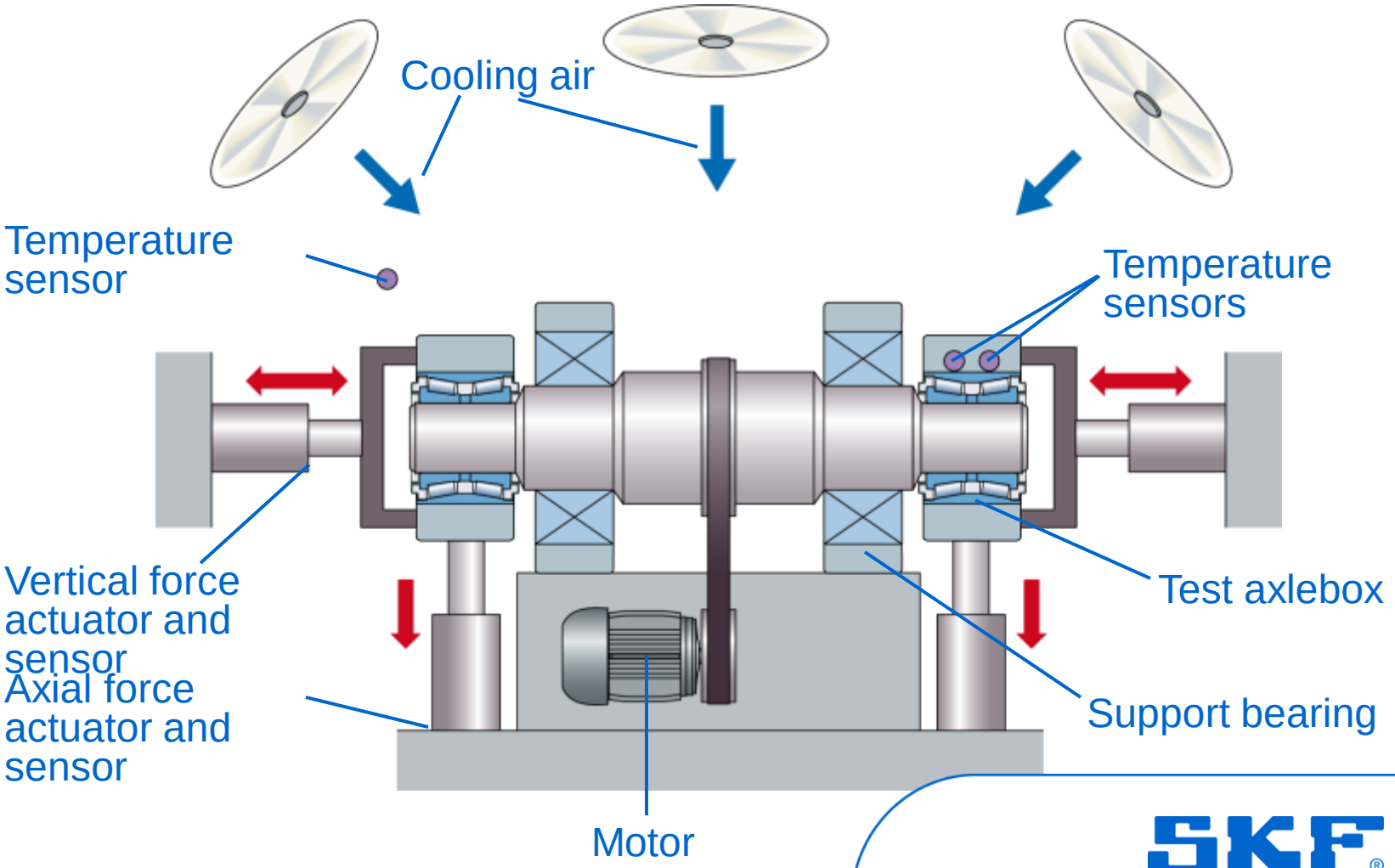


SKF R3 railway bearing test rig in detail

© SKF Group

Quasi-static performance testing

Test rig principle of the EN 12082. The axlebox bearings are mounted on both ends of the shaft. Actuators provide radial and axial forces. Fans on both sides simulate the wind cooling while travelling.



© SKF Group

Dynamic testing



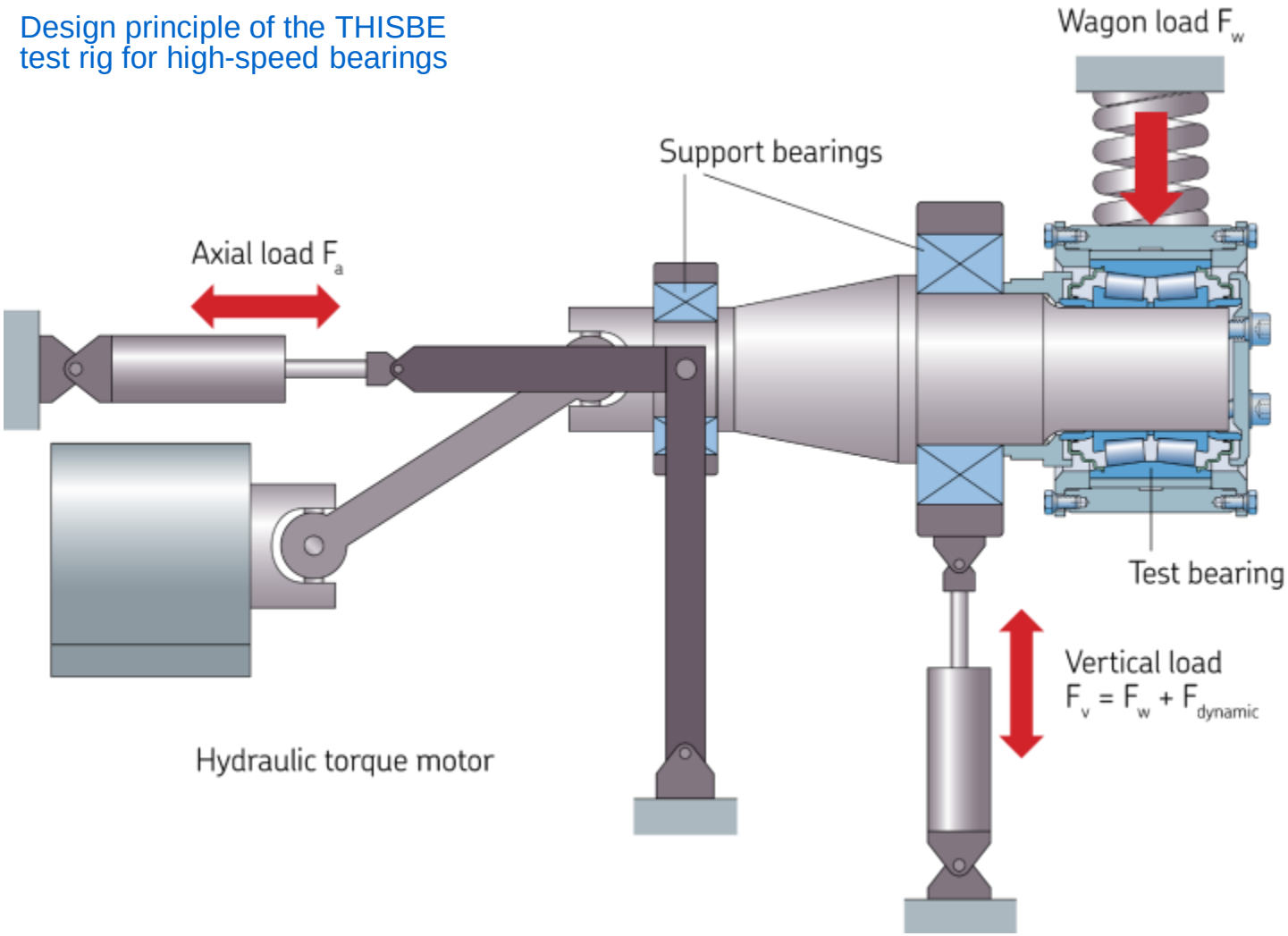


THISBE test rig for high-speed bearings which can simulate dynamic load conditions equipped with an original bogie frame

© SKF Group

Dynamic testing

Design principle of the THISBE test rig for high-speed bearings



© SKF Group

Field testing



Field testing equipment design



Field testing software installation



Sensor application for field testing

© SKF Group

Field testing



Field test with SKF axlebox bearing units

Russian Vorkuta – Cherepovets coal railway line, 1900 km long, max. speed 91 km/h, lowest temperature during the test –37 °C

4.2

Railway traction motor bearings

Special cages for traction motor bearings

Detailed description of SKF one-piece machined brass cages:

ECMR(D)

The SKF ECMR cage is a roller-guided version. In 1992 it was further developed into the ECMRD (see Fig. 6) mixed-guided variant. In the event of shock loads the cage is supported by the ring shoulders.



© SKF Group

INSOCOAT™ bearings from SKF - features

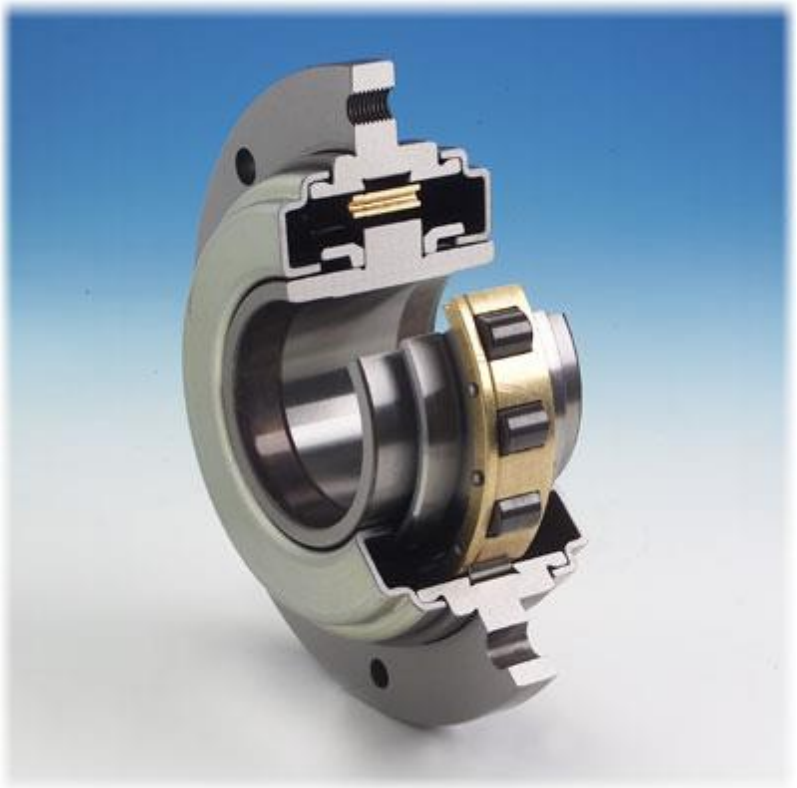
Commercial:

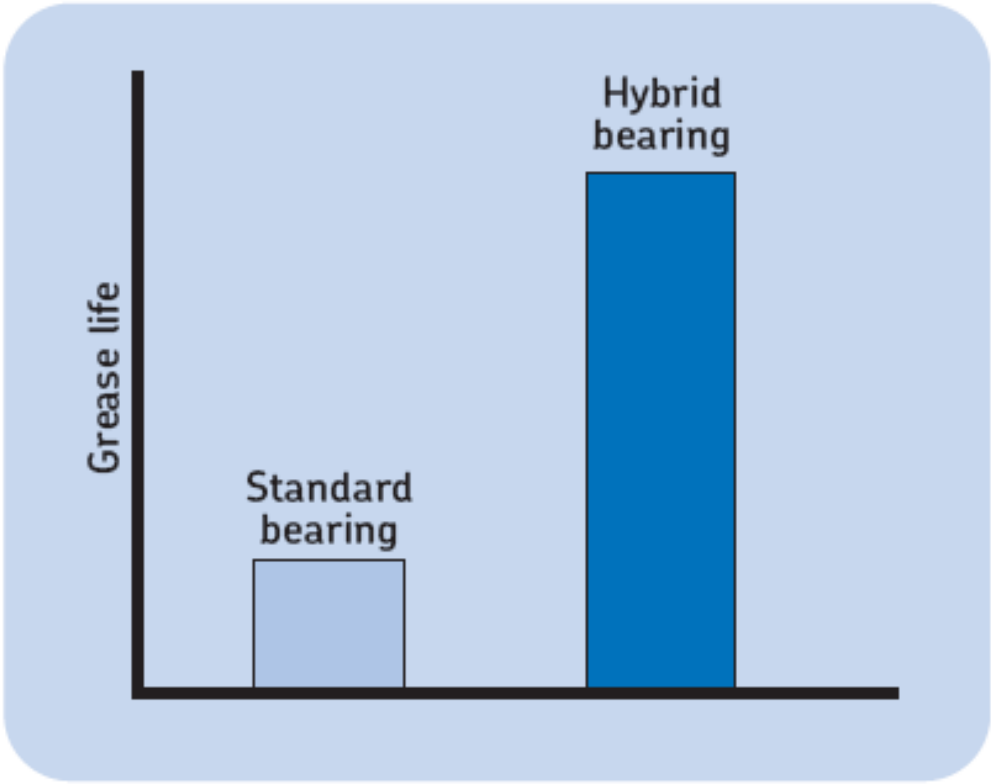
- two features - one product
- bearing function
- insulation function
- most economical solutions for insulation
- global availability of products - SERVICE
- SKF is represented in about 130 countries world wide



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Hybrid bearings and TMBU





© SKF Group

Hybrid bearings and TMBU





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4.3

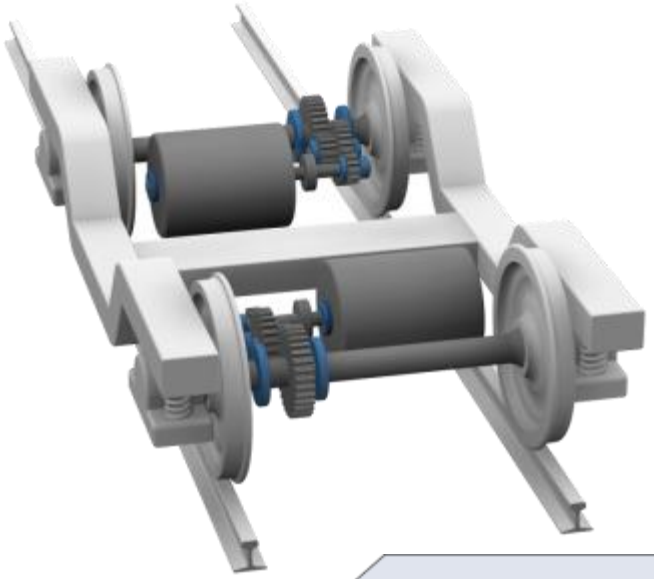
Bearings for Railway Gearboxes

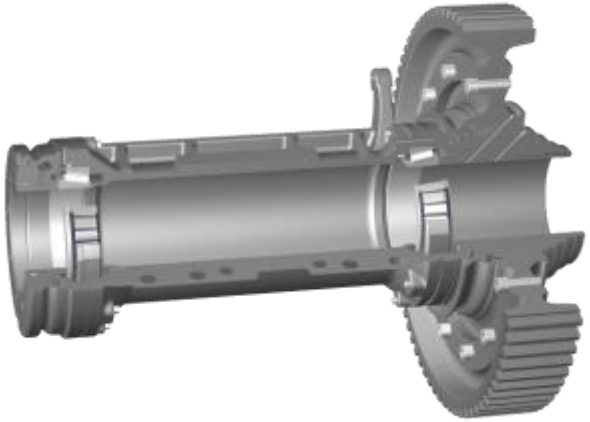
SKF Solutions for Railway Gearboxes

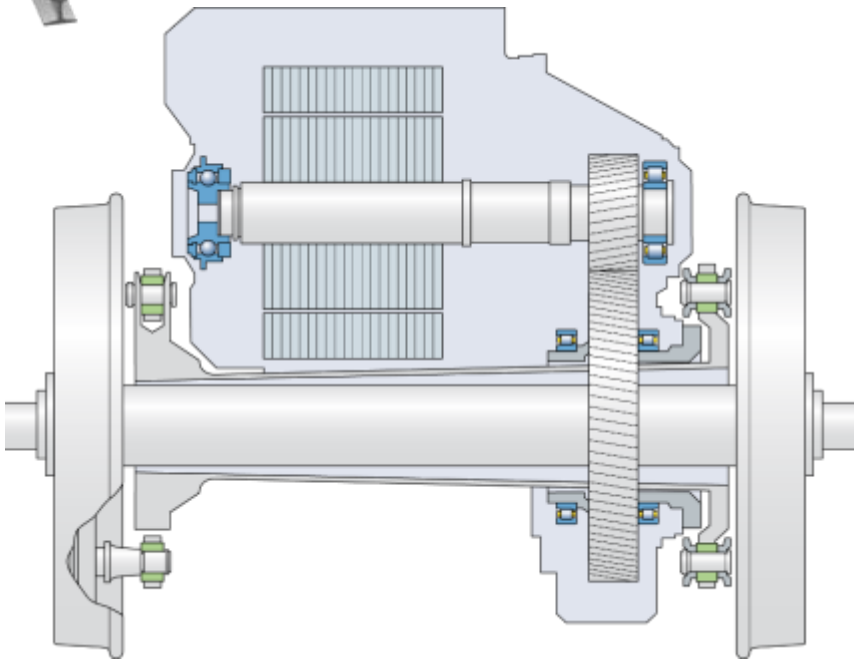


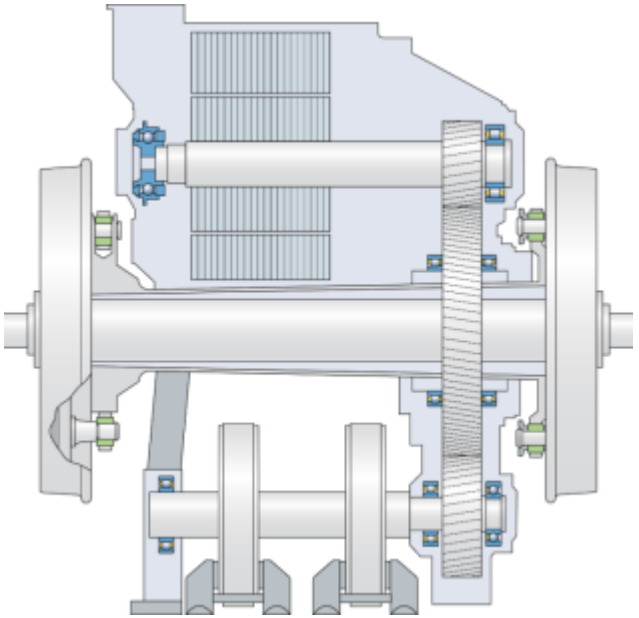
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SKF Solutions for Railway Gearboxes



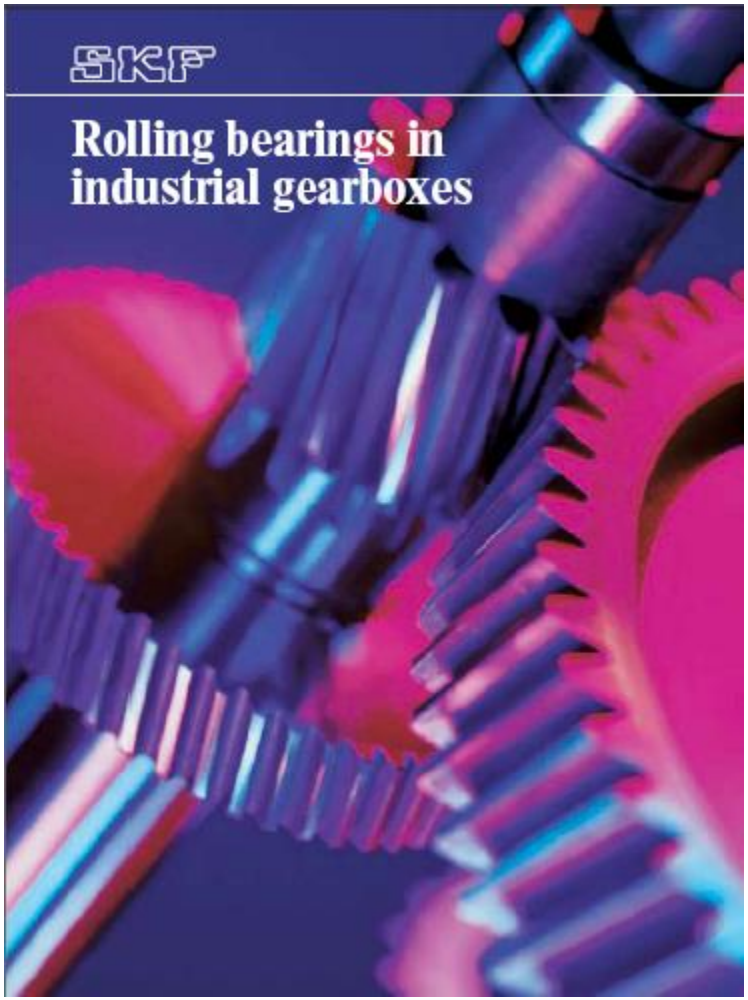






© SKF Group

SKF Solutions for Railway Gearboxes, Publ 4560



Types of gearbox

Gearboxes are characterised by having at least three members: the power input, power take-off and the casing. The casing transmits the support moment to the base.

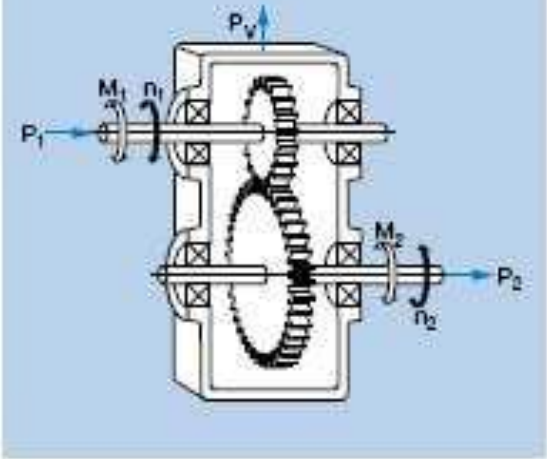
In contrast, a coupling has only two members: the power input and power

Gear
Torque
$M_1 \lesseqgtr M_2$

Rotational speed
$n_1 \lesseqgtr n_2$

Power
$P_1 = P_2 + P_v$

Fig 1



© SKF Group

4.4

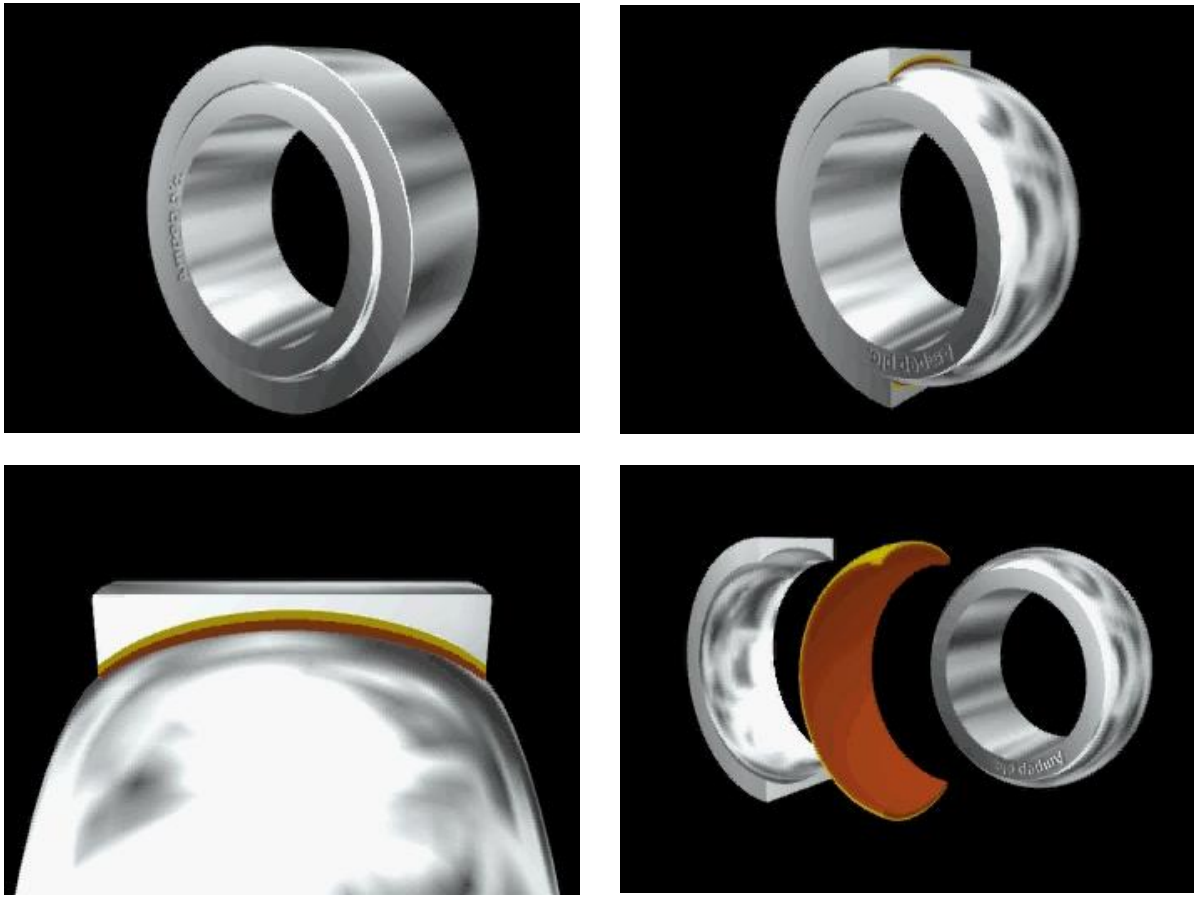
Plain Bearings for Railway Vehicles

Plain bearings for railway vehicles



SKF Ampep

Ampep Spherical Bearing Components



© SKF Group

5

TBU

TBU

5.1 Design
5.2 Maintenance Intervals
5.3 Mounting and Maintenance
5.4 Factors Affecting TBU Performance

© SKF Group

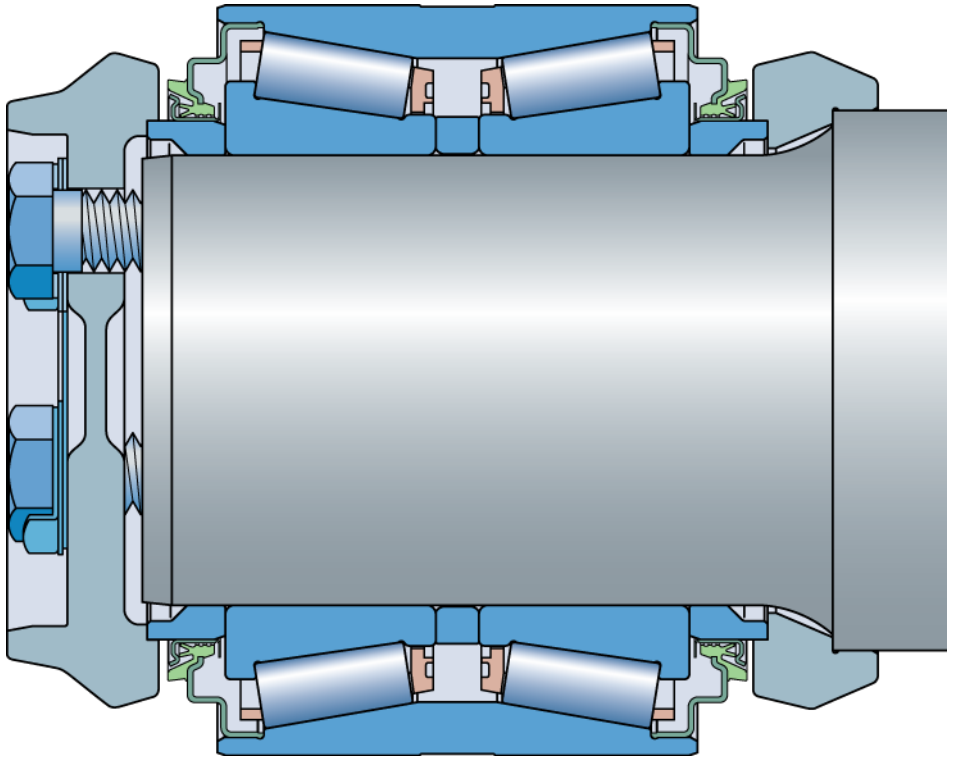
5.1

TBU design

Tapered roller bearing units (TBUs)

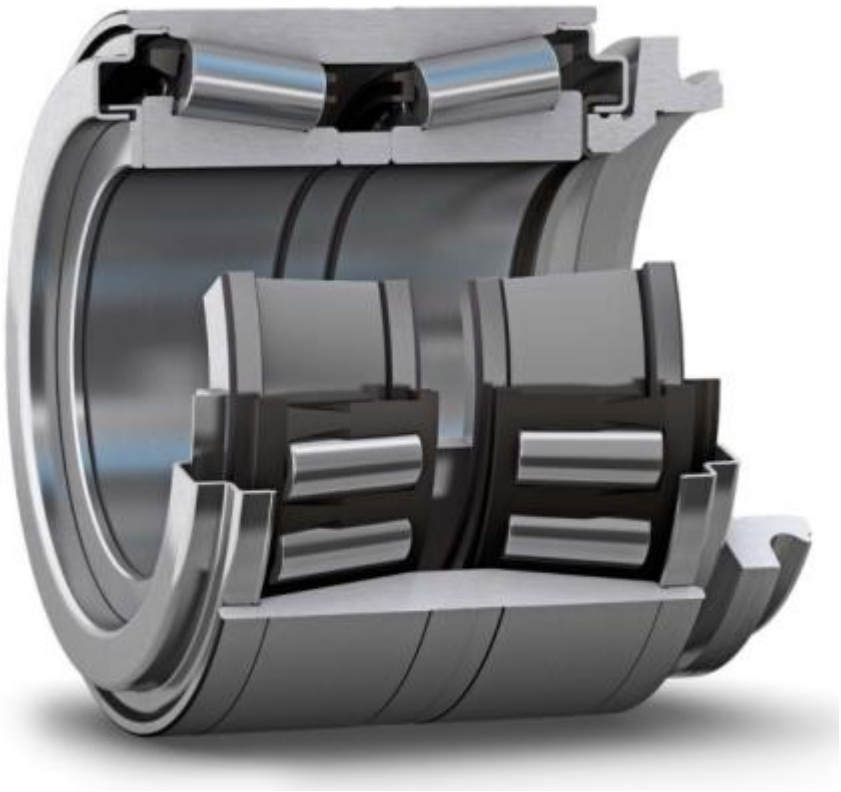
Consist of two inner rings, one common outer ring, two tapered roller and polymer cage assemblies, a central spacer, grease fill and two sealing systems.

Further components like lateral spacers, backing rings and end caps with their locking device can be added to the assembly as well as components based on specific customer requests.



© SKF Group

TBU and CTBU



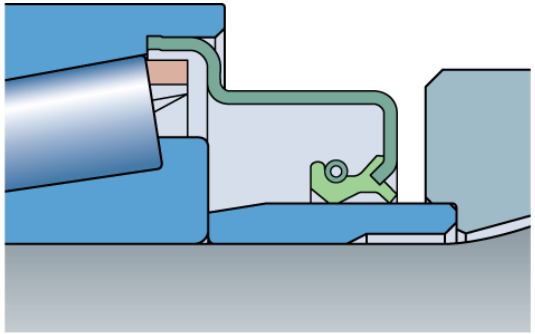


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Seal designs - Garter seal

As mentioned earlier, the first tapered roller bearing units were designed to replace plain bearings. These inch size TBU designs had to match the existing relatively long journal dimension. This design enables the integration of a seal wear ring on both sides where the garter seals are riding.

AAR has standardized these garter seals and seal wear rings, which are interchangeable with components from different bearing manufacturers. Today, SKF offers special LL seal designs for inch size TBUs that generate much lower friction.

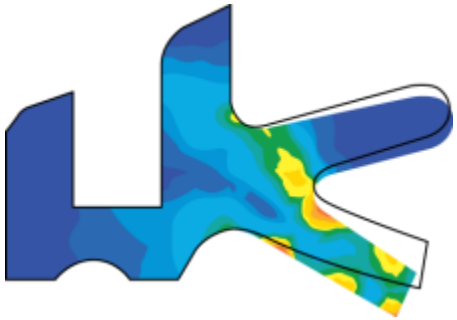


Garter seal design for inch size TBUs

© SKF Group

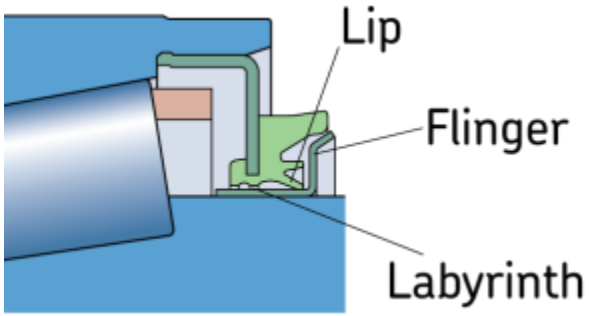
Seal designs - LL seal

LL seal benefits
- improved protection against contaminants
- longer grease life
- better and longer performance

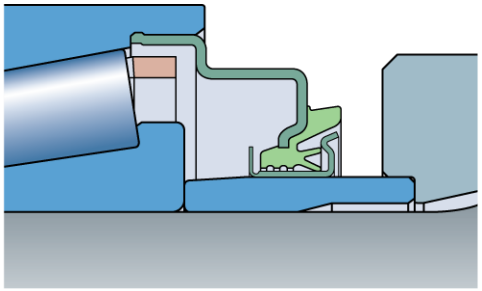


LL (labyrinth-lip) seal design

Display of the FEM calculation result



LL seal design for compact TBU



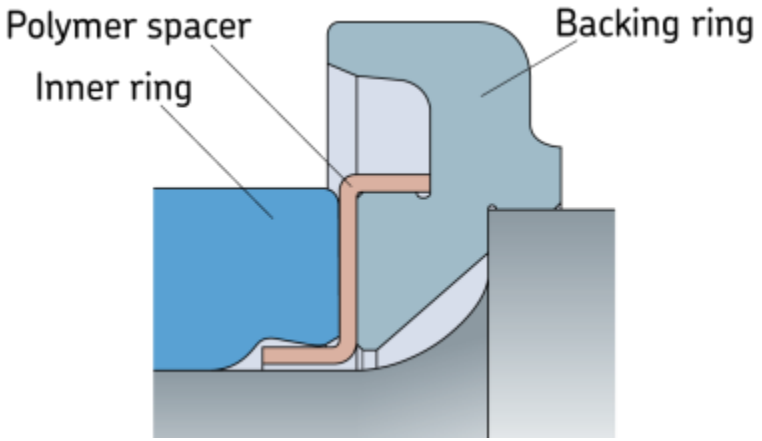
LL seal design for inch size TBU

© SKF Group

Polymer spacer

Polymer spacer benefits:

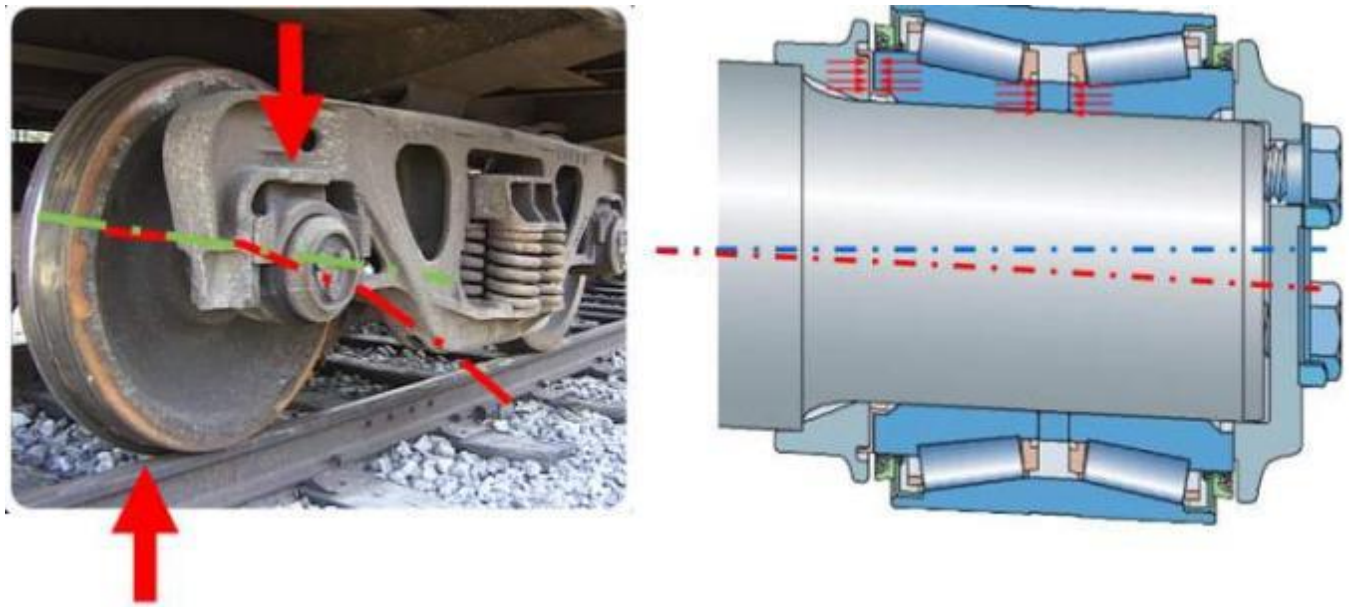
- fretting corrosion avoided
- lower wear rate of the inner ring side face/backing ring contact zone
- longer performance and longer maintenance intervals achievable because of longer grease life



Polymer spacer design principle

© SKF Group

Fretting in wheel set bearings



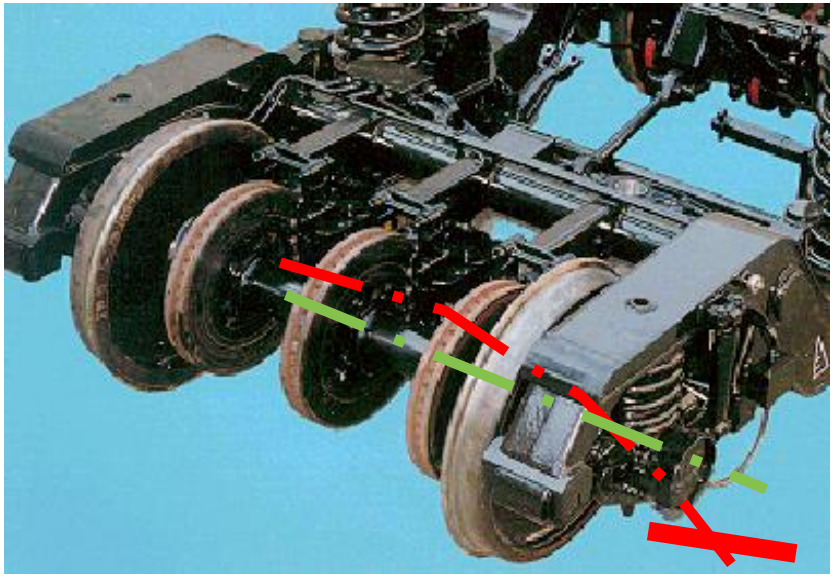
Due to axle bending, relative micro movements occur between bearing components and between bearing and adjacent parts

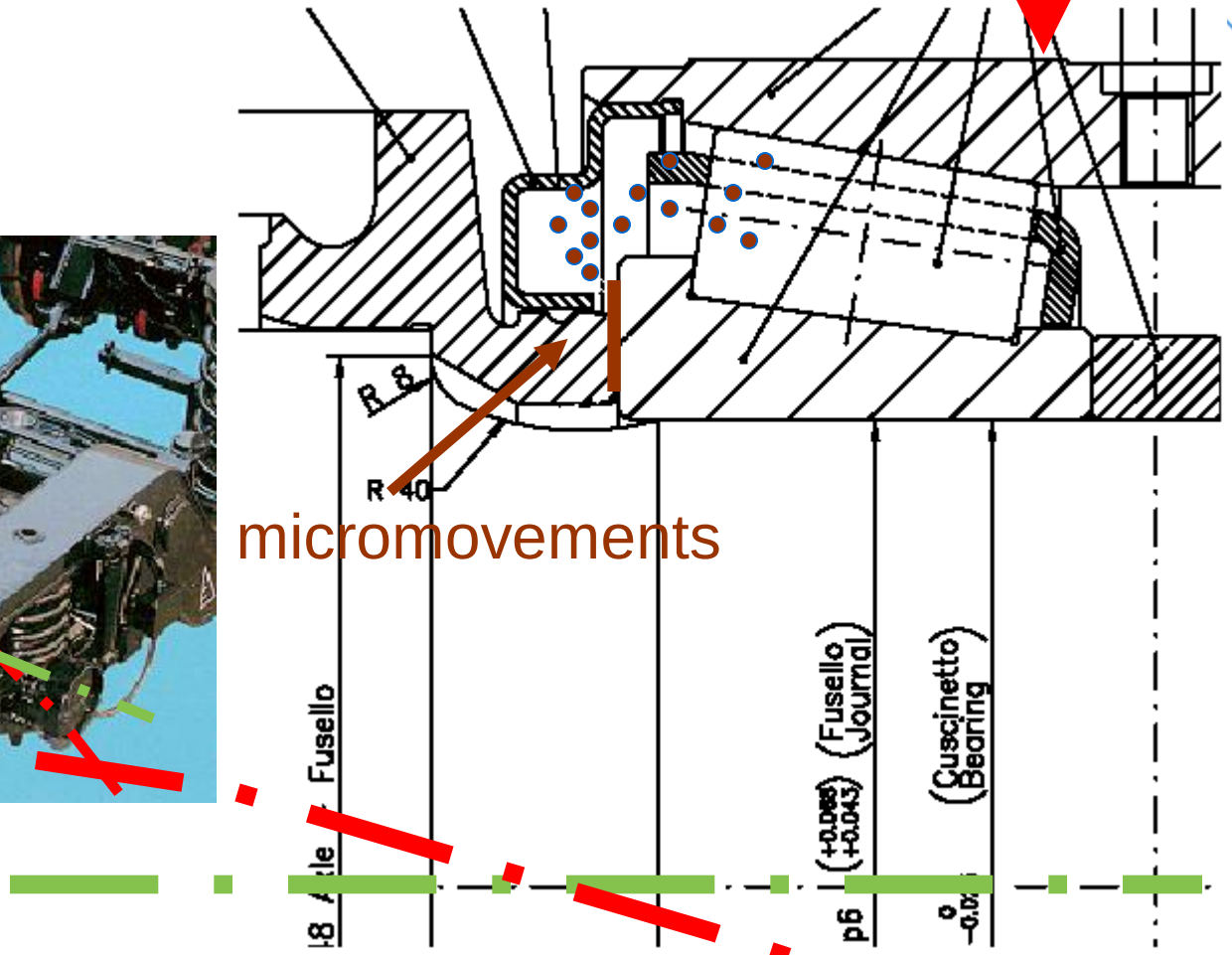
Most affected interfaces are:

- Inner rings – spacer
- Inner ring inboard side – backing ring

© SKF Group

The deflection of the axle and fretting corrosion formation:

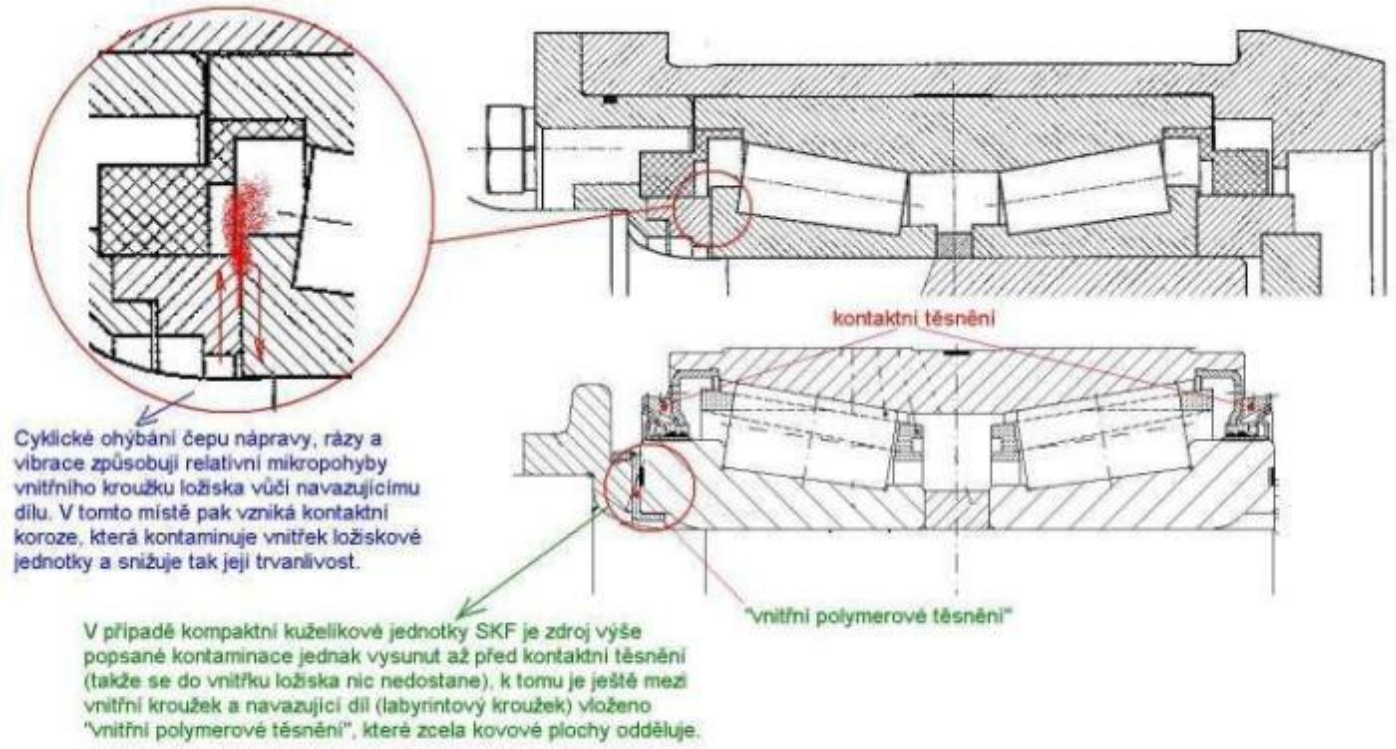




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P-spacer

Contact corosion between inner ring and backing ring



Cyklické ohýbání čepu nápravy, rázy a vibrace způsobují relativní mikropohyby vnitřního kroužku ložiska vůči navazujícímu dílu. V tomto místě pak vzniká kontaktní koroze, která kontaminuje vnitřek ložiskové jednotky a snižuje tak její trvanlivost.

V případě kompaktní kuželíkové jednotky SKF je zdroj výše popsané kontaminace jednak vysunut až před kontaktní těsnění (takže se do vnitřku ložiska nic nedostane), k tomu je ještě mezi vnitřní kroužek a navazující díl (labyrintový kroužek) vloženo "vnitřní polymerové těsnění", které zcela kovové plochy odděluje.

© SKF Group

Polymer spacer



Without polymer spacer:
strong fretting corrosion after 800 000 km



With a polymer spacer:
no fretting corrosion after 800 000 km

© SKF Group



© SKF Group

Polymer cage

Polymer cage benefits:

- reduced friction and roller slip, reduced wear and lower operating temperature
- improved safety and performance
- safe failure mode without seizing



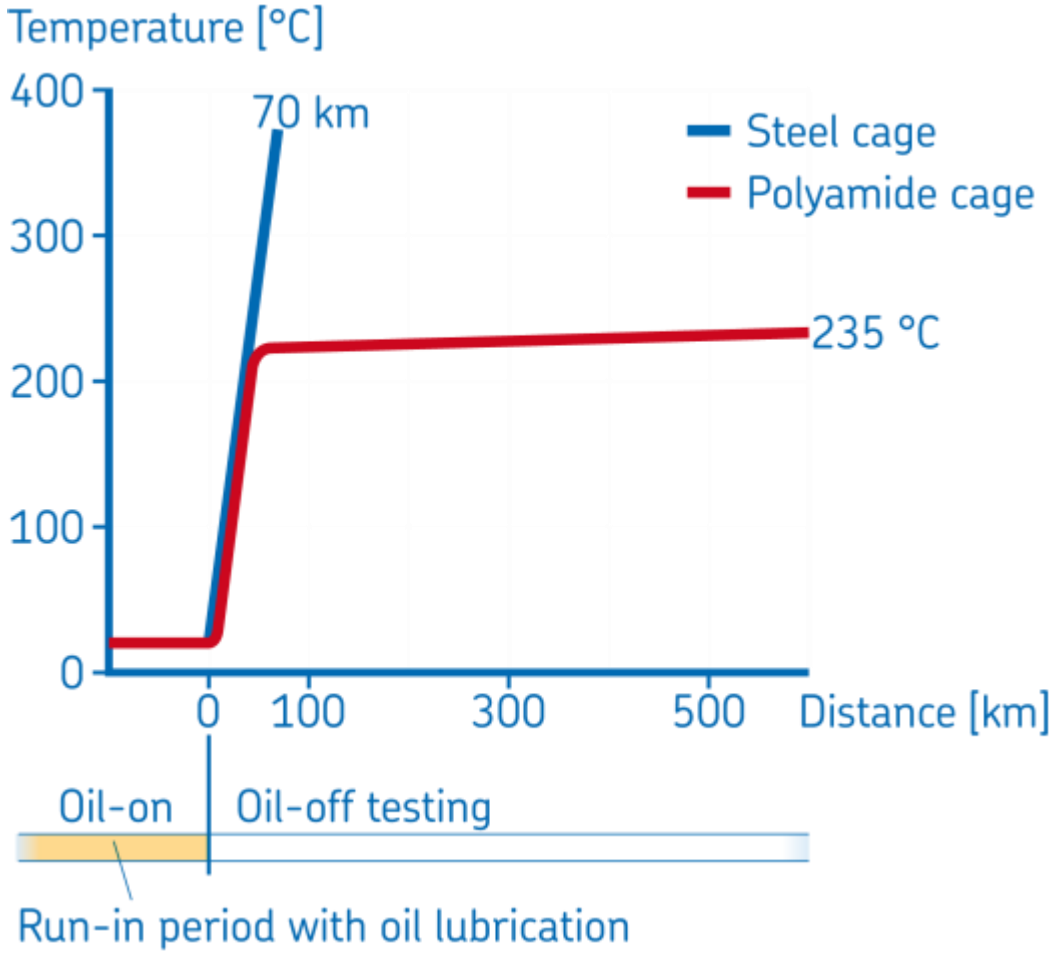
SKF polymer cage for TBUs

© SKF Group

SKF “oil-off test”

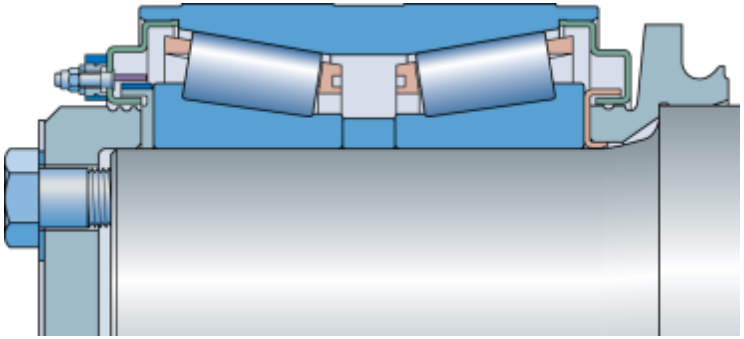
The comparison between a TBU steel cage and a polymer cage

TEST FILM



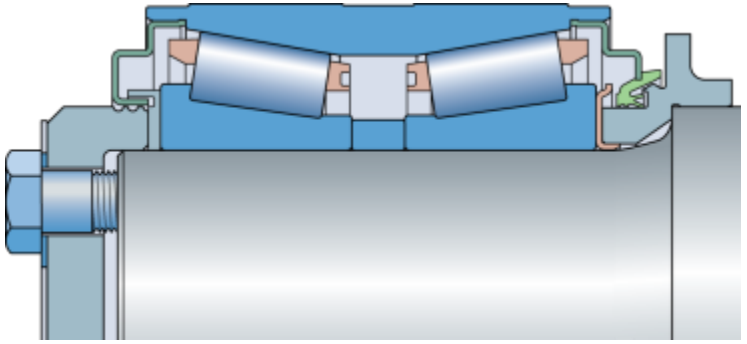
© SKF Group

Application-specific designs



Metric size TBU with a labyrinth seal on both sides as used for high-speed applications.

On the right side, a polymer spacer is applied which is part of the sealing system design. On the left side, an impulse wheel is flanged for the sensor application.

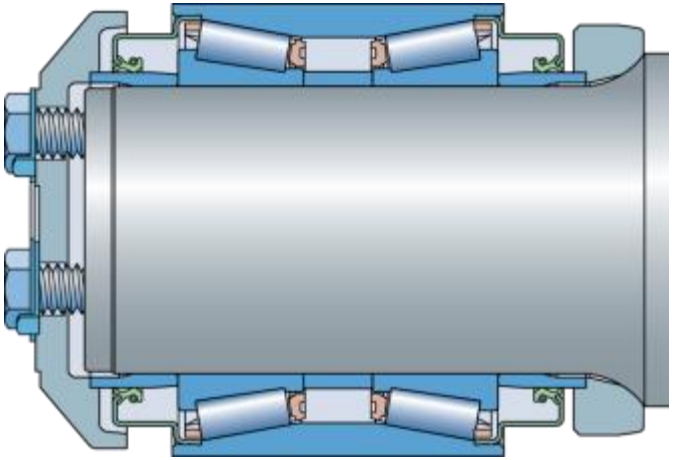


Metric size TBU with a labyrinth seal on the end cover side and an LL seal on the wheel side as used with multiple unit applications.

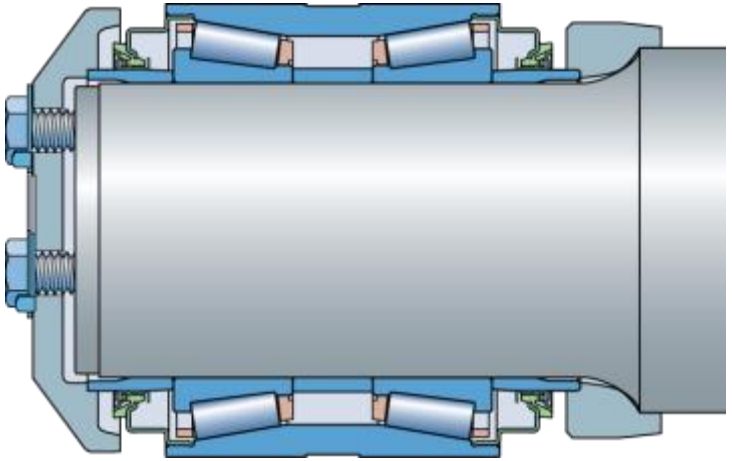
On the right side a polymer spacer is applied which is part of the sealing system design.

© SKF Group

Application-specific designs



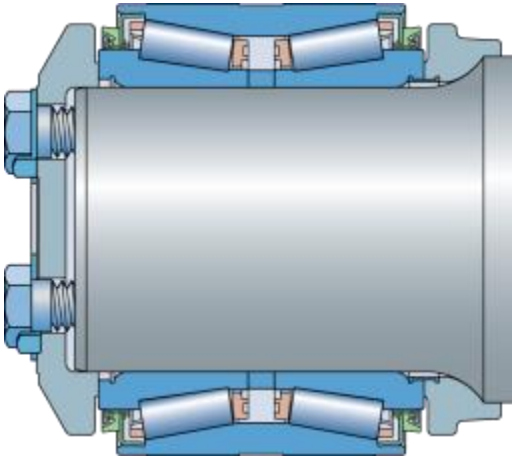
Traditional inch size TBU design following the AAR specification fitted with a garter seal on both sides



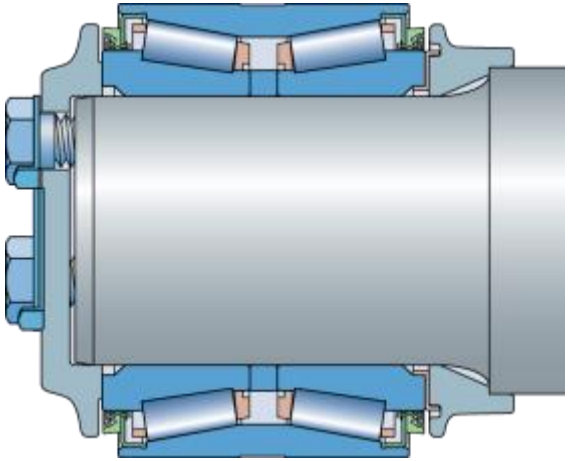
Enhanced inch size TBU design with LL seals and special material selection for customers where AAR requirements are not compulsory

© SKF Group

Application-specific designs



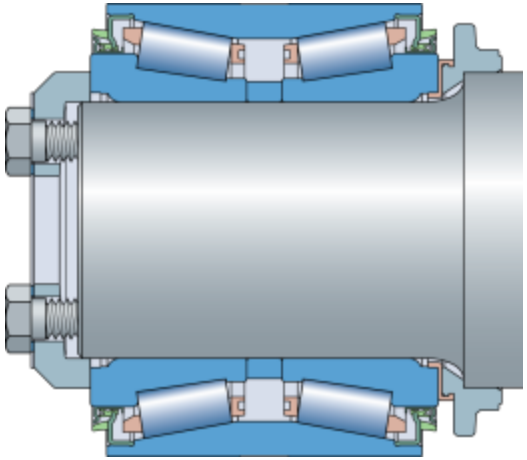
Inch size compact TBU class K for freight cars



Metric size compact TBU for Chinese freight cars

© SKF Group

Application-specific designs

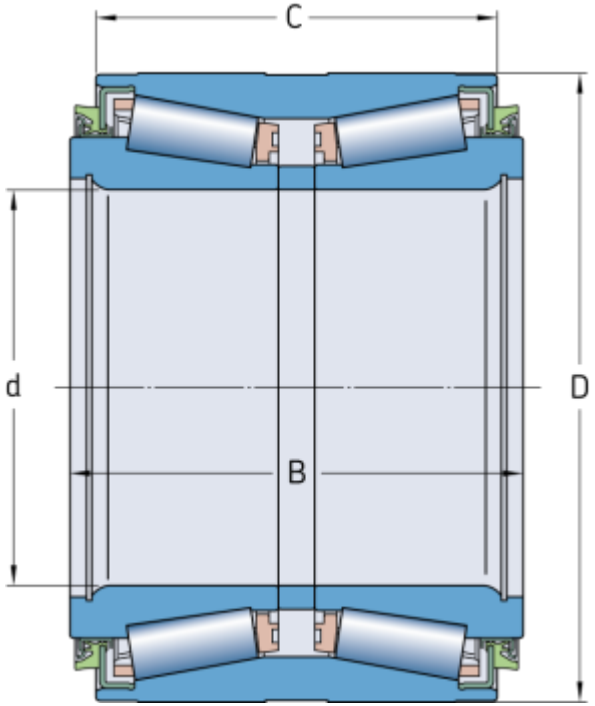


Compact TBU for Russian freight cars

© SKF Group

CTBU compact tapered roller bearing units

Size	Principal dimensions			
	d	D	B	C
Metric sizes	mm			
CTBU 100 x 175	100	175	130	120
CTBU 110 x 180	110	180	142	142
CTBU 130 x 210	130	210	148	132
CTBU 130 x 220	130	220	145	135
CTBU 130 x 230	130	230	166	150
	130	230	176	160
CTBU 130 x 240	130	240	172	160
CTBU 130 x 250	130	250	172	160
CTBU 140 x 220	140	220	150	140
CTBU 150 x 250	150	250	180	160
CTBU 160 x 280	160	280	195	180
Inch sizes	mm *(in)*	-	-	-
CTBU Class K 6 1/2” x 9”	157 *(6.1880)*	250 *(9.8420)*	181 *(7.1102)*	160 *(6.2992)*
CTBU Class G 7” x 9” and 7” x 12”	178 *(7.0005)*	276 *(10.8750)*	200 *(7.8740)*	186 *(7.3120)*

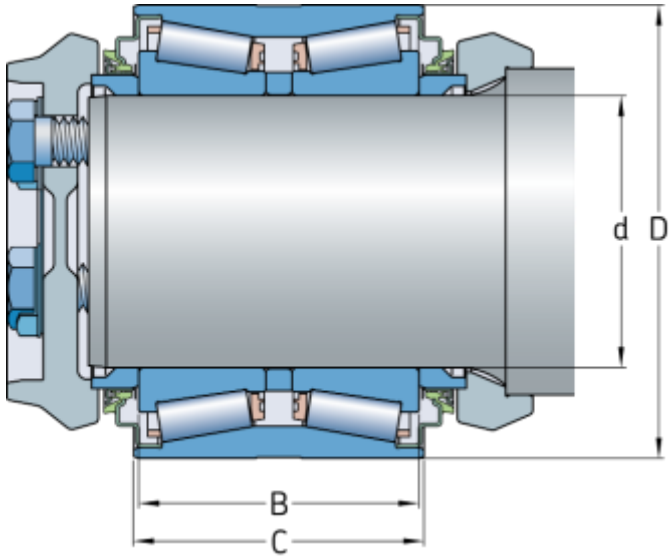


These figures are for information only. Contact SKF for detailed product specifications.

© SKF Group

TBU tapered roller bearing units, metric sizes

Size	Principal dimensions			
	d	D	B	C
–	mm			
TBU 90	90	154	106	115
TBU 100	100	175	113,5	120
TBU 120	120	195	126	131
TBU 130 x 210	130	210	126	132
TBU 130 x 220	130	220	145	150
TBU 130 x 230	130	230	150	160
TBU 140	140	220	133	140
TBU 150	150	250	154,5	160
TBU 160 x 270	160	270	160	150
TBU 160 x 280	160	280	180	180
TBU 178 x 265	178,62	265,137	134	139

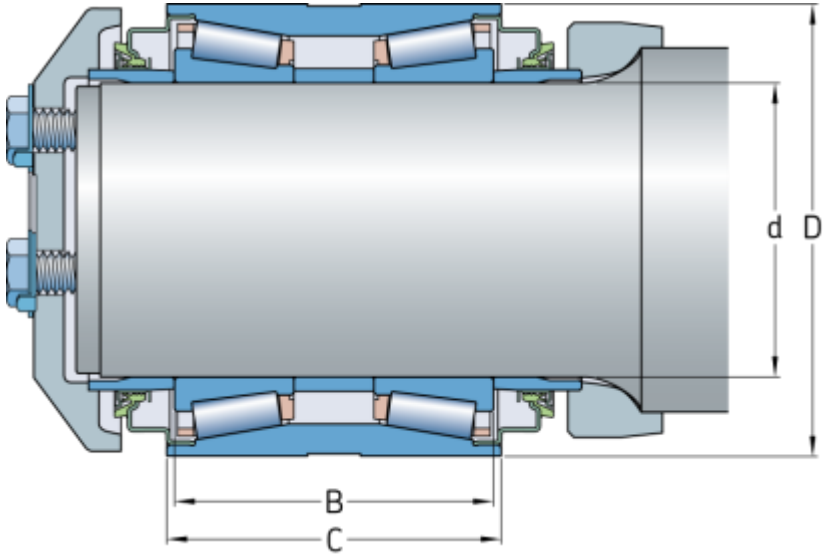


These figures are for information only. Contact SKF for detailed product specifications.

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TBU tapered roller bearing units, inch sizes

Size	Principal dimensions			
	d	D	B	C
–	mm *(in)*			
Class B	101,600	165,100	106,35	114,30
4 1/4” x 8”	*(4.0000)*	*(6.5000)*	*(4.1870)*	*(4.5000)*
Class C	119,088	195,263	136,525	142,875
5” x 9”	*(4.6885)*	*(7.6875)*	*(5.3750)*	*(5.6250)*
Class D	131,775	207,963	146,75	152,40
5 1/2” x 10”	*(5.1880)*	*(8.1875)*	*(5.7780)*	*(6.0000)*
Class E	144,475	220,663	155,575	163,51
6” x 11”	*(5.6870)*	*(8.6875)*	*(6.1250)*	*(6.4370)*
Class F	157,175	252,413	177,80	184,15
6 1/2” x 12”	*(6.1879)*	*(9.9375)*	*(7.0000)*	*(7.2500)*



These figures are for information only. Contact SKF for detailed product specifications.

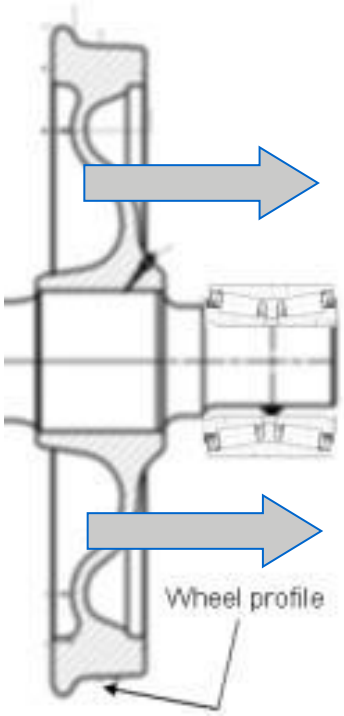
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5.2

Maintenance Intervals

Maintenance Intervals

General notes about Maintenance Intervals:



•To dismount the wheel it is necessary to dismount the TBU

•Once the TBU is dismounted from the journal, it needs to be refurbished

Consequently the maintenance interval of the TBU is dictated by the wheel dismounting

•The wheel is dismounted when it reaches the end of its life
(Wheel end life is when, due to the subsequent machining operations to restore the wheel profile in contact with the rail, the thickness of the wheel approaches the minimum value fixed by the structural integrity of the wheel)

Therefore:

Maintenance interval of the TBU
is dictated by the wheel life

© SKF Group

Maintenance Intervals for TBU (*) :

Application type	Bearing type	Proposed Maintenance Interval (ML km)	Proposed Maintenance Interval (years)
Freight Europe (closed axlebox)	CRB	0.6 - 0.8	from 6 to 8
Mass Transit Metrò Tramways	TBU/CTBU/CRB	0.6 - 0.8	from 6 to 8
Freight in adapter Similar to AAR AAR	TBU/CTBU	0.6 - 0.8	from 6 to 8
Loco freight up to 120 km/h	TBU/CTBU	0.6 - 1.0	from 6 to 8
Passenger coaches up to 200 km/h	TBU/CTBU	0.8 - 1.2	up to 6
Multiple units up to 200 km/h	TBU/CTBU	0.8 - 1.2	up to 6
Loco up to 200 km/h	TBU/CRU	0.6 - 1.0	up to 6
High Speed Trains from 200 to 250 km/h	TBU/CRU	0.8 - 1.2	up to 6
High Speed Trains from 250 to 300 km/h	TBU/CRU	0.8 - 1.2	up to 6
High Speed Trains from 300 to 350 km/h	TBU/CRU	0.8 - 1.2 ?	up to 6

WHICHEVER COMES FIRST !

(*) values are valid without having relubrication in service

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Maintenance Intervals for TBU:

The limiting factor to have long maintenance intervals for a wheel-set bearing is the grease life

Grease life is affected by:

- mechanical stress in service
- pollution from external factors
- temperatures in service

As general rule, the TBU maintenance interval cannot be given as a punctual value, but as a range (min / MAX)

The value is infact influenced by a number of factors, such as :

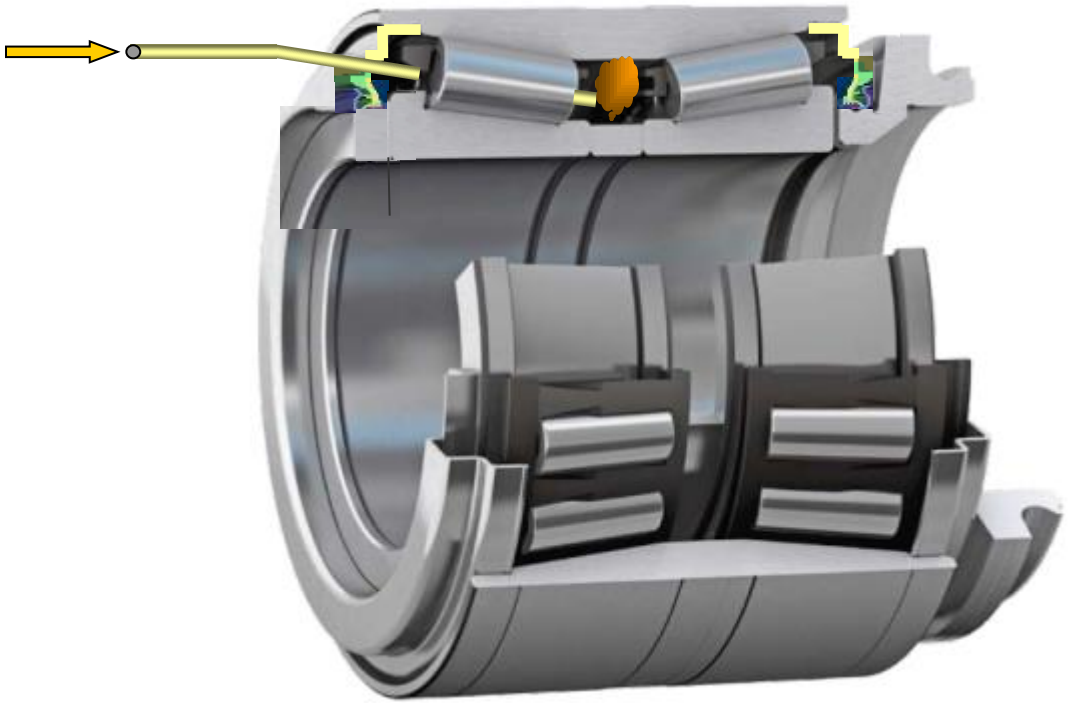
- uncertainty of the environment (track conditions, climate conditions, etc…..)
- uncertainty on maintenance on track and on wheel
- Still unsufficient experience with the product
- Others…..

The maintenance Interval must be given in terms of mileage AND years, **WHICHEVER COMES FIRST**

© SKF Group

Maintenance Intervals for TBU – relubrication :

Grease life (and consequently TBU maintenance intervals) can be increased by providing a relubrication in service:
An amount of fresh grease is pumped into the unit and mixed with the already used grease
In this way it is possible to respect the most demanding maintenance intervals



Note:
Relubrication is not done to push out the exaust grease, but by mixing this one with the fresh grease.

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5.3

TBU Mounting and Maintenance

Checking TBU after transport



© SKF Group

Mounting example



1 Protected bearings inside the pallet box



2 Exposed bearings



3 Calibrating the measuring device, using a master

© SKF Group

Mounting example



4 Cleaning the journal



5 Checking journal straightness with a ruler

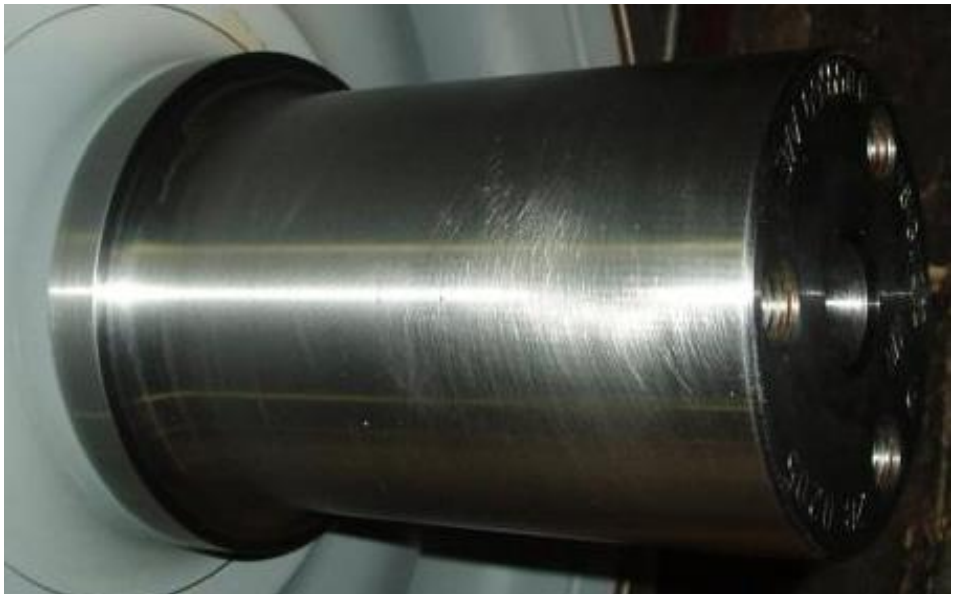


6 Checking the journal temperature

© SKF Group

Mounting example





Grit size table			
General Grits Dimensions	ISO/FEPA Grit Designation	CAMI Grit Designation	Average particle diameter relative to FEPA Designation(μm)
MACROGRIT	P220	220	68.0
MICROGRIT	P320	240 or 320	46.2

© SKF Group

Mounting example



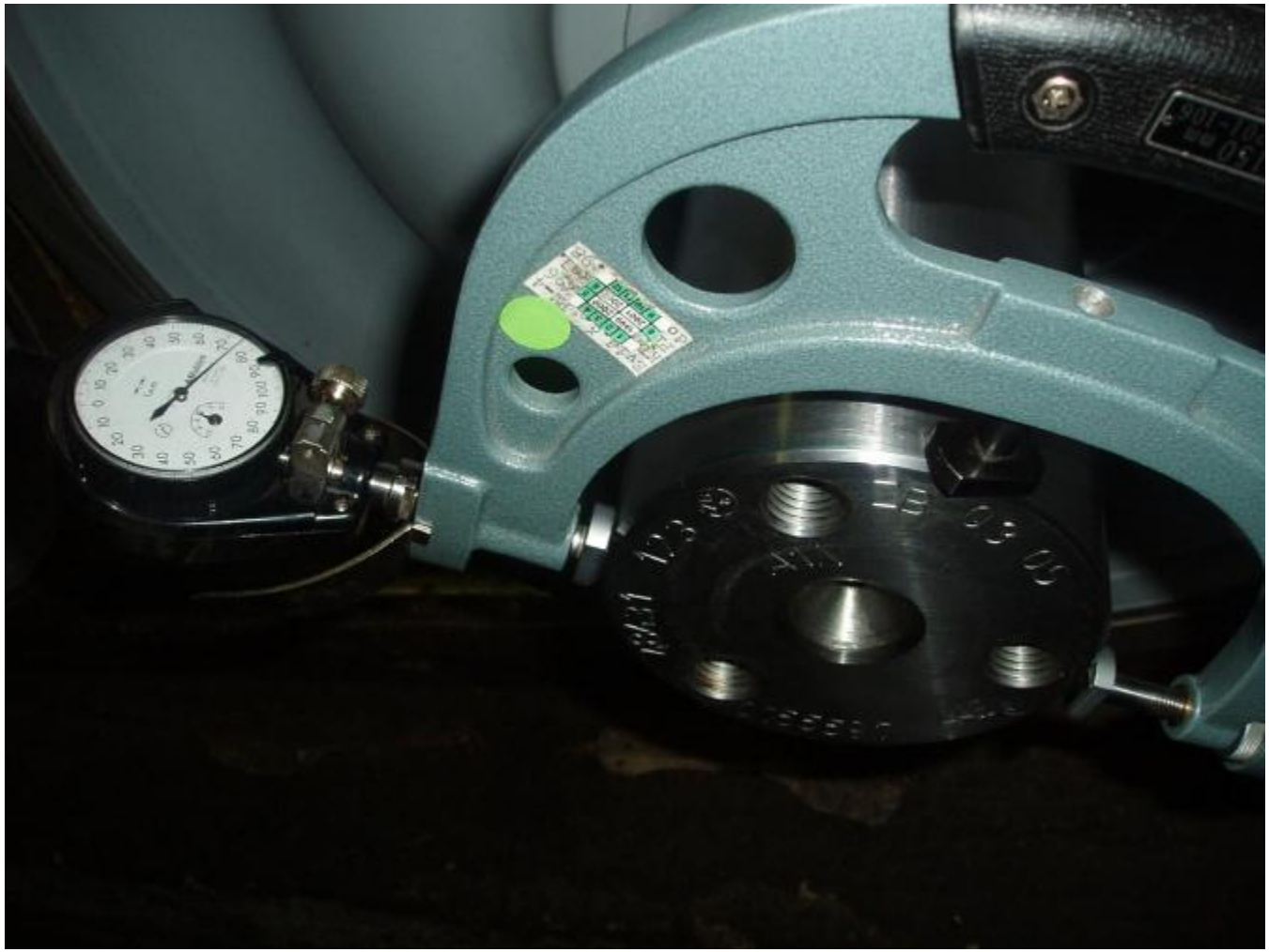






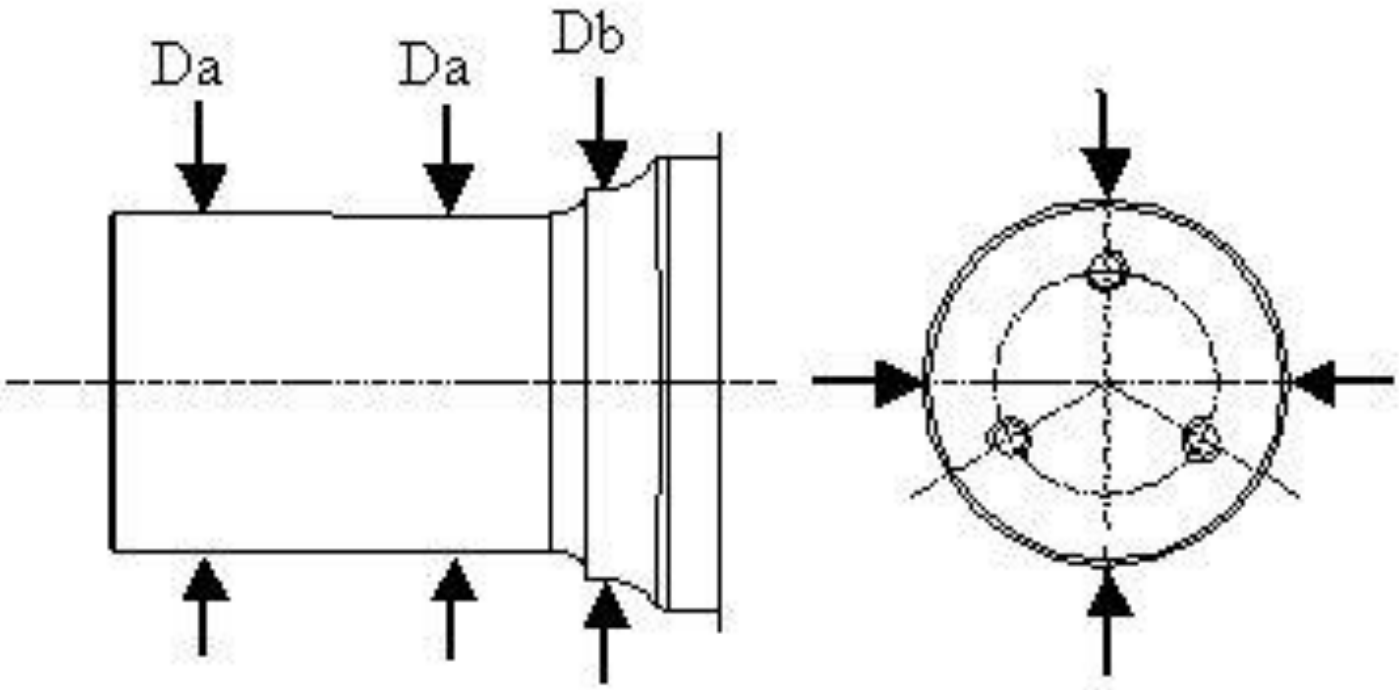
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Mounting example



© SKF Group

Mounting example



© SKF Group

Mounting example



7 Checking the bearing seat diameter, journal end, vertical position



8 Checking the bearing seat diameter, journal end, horizontal position



9 Checking the bearing seat diameter, journal middle, vertical position

© SKF Group

Mounting example



10 Checking the bearing seat diameter, journal middle, horizontal position



11 Checking the bearing seat diameter, journal inside, vertical position



12 Checking the bearing seat diameter, journal inside, horizontal position

Back

© SKF Group

Mounting example



13 Checking the backing ring seat diameter, vertical position



14 Checking the backing ring seat diameter, horizontal position



15 Attaching the pilot sleeve

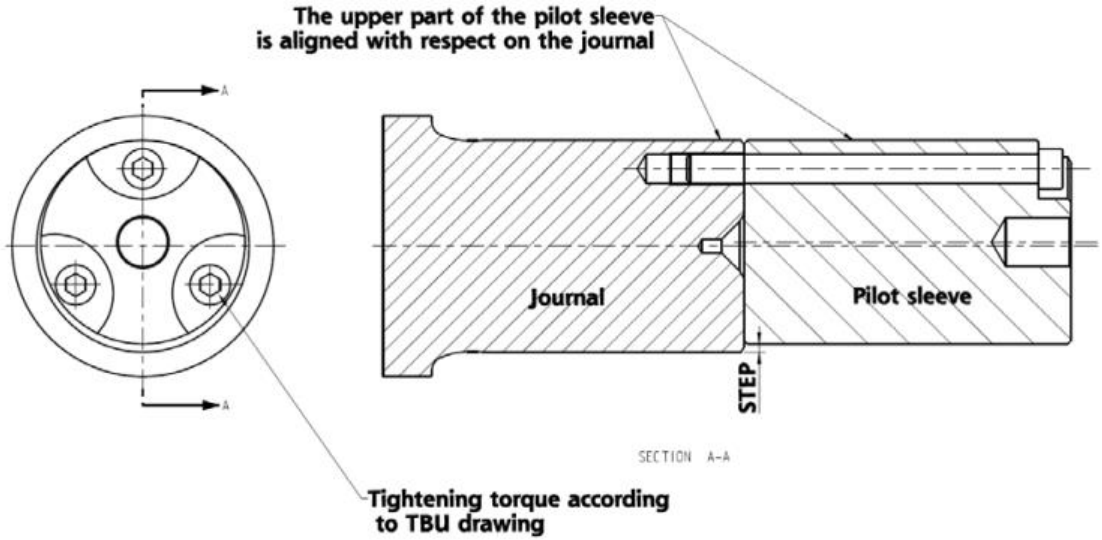
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Mounting example



16 Check the alignment of the upper part of the pilot sleeve with the journal using a ruler

and by measuring it at 0° (12 o' clock). No step must be detected in the upper part.



© SKF Group

Mounting example



17 Coating the journal with a thin layer of light oil prior to mounting



18 Preparing to install the tapered roller bearing unit including the backing ring. Do not remove triangular retainer

© SKF Group

Mounting example



19 Installing the tapered roller bearing unit on the pilot sleeve



20 Sliding the tapered roller bearing unit to the end position on the pilot sleeve



21 Preparing the TBU press

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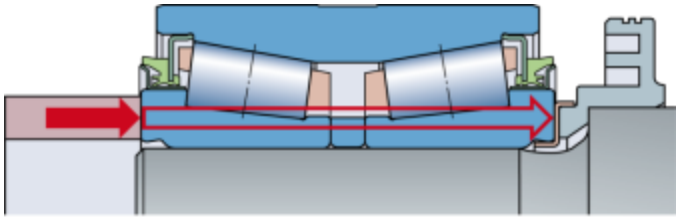
TBU mounting by hydraulic press



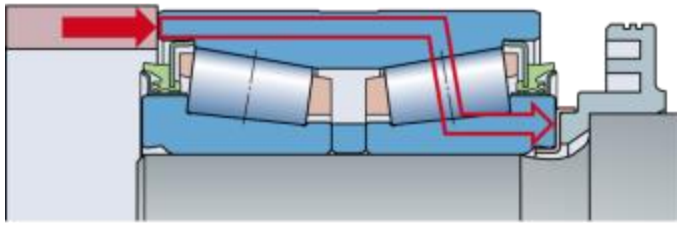


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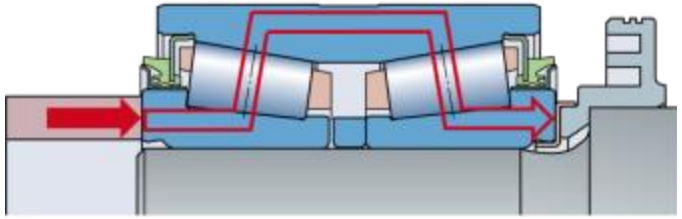
Correct and incorrect cold mounting methods



Correct



Incorrect

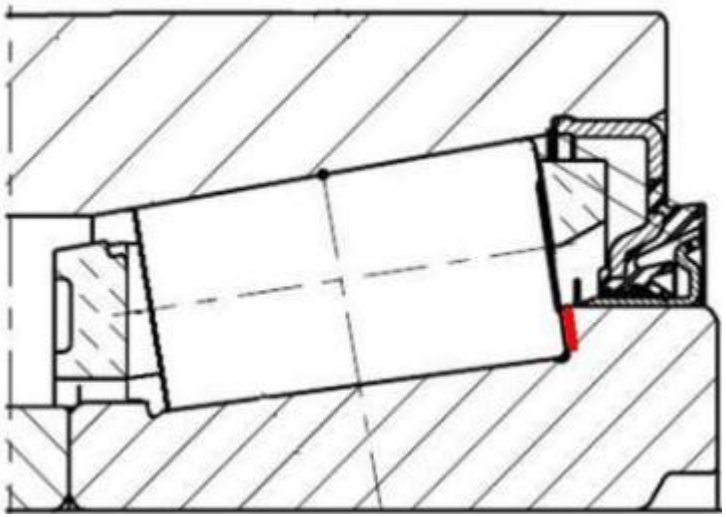


Incorrect

Mounting without outer ring rotation. In this case, the left inner ring has no axial contact and the axial load is transmitted via the roller set

© SKF Group

TBU mounting – outer ring rotation



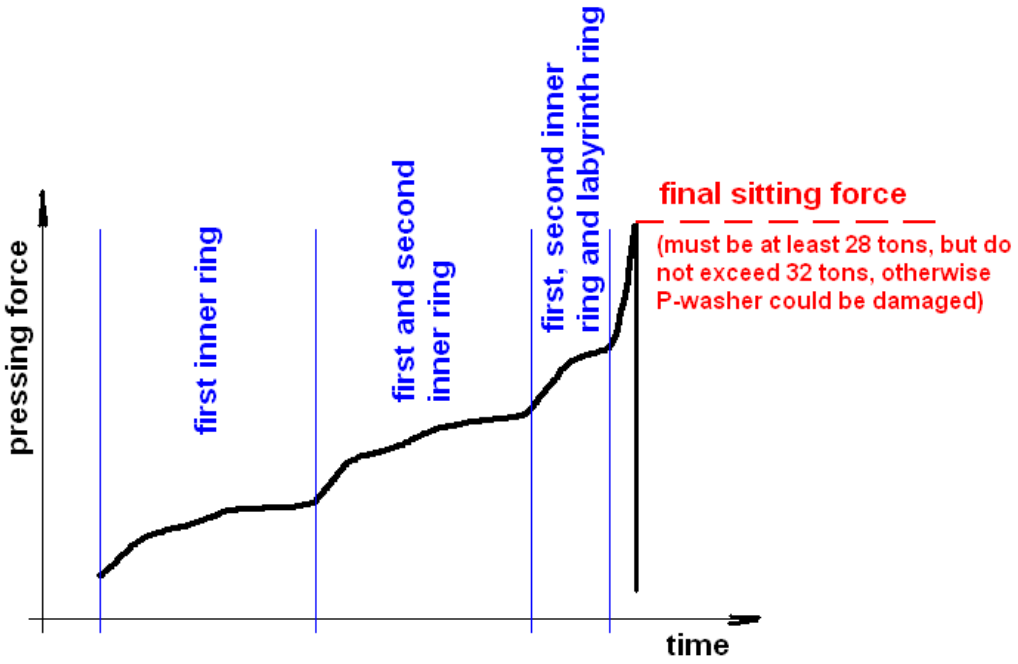


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TBU mounting

Manometer curve





© SKF Group

Mounting example



22 Pressing the TBU on its journal seat while rotating the outer ring by hand



23 Removing the pilot sleeve



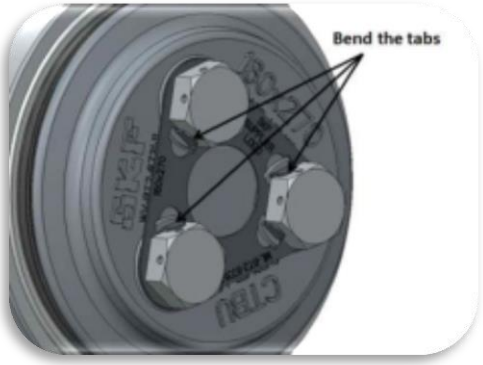
24 Installing the end cap

© SKF Group

Mounting example



25 Tightening the end cap bolts



26 Bending the tabs of the locking plate



27 Installing the equipment to measure axial clearance in the tapered roller bearing unit

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Mounting example



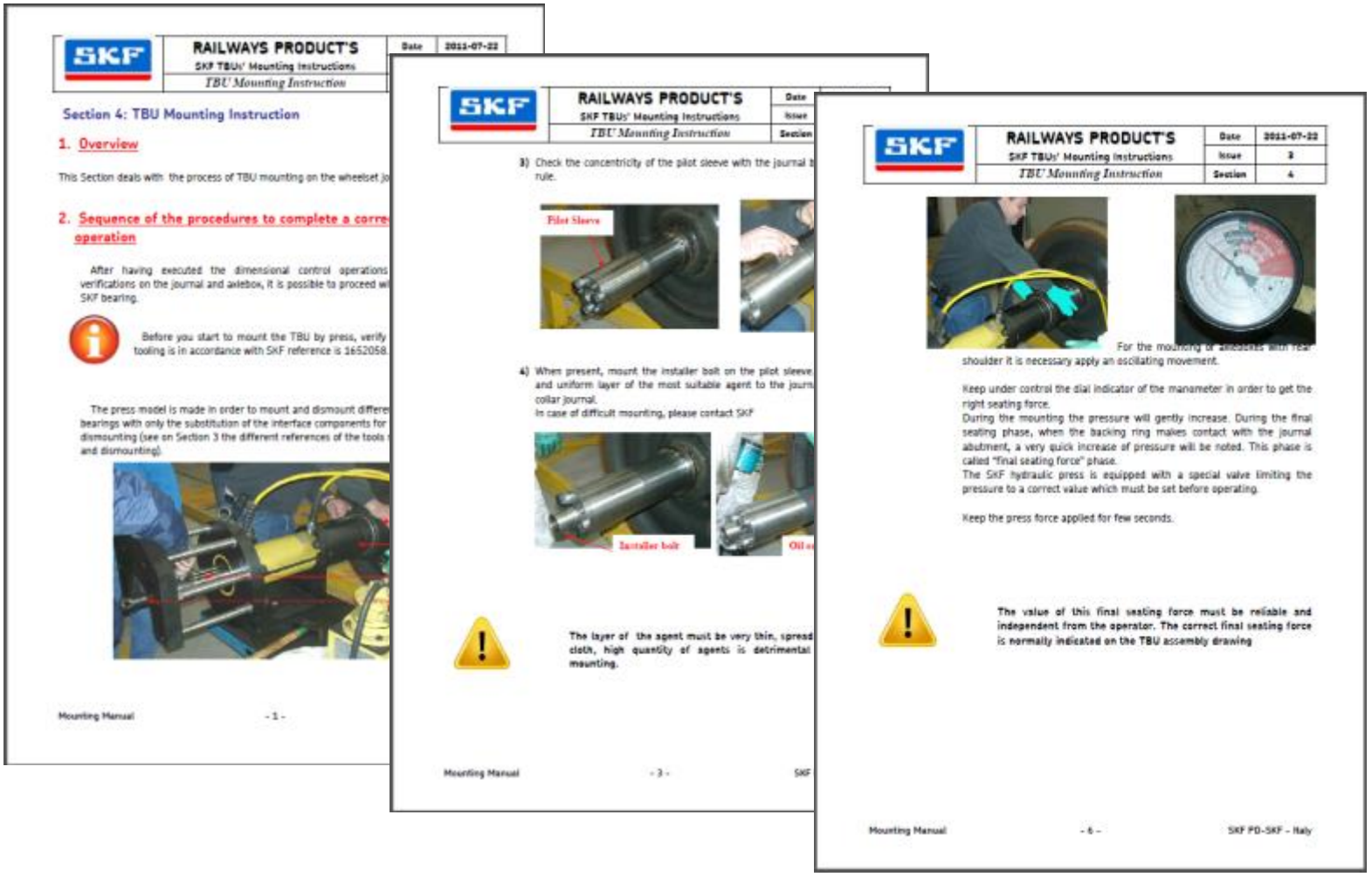


28 Measuring the axial clearance in the tapered roller bearing unit

Axial Clearance (minimum) 0.020 mm

© SKF Group

SKF Manual



RAILWAYS PRODUCT'S
SKF TBUs' Mounting Instructions
TBU Mounting Instruction

Date 2011-07-22

Section 4: TBU Mounting Instruction

1. Overview

This Section deals with the process of TBU mounting on the wheelset jo

2. Sequence of the procedures to complete a corre operation

After having executed the dimensional control operations verifications on the journal and axlebox, it is possible to proceed wi SKF bearing.

Before you start to mount the TBU by press, verify tooling is in accordance with SKF reference is 1652058.

The press model is made in order to mount and dismount differe bearings with only the substitution of the interface components for dismounting (see on Section 3 the different references of the tools and dismounting).

Mounting Manual - 1 -

RAILWAYS PRODUCT'S
SKF TBUs' Mounting Instructions
TBU Mounting Instruction

Date
Issue
Section

3) Check the concentricity of the pilot sleeve with the journal rule.

Pilot Sleeve

4) When present, mount the installer bolt on the pilot sleeve and uniform layer of the most suitable agent to the journ collar journal.
In case of difficult mounting, please contact SKF

Installer bolt

The layer of the agent must be very thin, spread cloth, high quantity of agents is detrimental mounting.

Mounting Manual - 3 - SKF

RAILWAYS PRODUCT'S
SKF TBUs' Mounting Instructions
TBU Mounting Instruction

Date 2011-07-22
Issue 3
Section 4

For the mounting shoulder it is necessary apply an oscillating movement.

Keep under control the dial indicator of the manometer in order to get the right seating force.
During the mounting the pressure will gently increase. During the final seating phase, when the backing ring makes contact with the journal abutment, a very quick increase of pressure will be noted. This phase is called "final seating force" phase.
The SKF hydraulic press is equipped with a special valve limiting the pressure to a correct value which must be set before operating.

Keep the press force applied for few seconds.

The value of this final seating force must be reliable and independent from the operator. The correct final seating force is normally indicated on the TBU assembly drawing

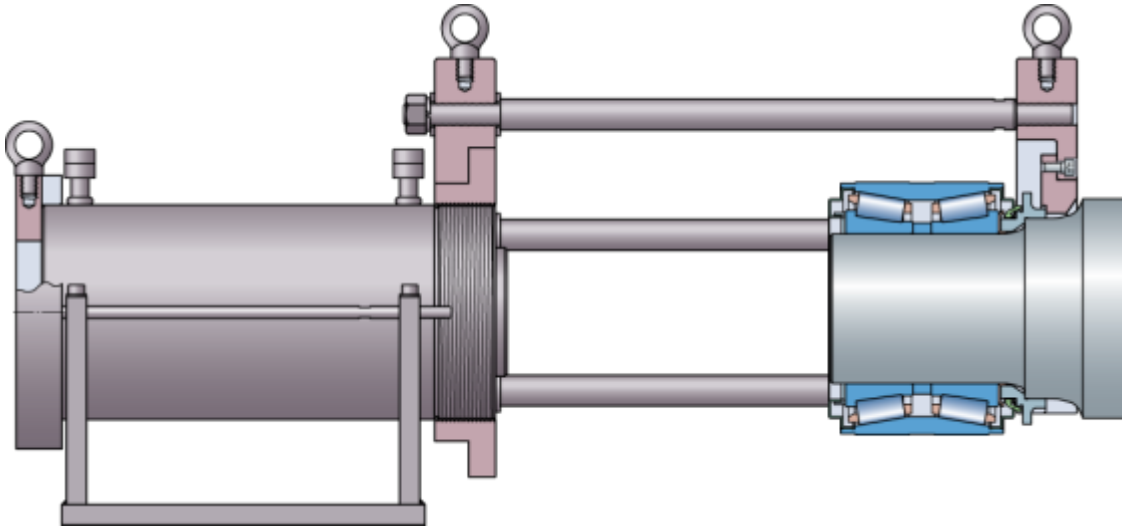
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Dismounting

Dismounting

Dismounting a tapered roller bearing unit using a hydraulic press



© SKF Group

Dismounting



Preparing for dismounting in the workshop

© SKF Group

Dismounting



Adjusting the dismounting tool

© SKF Group

Dismounting



Dismounting the tapered roller bearing unit with the TBU press

© SKF Group

5.3

Factors Affecting TBU Performance

Factors affecting TBU performance

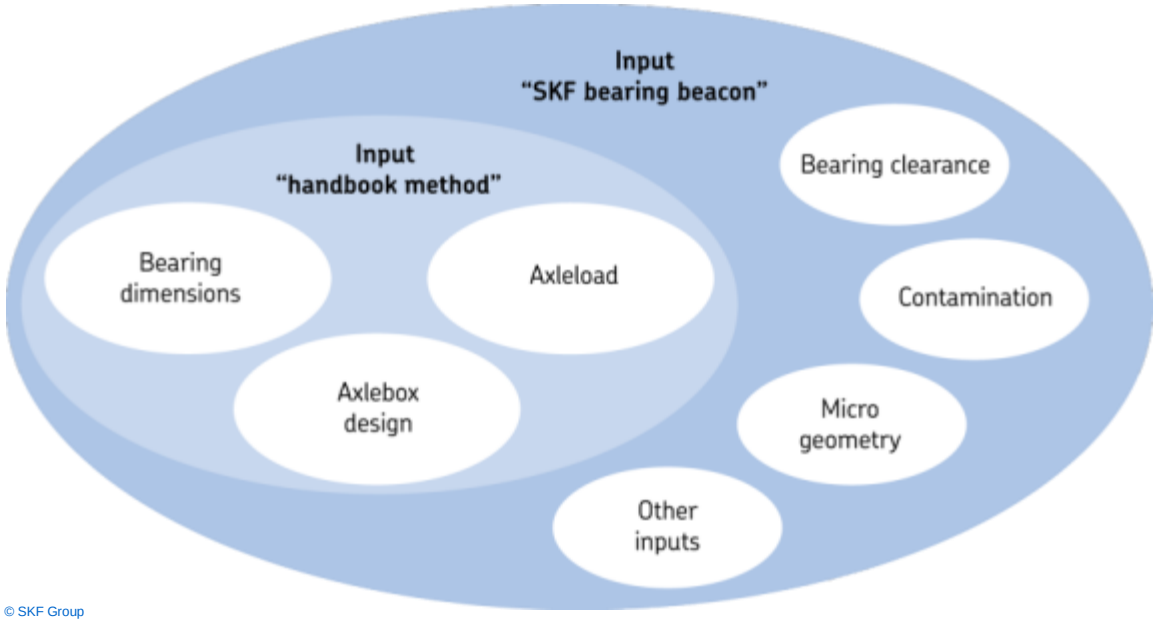
1.	TBU design	1.1. TBU size and type 1.2. TBU material and heat treatment
2.	TBU storage	
3.	TBU assembly process	3.1. Workshop cleanliness 3.2. TBU mounting press and tools 3.3. TBU handling 3.4. TBU pressing process
4.	Abutment parts design and quality	4.1. Journal design and quality 4.2. Adapter or axlebox design 4.3. Adapter or axlebox quality 4.4. Bogie design (espec. axial overload)
5.	Wheelset storage	
6.	Bogie assembly process	
7.	Vehicle operation	7.1. Excessive shock loads (e.g. wheel flats) 7.2. Electric current passages 7.3. Other inappropriate conditions 7.4. Disregard of recommended maintenance interval
8.	TBU disassembly process	8.1. TBU dismounting tools 8.2. TBU handling and transport
9.	TBU refurbishment	

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1.1. TBU size and type

For correct TBU design process, type and size selection it is necessary to submit correct input (axlel load, unsprung mass, vehicle speed, operating temperature, …etc.). Otherwise the selected TBU size and type might not fit to the application needs! Especially the grease must be carefully selected for given application conditions and TBU type.

The TBU size must be checked by life calculation. The picture below shows the input for basic („SKF Handbook method“) and advanced („SKF Bearing Beacon“) calculations.





© SKF Group

1.2 TBU Material and Heat Treatment

For correct TBU performance the proper TBU material and HT must be chosen. For axlebox applications usually TH rings are used, while for adapter it is necessary to go for CC or bainitic OR rings. The picture below shows residual stresses in different materials:

© SKF Group

2. TBU Storage

All the rules for TBU storage mentioned in SKF TBU manual must be kept. Otherwise the TBU performance might be influenced in many ways (raceways oxidation, mechanical damages, …):

“Following fitment of TBU or axlebox bearings charged with grease, to the new, overhauled, repaired, or otherwise serviceable wheelset, the wheelset should be used in traffic, within 12 months.

Within this storage interval, the grease contained within the bearing arrangement shall be agitated periodically to prevent oxidation. This may be undertaken by rotating the outer race of the bearing or the axle box several times, or rotating the wheelset whilst the bearing outer races or axleboxes are stationary, 20 rotations minimum. The latter may best suite wheelsets fitted within bogies. It is recommended that this redistribution of grease is undertaken at least every 4 months.

In case rotation is not undertaken and in any case after 12 months of mounted wheelset storage, it is necessary to dismount some units by sampling in order to check the condition and to take decision on the rest of the fleet. Sampling and conditions needs to be agreed between the parties”

© SKF Group

2. TBU Storage

TBU’s, when stored by the Customer, must remain sealed inside their pallet box until immediately prior to mounting.





© SKF Group

3.1. Workshop Cleanliness

All the rules for correct workshop mentioned in SKF TBU manual must be kept. Although the TBU unit is less sensitive in comparison with all open bearings (CRB, SRB), the TBU performance might be reduced in several ways by improper workshop conditions.



© SKF Group

3.2. TBU mounting press and tools

The TBU press must fulfill the requirements mentioned in SKF TBU manual. Especially the mounting force must be 100% under control. Too low pressing force would lead to wrong TBU axial position on the shaft with fatal consequences. Too high pressing force would lead to p-spacer damage.

The mounting tools must assure that the mounting force is transmitted entirely through the IRs in order to avoid roller blocking and consequent raceways damages (imprints).

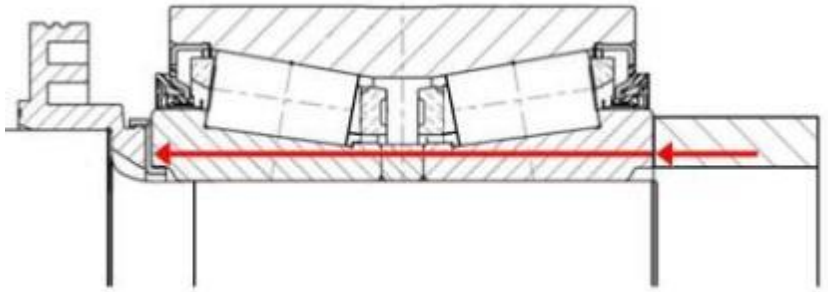




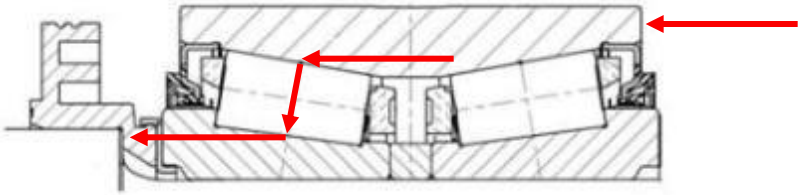
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3.2. TBU mounting press and tools

Correct



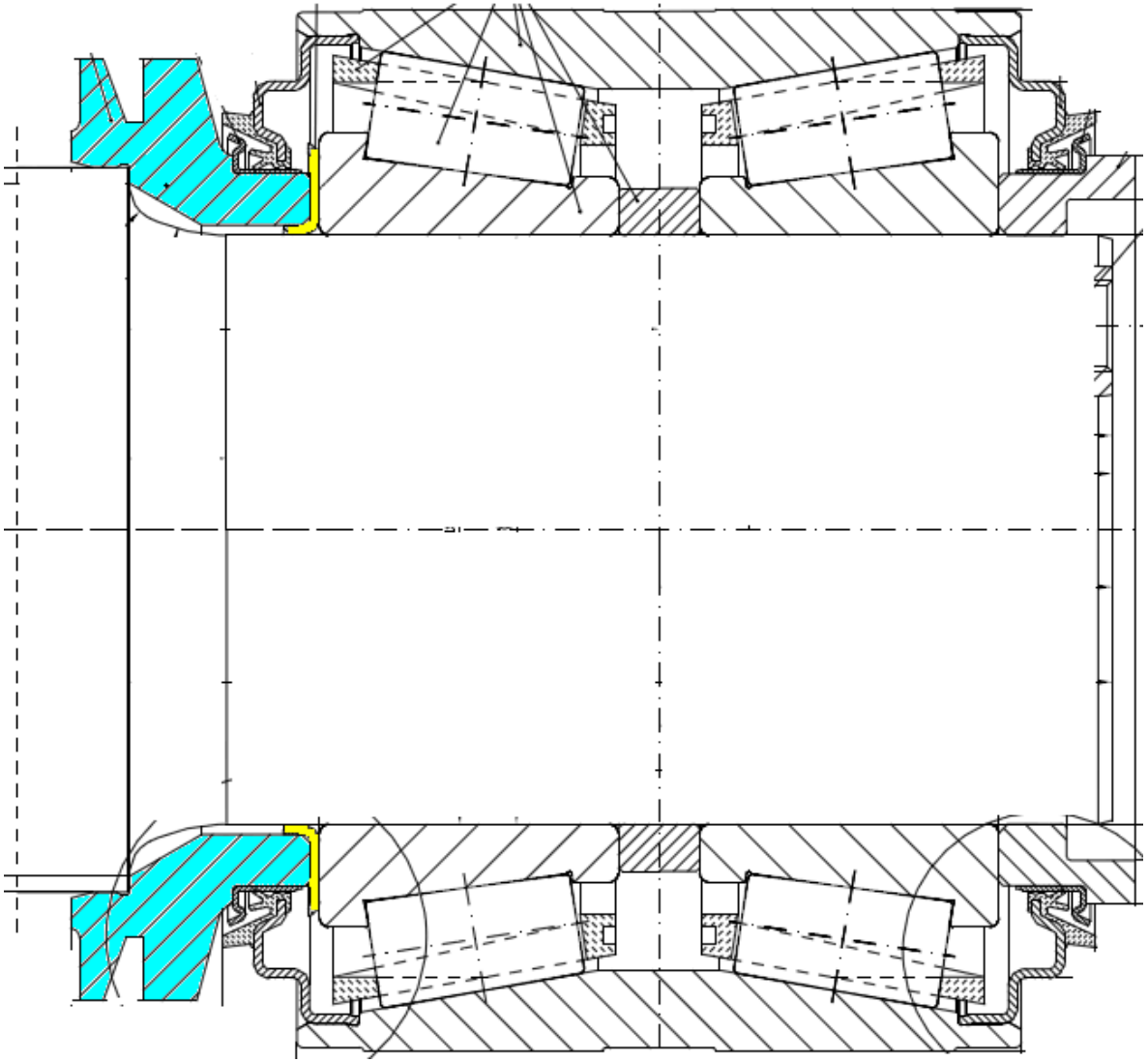
Incorrect





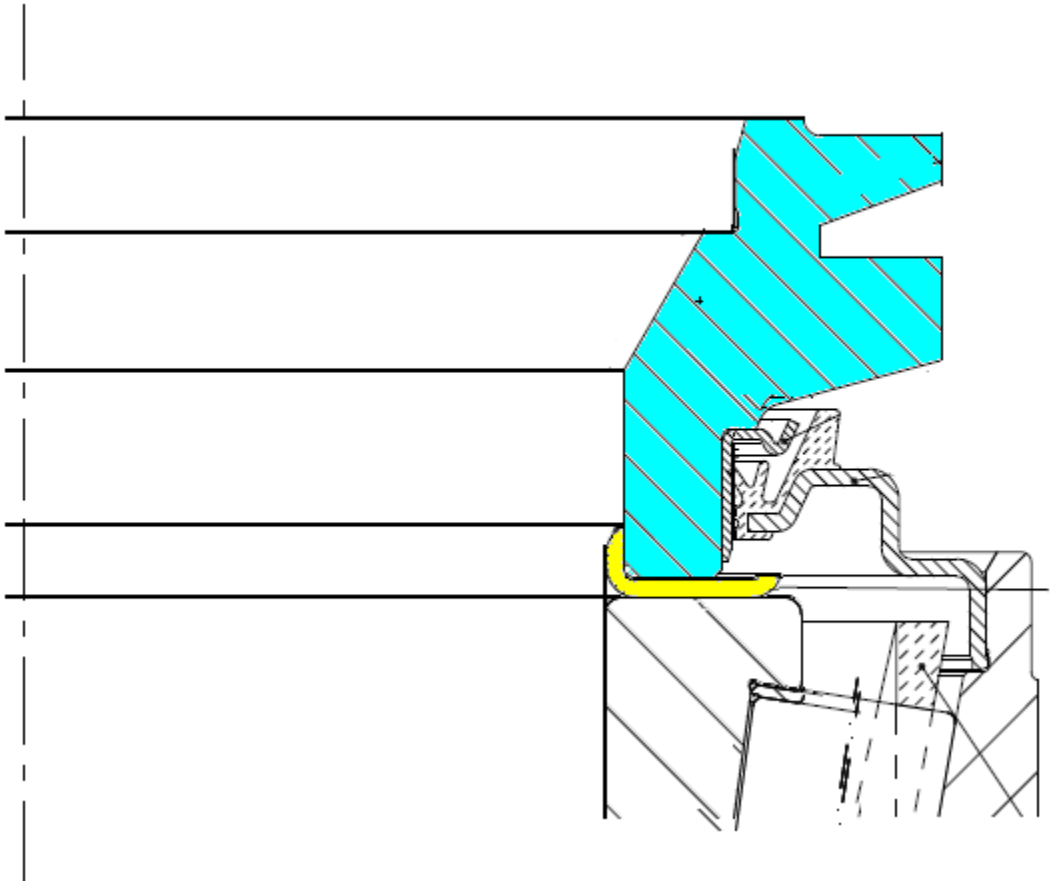
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3.3 TBU Handling



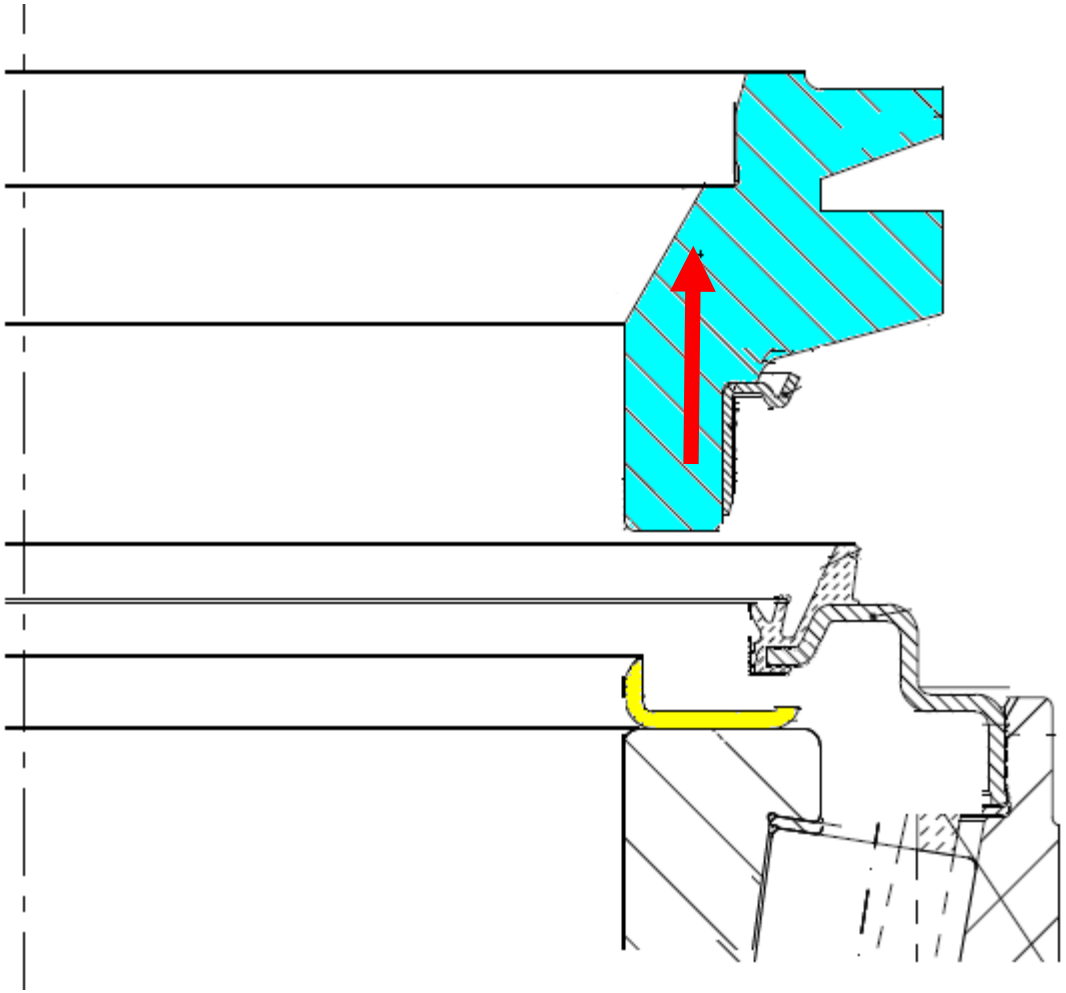
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3.3 TBU Handling



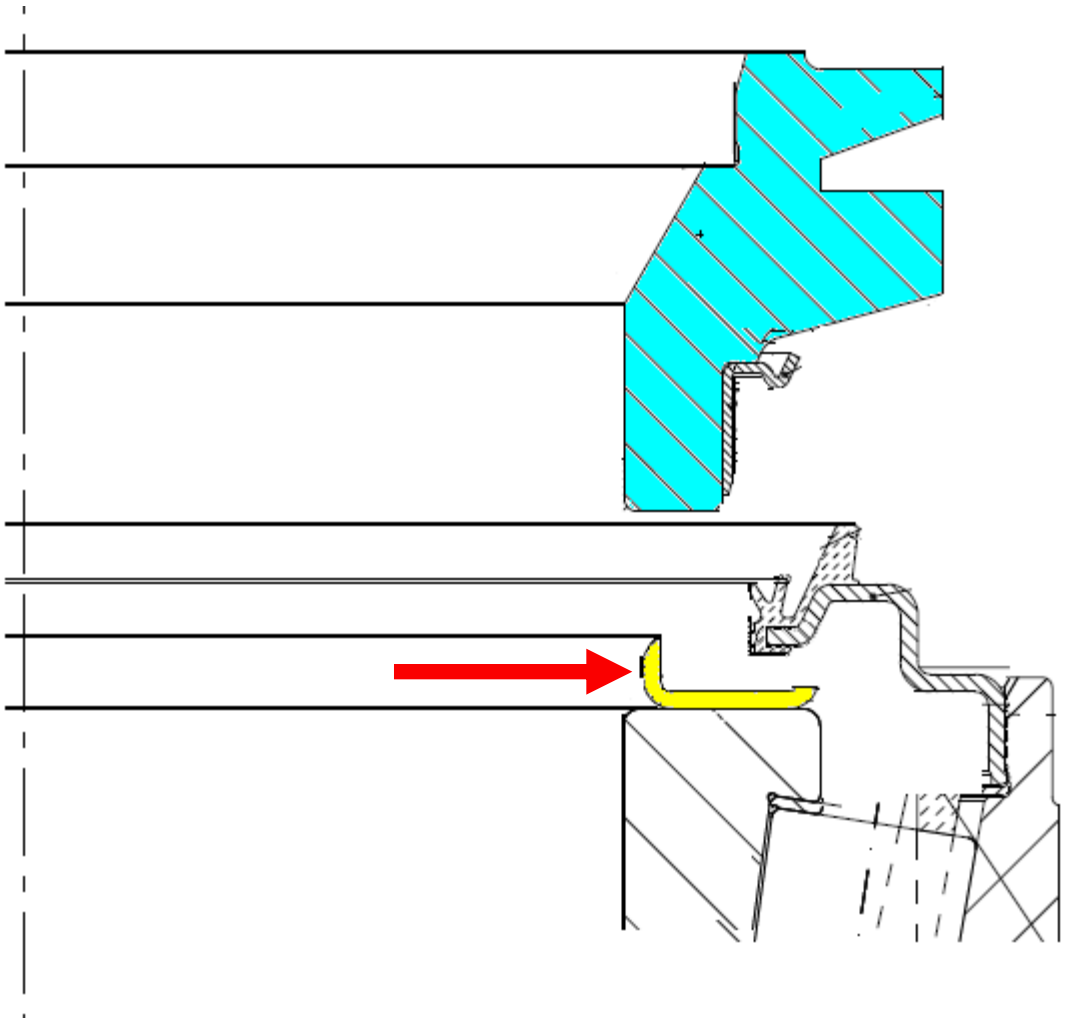
© SKF Group

3.3 TBU Handling



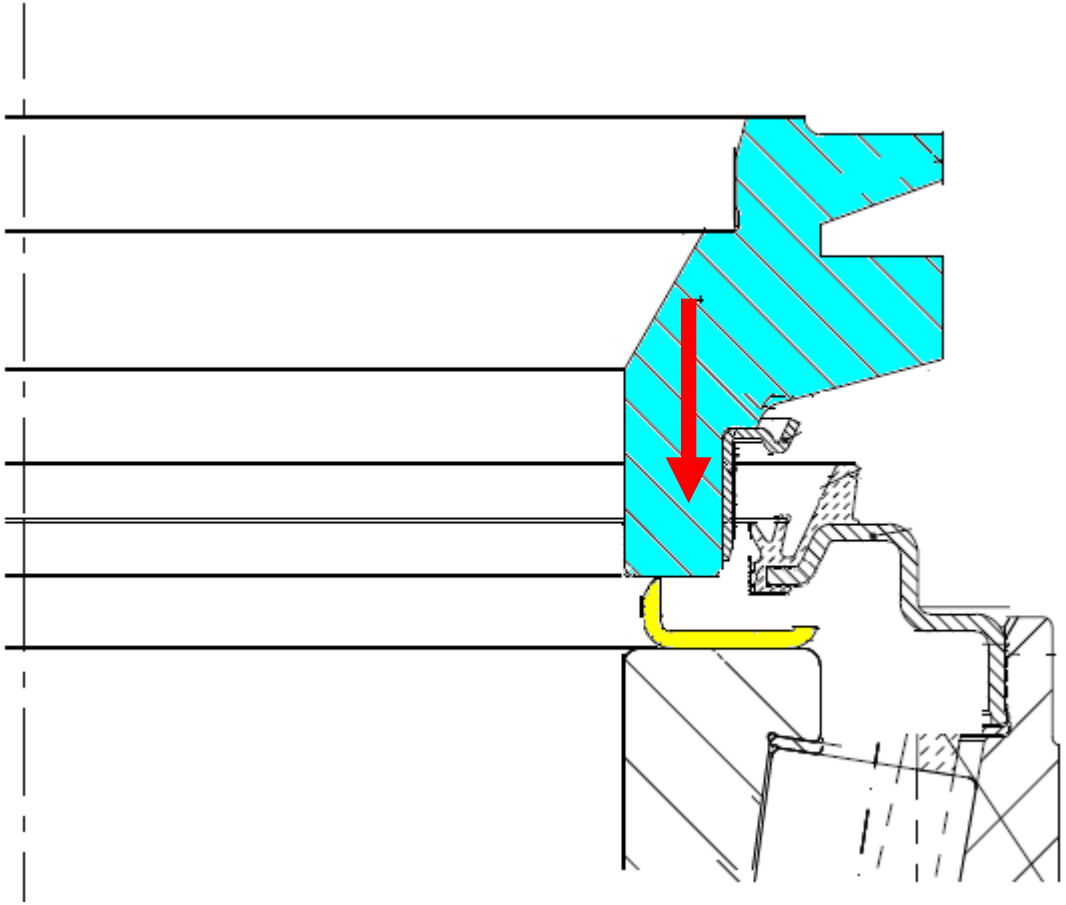
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TBU Handling



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3.3 TBU Handling



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3.3 TBU Handling

Unpack the TBUs immediately before mounting

Correct hand grif





© SKF Group

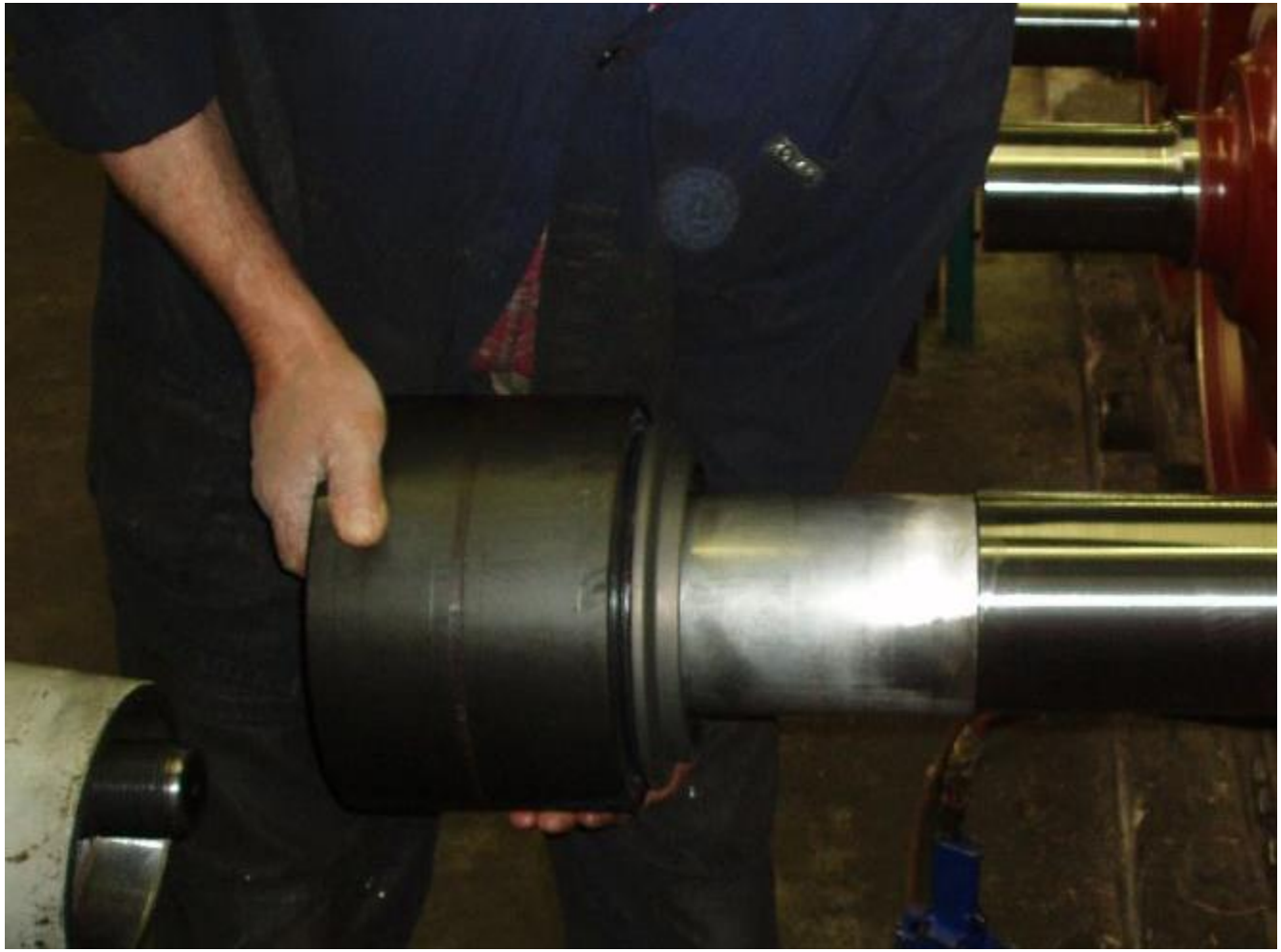
Be careful both with SKF and competitor bearing





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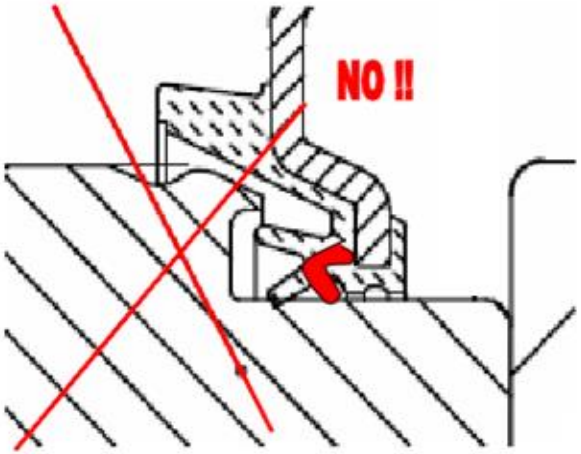
3.3 TBU Handling



© SKF Group

3.3 TBU Handling

Particular care must be taken when mounting the distance ring and/or the backing ring, in order to avoid the bending of the seal lip, as in figure



To be sure that LL-seal lip is not bent, rotate once the distance ring and/or the backing ring: if the rotation is free the lip is not bent.

© SKF Group

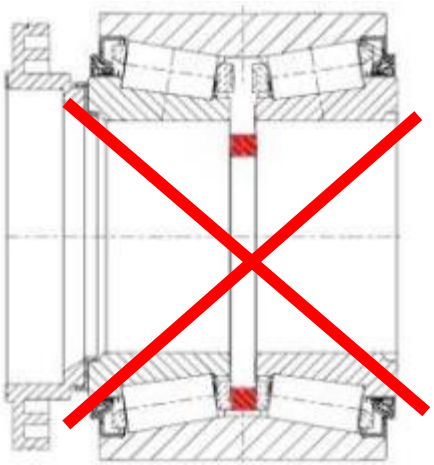
3.3. TBU Handling – do not remove the cartoon insert



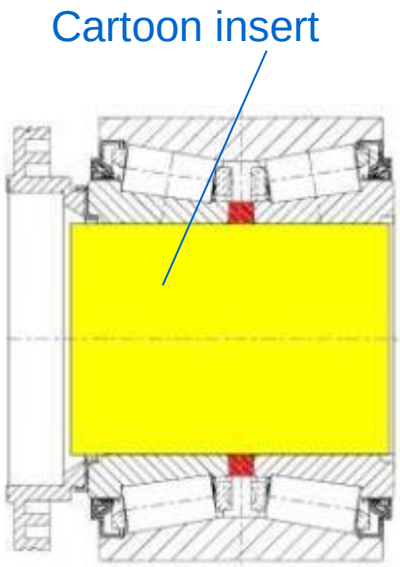


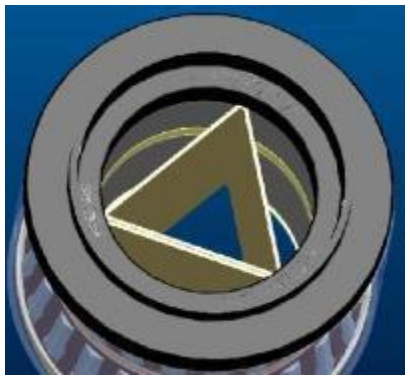
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3.3. TBU Handling – do not remove the cartoon insert









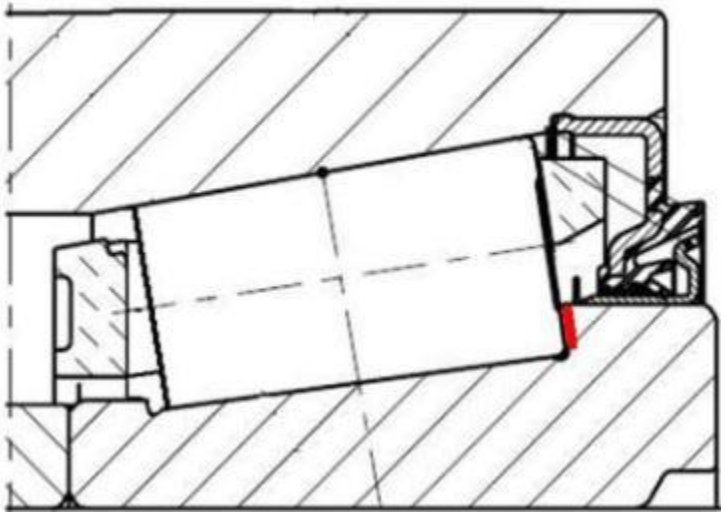
© SKF Group

3.4. TBU pressing process

TBU Pressing process

All the rules for correct TBU pressing mentioned in SKF TBU manual must be followed. Especially the TBU OR rotation before and during TBU pressing is essential in order to avoid roller blocking and consequent raceways damages (imprints).

It is very advisable to train periodically the workers by SKF expertsin TBU handling,mounting and dismounting.



When rotating the TBU OR, the rolers move to their upper position (when the roller side faces are in contact with IR flange – see the picture). In this position the rollers are not sensitive to blocking between IR and OR raceways.



© SKF Group

Factors Affecting TBU Performance

4.1. Journal Inspection

The rules for journal checking described in SKF TBU Manual must be followed.

4.2. Adapter or axle box design

Adapter and axlebox design have enormous influence on TBU performance, because they are the interface for loads transfer from the bogie to TBU. Specially the adapter/axlebox bore diameter and tolerance are important for the correct osculation and might lead to OR pinching leading to TBU loading zone disproportion and deformation, causing premature TBU failures.

Also the axlebox bore grooves must correspond in correct way with the TBU OR central groove.

© SKF Group

4.3. Adapter or axlebox quality

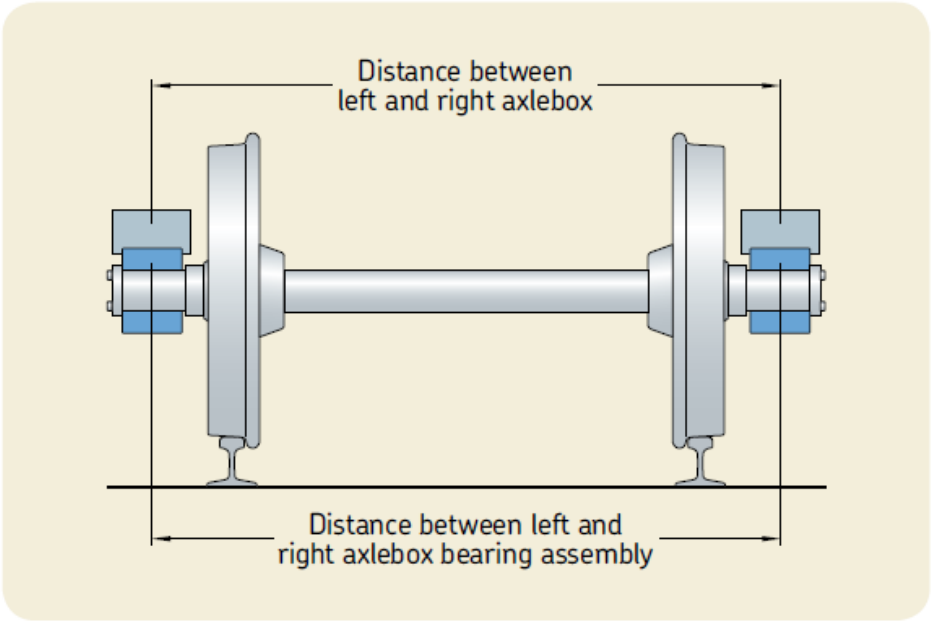
Adapter or axlebox might be correctly designed, but their dimensional, form and material quality might depreciate the design substantially and lead again to TBU loading zone disproportion and deformation, causing premature TBU failures.

(We will discuss about checking of used housings in next slides)

© SKF Group

4.4. Bogie design (espec. axial overload)

The bogie design might influence the TBU performance in several ways. One of the most important is the possible permanent axial overload, which must be 100% avoided by bogie design. This phenomena is described e.g. in „SKF Railway technical handbook, Volume 1, Axle boxes“, page 40

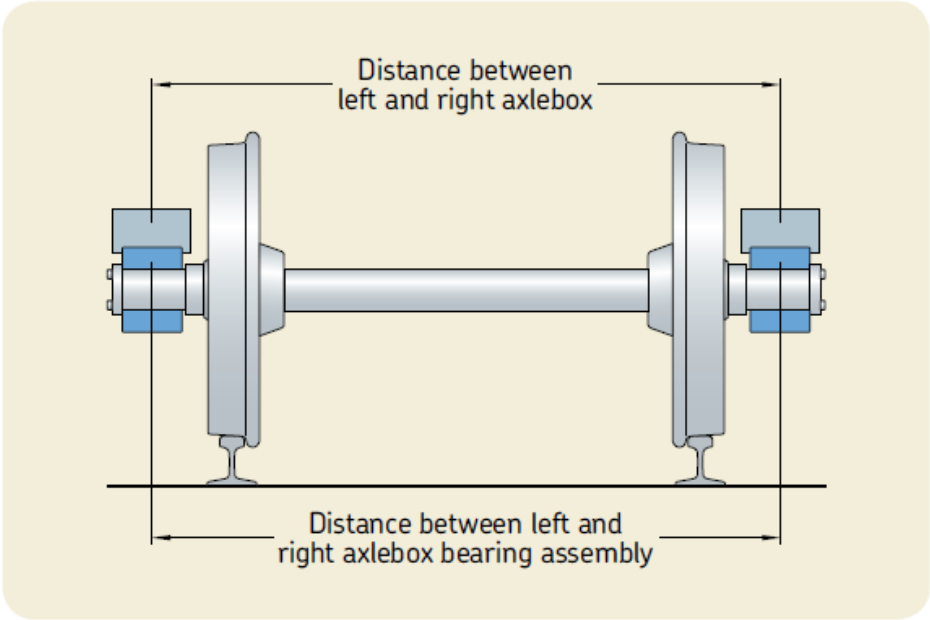


Axial tolerance principle

© SKF Group

4.4. Bogie design (Axial Overload)

The bogie design might influence the TBU performance in several ways. One of the most important is the possible permanent axial overload, which must be 100% avoided by bogie design. This phenomena is described e.g. in „SKF Railway technical handbook, Volume 1, Axle boxes“, page 40



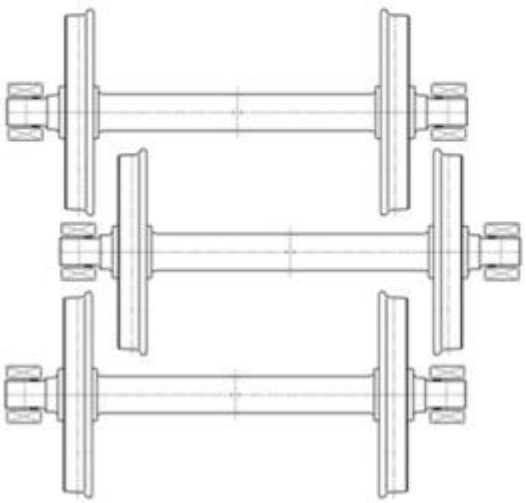
Axial tolerance principle

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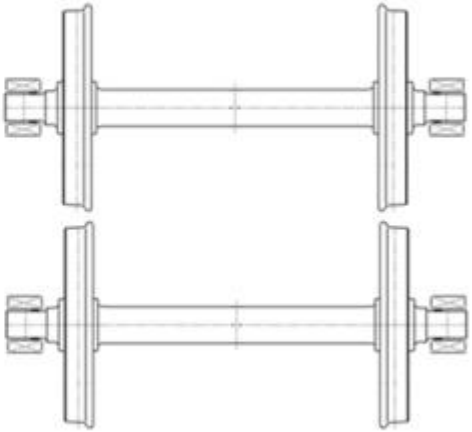
5. Wheelset storage

All the rules for correct wheelset handling mentioned in SKF TBU manual must be kept. Otherwise the TBU might be damaged already before its operation. Especially dangerous is so called wheelset staggering, oft leading to TBU OR crack (typically in „moon“ form).

Incorrect wheelset storage (staggering)



Correct wheelset storage



© SKF Group

5. Wheelset storage

Extremely care must be taken during the handling and transportation of the wheel-sets in particular (but not only), without axleboxes. This in order to completely avoid shock loads on the bearings, which is extremely detrimental to the integrity of the product.



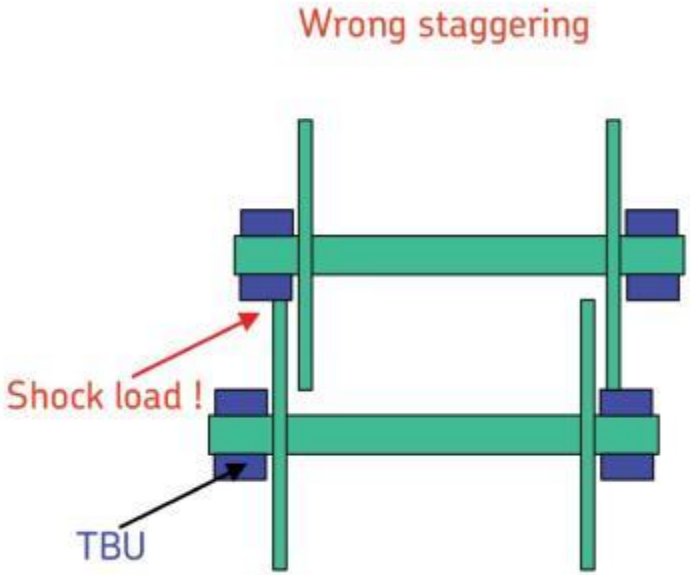


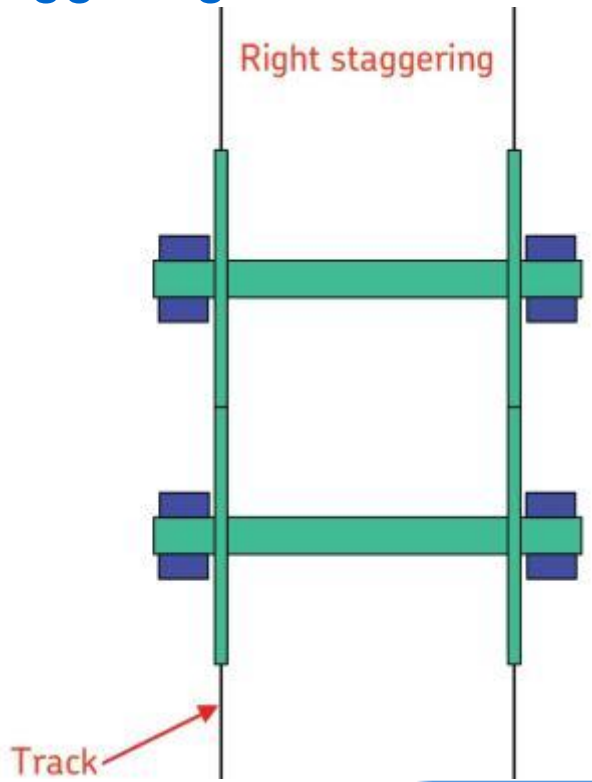
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© SKF Group

5. Wheelset storage

Also the storage of the wheelsets on the tracks must be managed with care: on the left picture below there is an example of a wrong staggering: the wheels strike the TBUs. On the right picture there is an example of a right staggering: the wheels touch together.





© SKF Group

5. Wheelset storage

SKF bearing's mounted on wheelsets with axleboxes fitted must be stored in covered areas (possibly closed), protected from bad weather conditions.

Sealed plastic bags (like this one shown) wrapping SKF TBUs are forbidden, as they promote condensation.

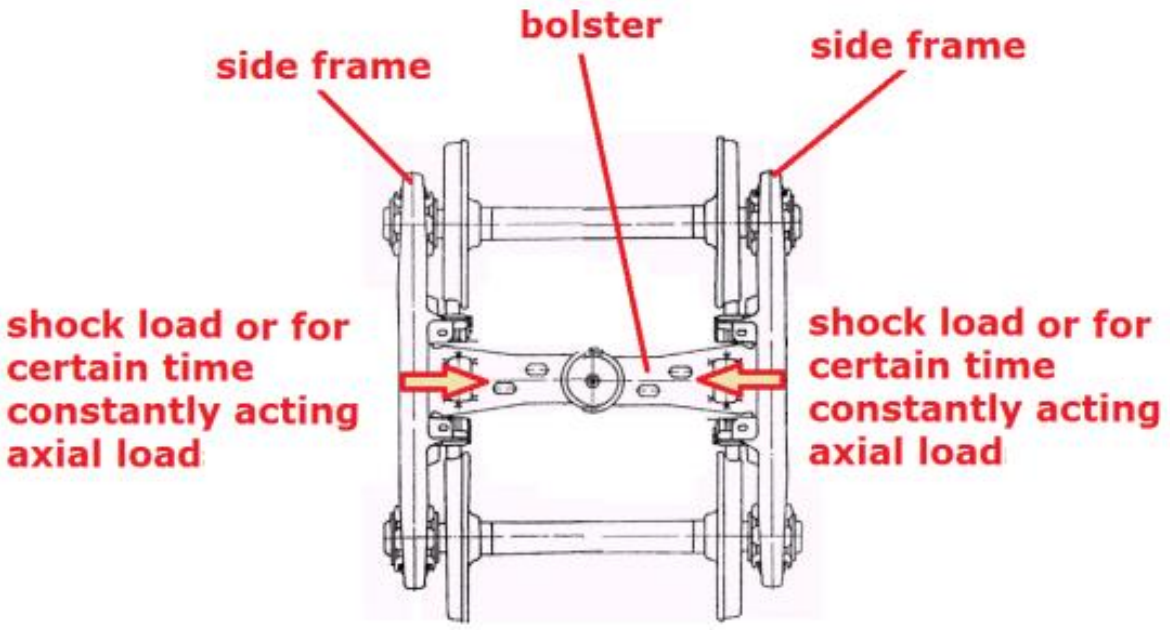




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6. Bogie Assembly Process

During bogie assembly process the TBU OR is exposed to possible excessive hits by other bogie parts (adapter, bogie side frame, …), oft leading to TBU OR crack (typically in “Half Moon” form).







© SKF Group

7.1. Excessive shock loads (e.g. wheel flats)

Excessive shock loads might damage e.g. TBU cage or might lead to improper grease function (hindered oil film building). Shock loads in TBU operationare very often caused by wheel flats or other wheel damages.



Example of deformed wheel rim



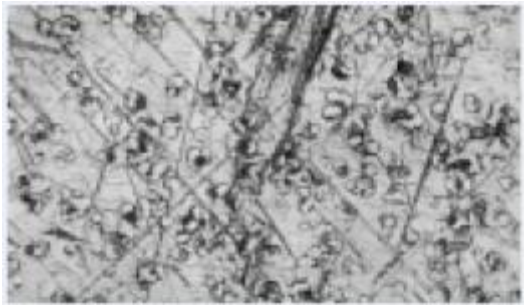
Example of wheel flats

© SKF Group

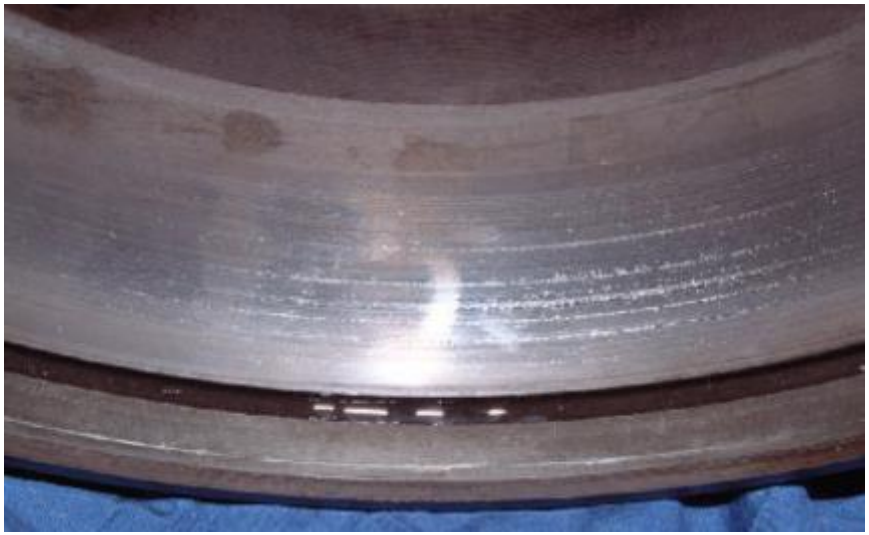
7.2. Electric current passages

The electric current passages occur not only on electric locos with improperly working earth returns, but also on connected wagons. This is given by unpredictable behaviour of current flow through the train.

The electric current passage damage might also occur during bogie maintenance (welding with incorrect grounding).



Example of raceway surface with micro craters (500x enlarged)



El. Current passage on TBU OR

© SKF Group

7.3. Other inappropriate conditions

There are several other possible (also unpredictable) influences, which might influence TBU performance. It can be e.g. flood, accidents, adapter or axlebox crack …



© SKF Group

7.4. Disregard of recommended maintenance interval

When the recommended maintenance interval is exceeded (wittingly or un wittingly), it might lead to TBU damage. Especially the function of the grease might be deteriorated, which might lead to TBU failure or to increased refurbishment scrap rate.



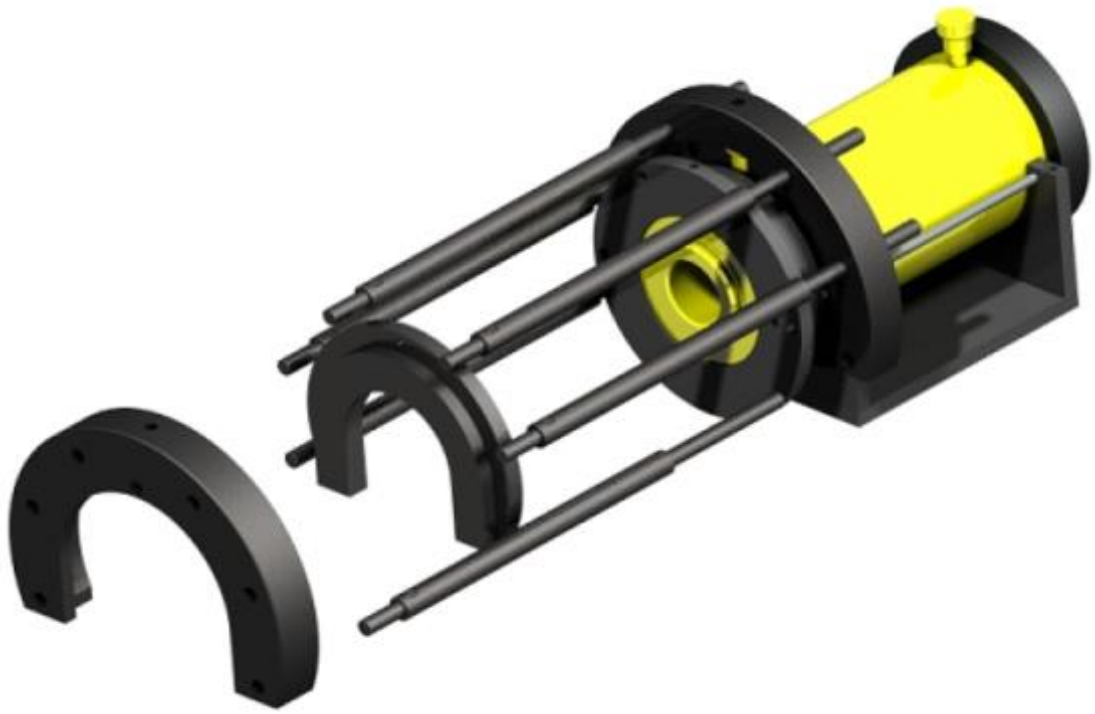


Example of correctly lubricated TBU. The critical areas are well supplied by base oil from grease reservoirs.

© SKF Group

8.1. TBU dismounting tools

Similar to the mounting tools, also the dismounting tools must assure especially that the dismounting force is transmitted entirely through the Inner Ring in order to avoid roller blocking and consequent raceways damages (imprints).



© SKF Group

8.2. TBU handling during dismounting and transport

Similar to TBU handling before and during mounting, all the rules must be kept also during dismounting in order to not damage the dismounted TBU. For TBU transport to refurbishment workshop the TBUs must be properly packed to avoid any damages.



© SKF Group

9. TBU Refurbishment

The importance of proper TBU refurbishment is equal to importance of new TBU production. Therefore the TBU refurbishment must be performed in highest quality by highly qualified and knowledgeable personnel. The quality of TBU performance depends directly on the quality of refurbishment. From this reason the best solution is to let the TBU to refurbish in SKF specialised workshop or to train periodically the workers by SKF experts.

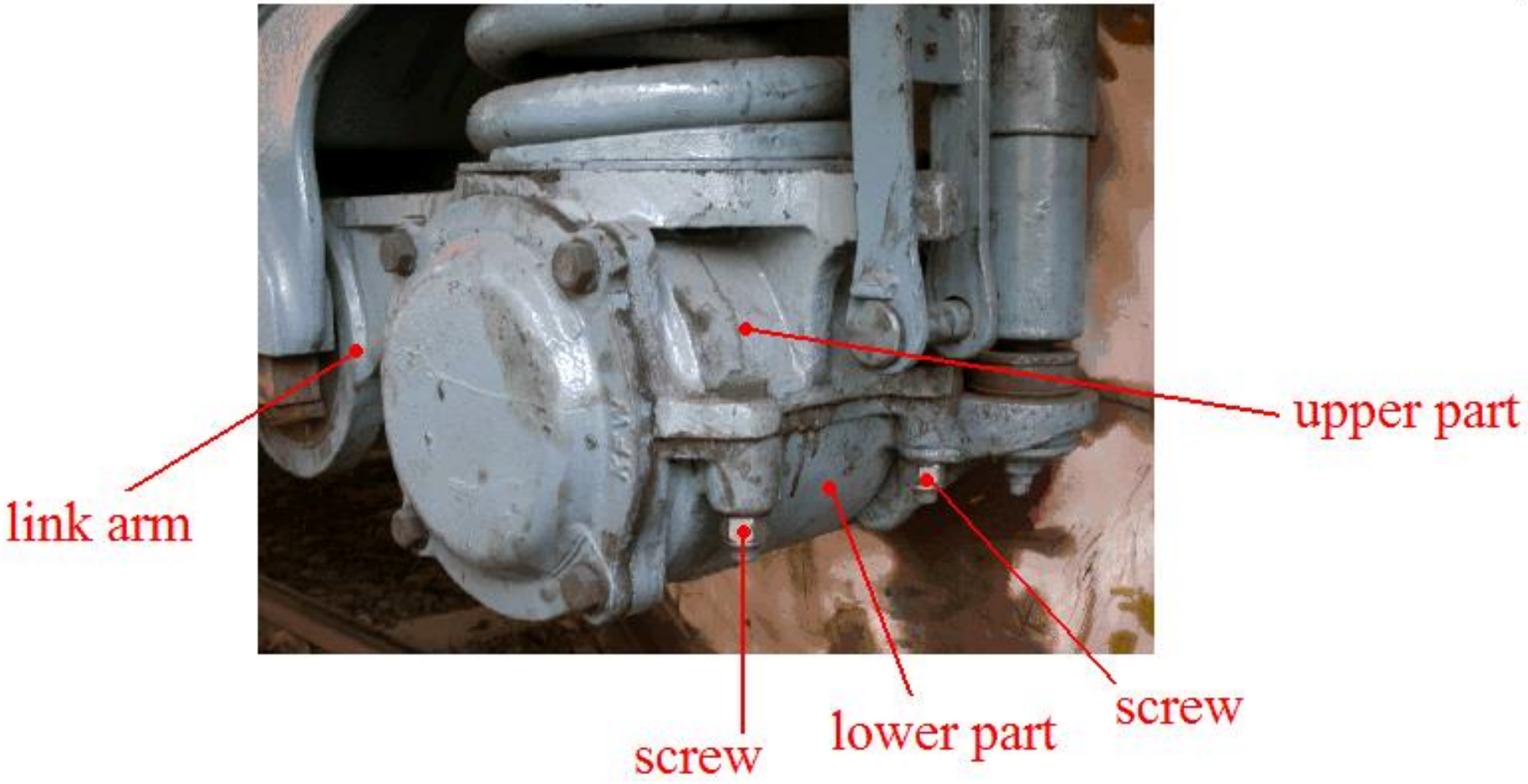




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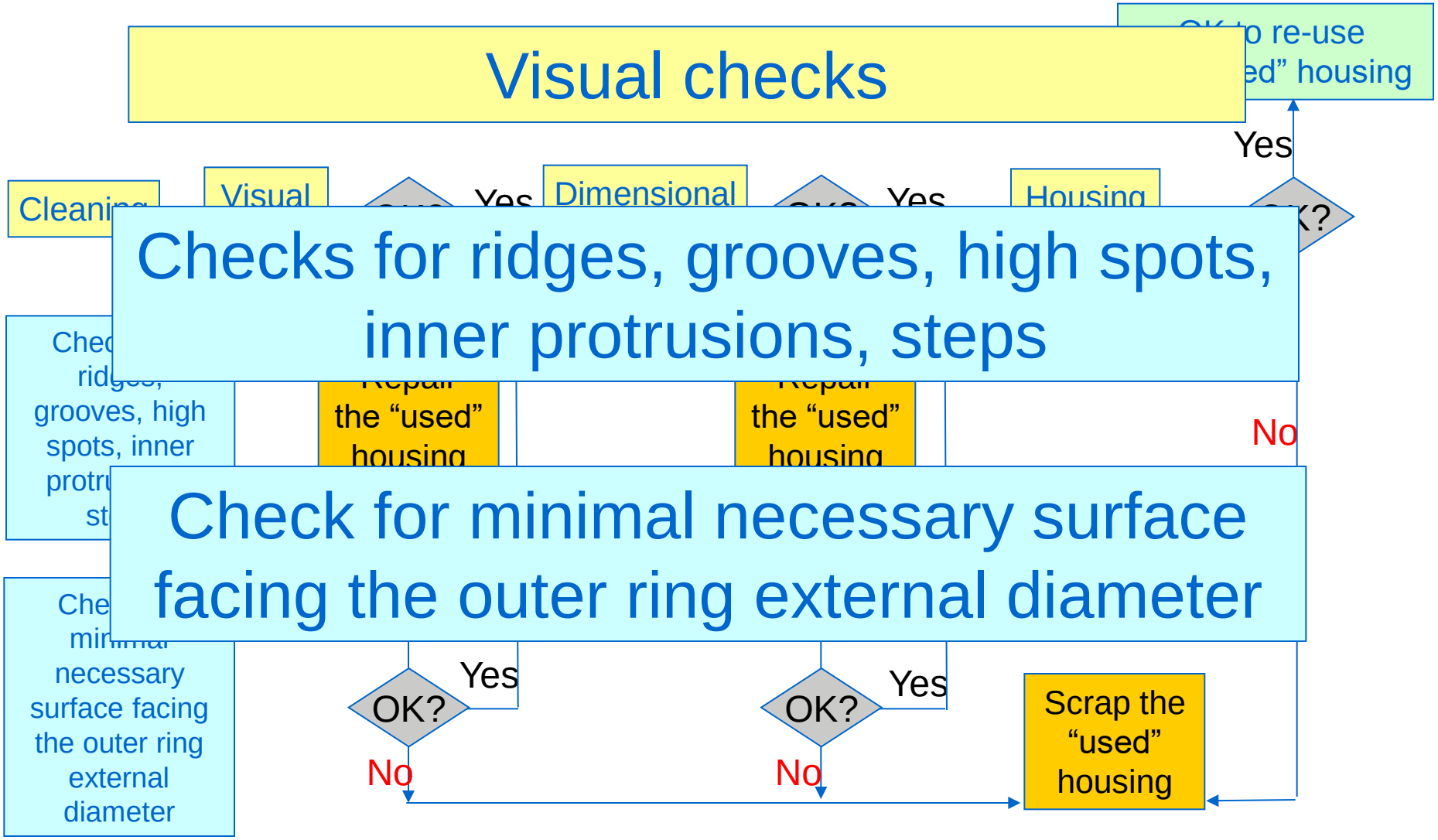
Control Arm Housing - LHB Coaches



© SKF Group

Visual checks

Checks on the “used housing” - General scheme :



© SKF Group

Check of the housing bore :

The bore of the housing shall be closely monitored because it is directly in contact with the outer ring of the bearing.

In fact, the TBU outer ring cross section is thin, "copies " the housing bore and it is submitted to the deformations of the housing itself, including its local defects, which must therefore be removed.

© SKF Group

6.1.a Check for the ridges, protrusions, steps

The bore of the housing must be completely free from steps, ridges, internal protrusions of material with respect to the bearing seat, and other localized defects that could have been created during the axlebox usage in service

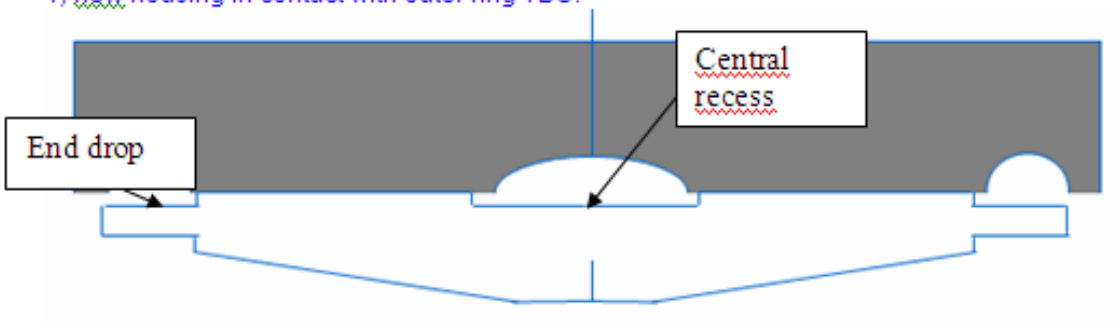
For the rest of the discussion, we will call all these defects with the name “steps”

Check carefully for any "dimples” and steps of the housing of the axlebox, even and especially in the vicinity of the contact areas such as central recesses of the TBU outer ring and outer ring "end-drops”

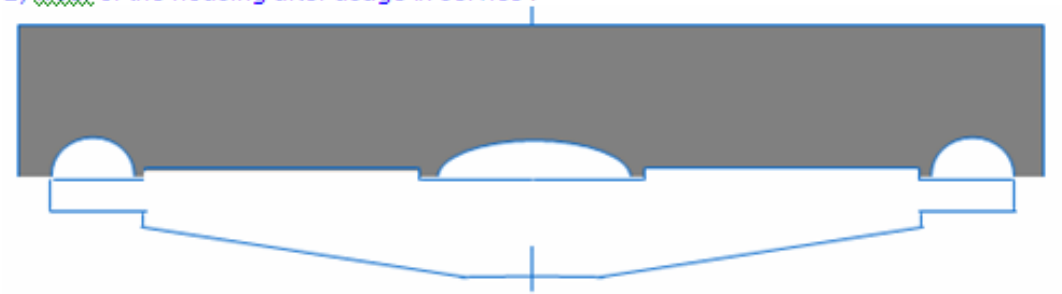
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6.1.a Check for the ridges, protrusions, steps

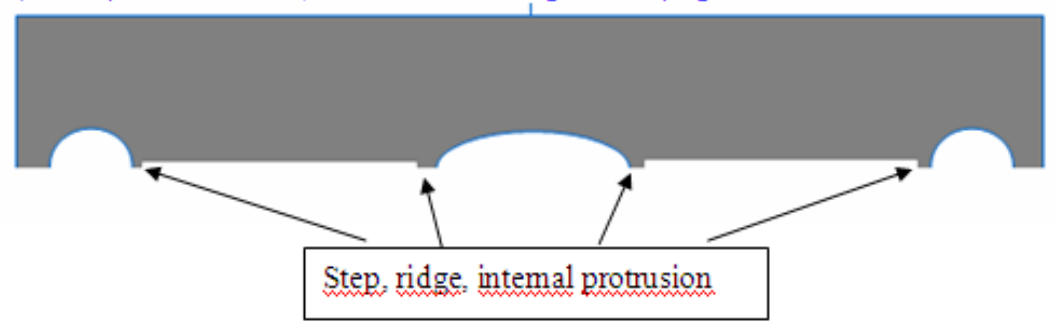
1) new housing in contact with outer ring TBU:



2) wear of the housing after usage in service :



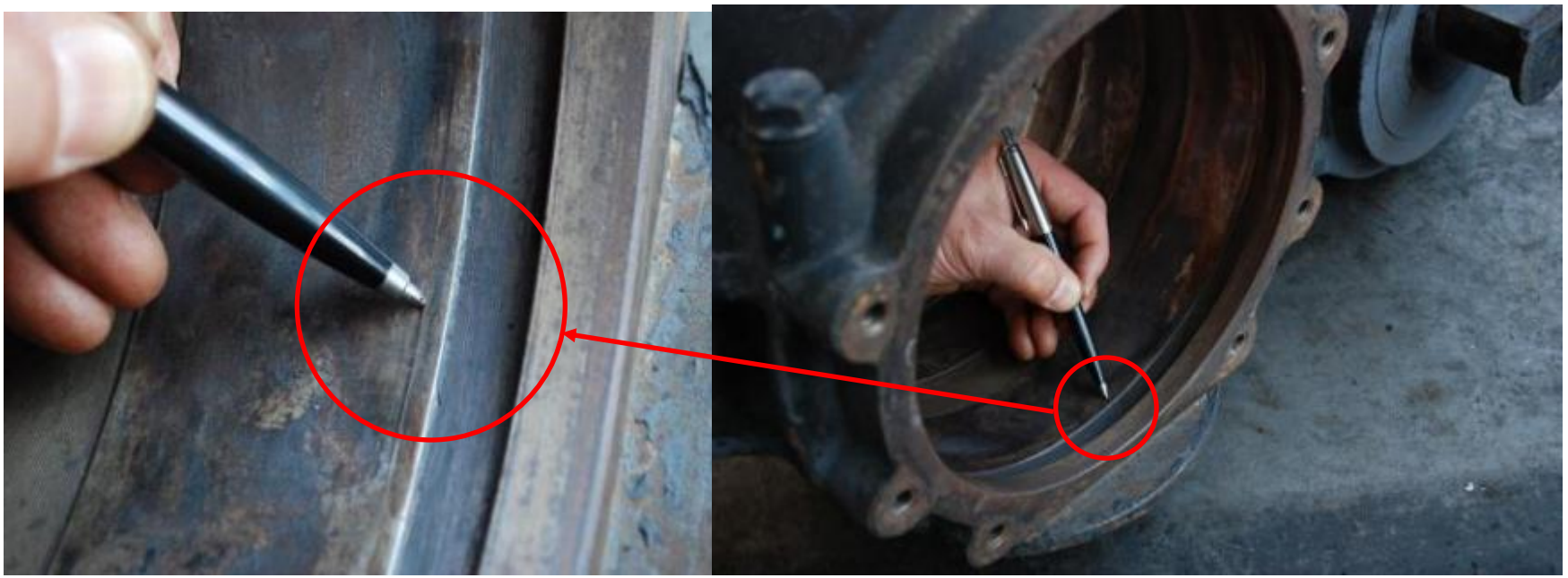
3) same picture as above, but without outer ring. The steps generated are visible:



© SKF Group

6.1.a Check for the ridges, protrusions, steps

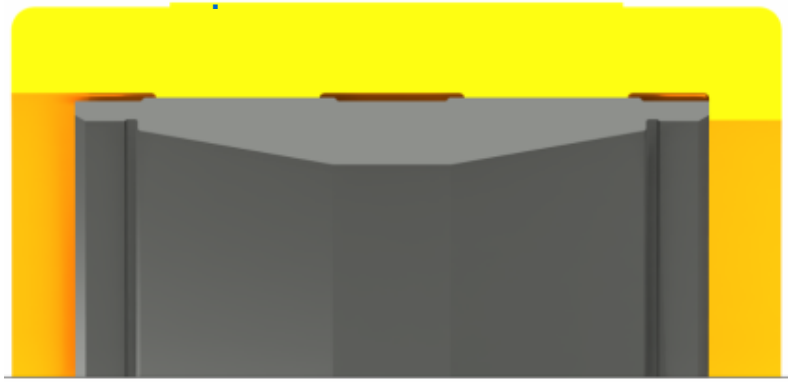
The steps can be formed because of the wear of the housing bore during the previous period of operation. Here below an example of possible housing wear and steps (the picture does not exhaust the possible cases, anyway it offers a good example; it must be care of the operator to foresee similar situations):

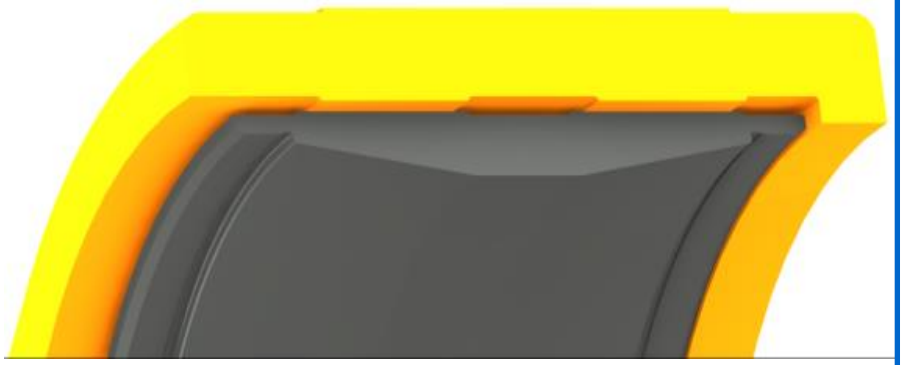


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Correct interface vs not-correct interface :

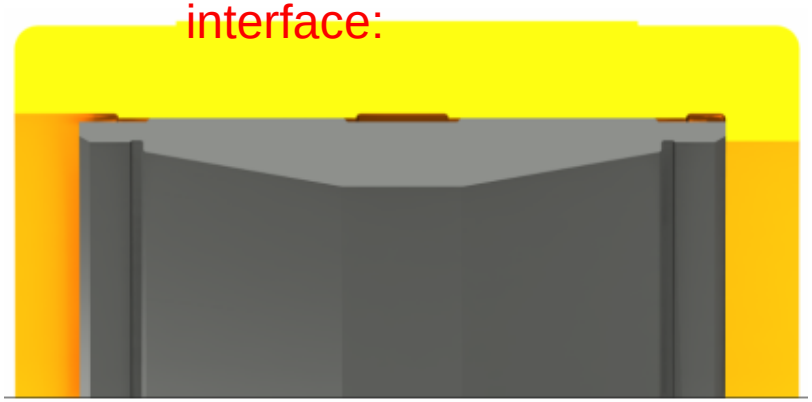
Correct interface :

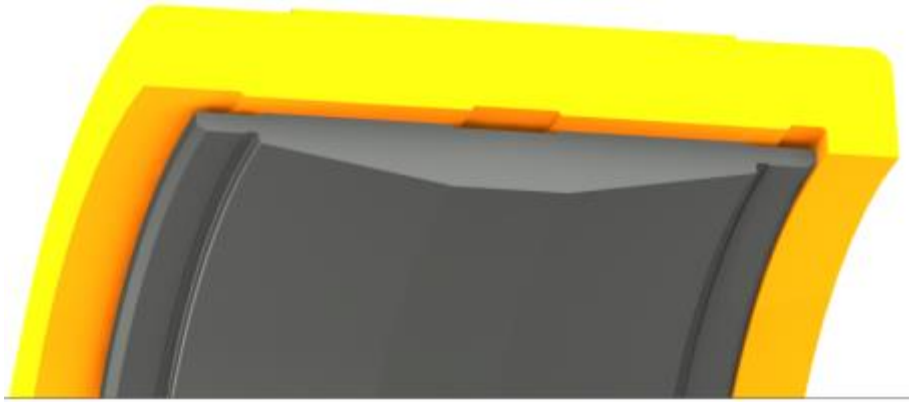






NOT Correct interface:

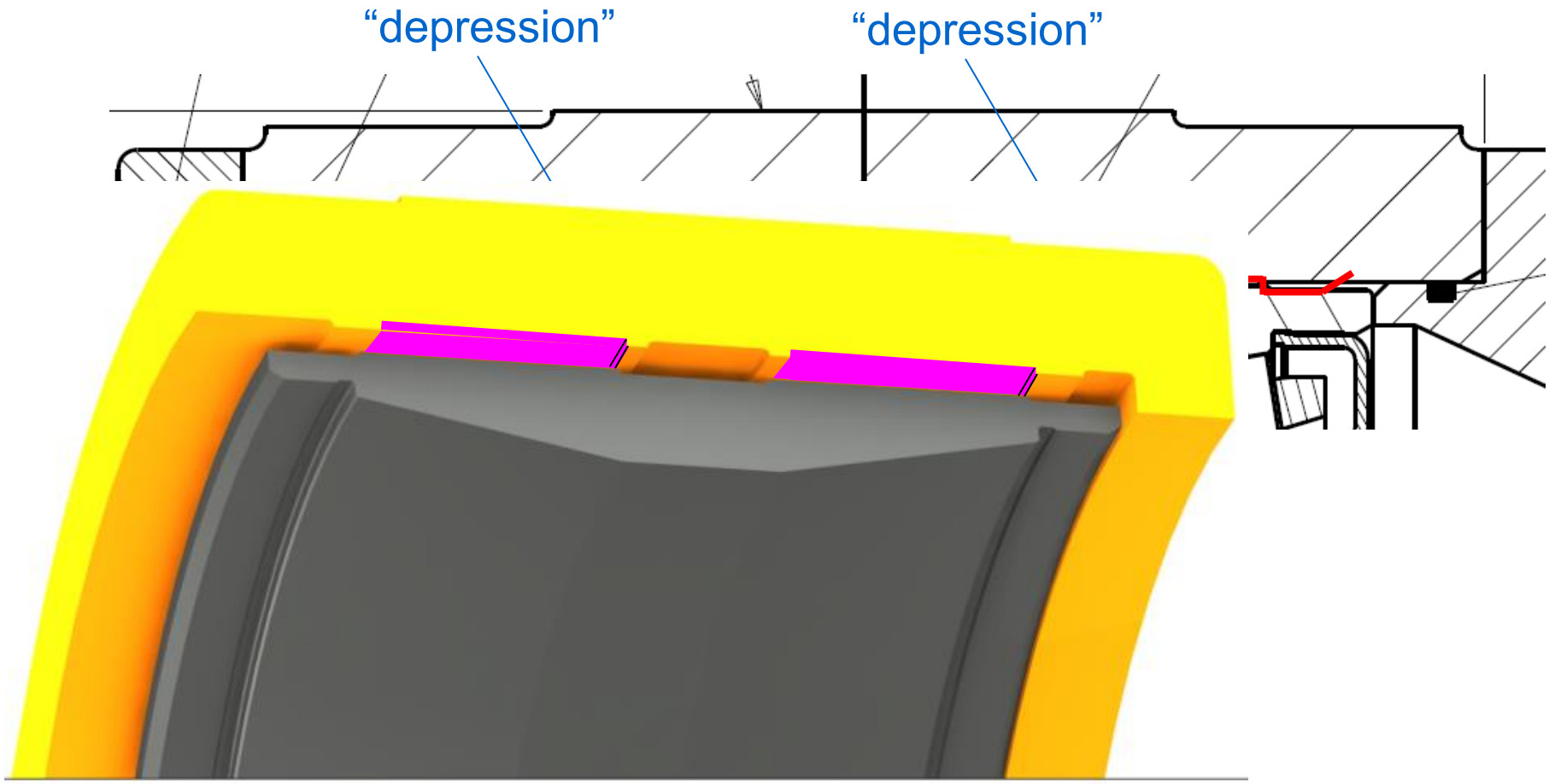




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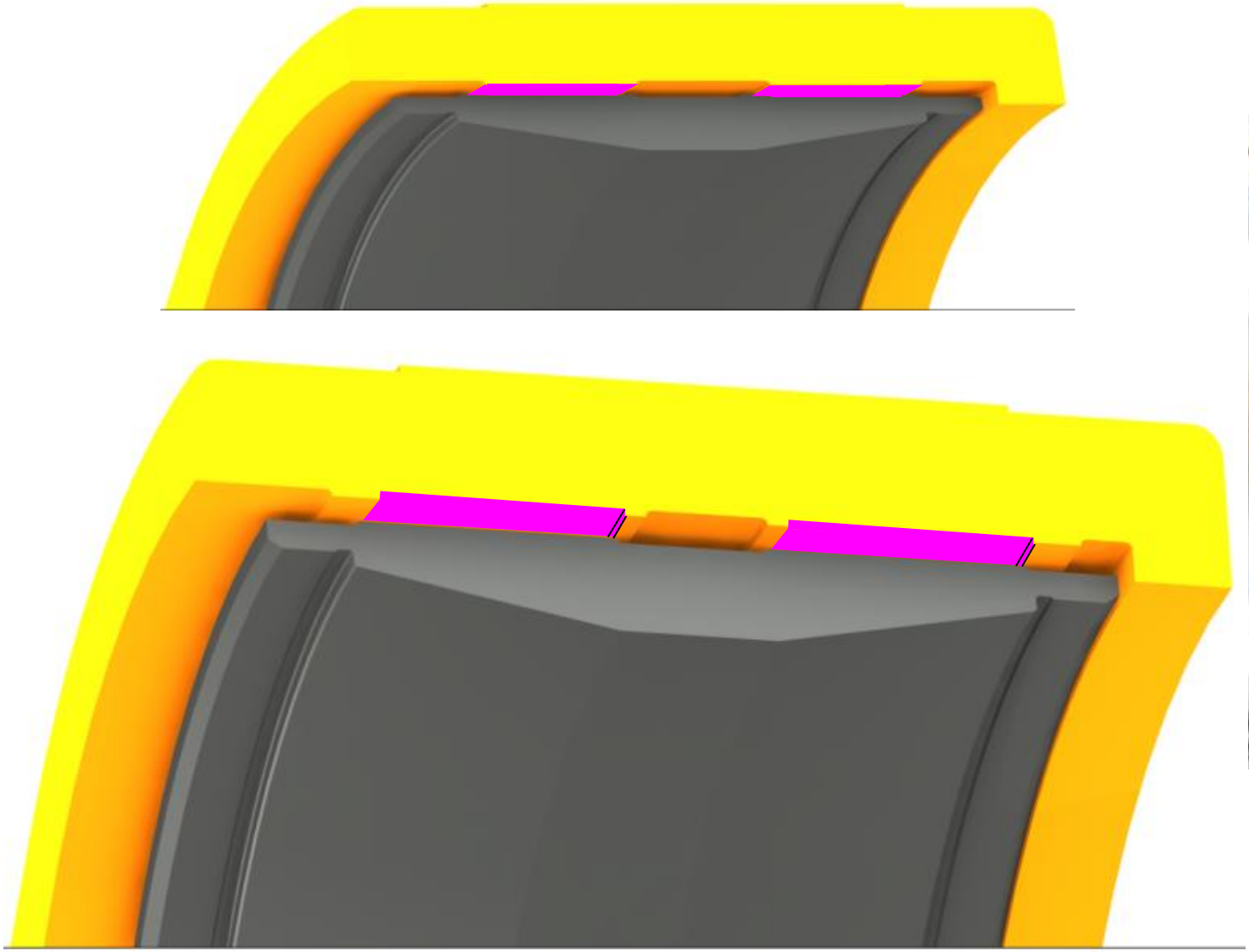
What happens with axlebox with NOT correct recesses in the housing FIRST PERIOD OF SERVICE :

Wear of the housing bore (material is softer than the bearing steel material) after the first period of service :



© SKF Group

Fretting corrosion in the bore :



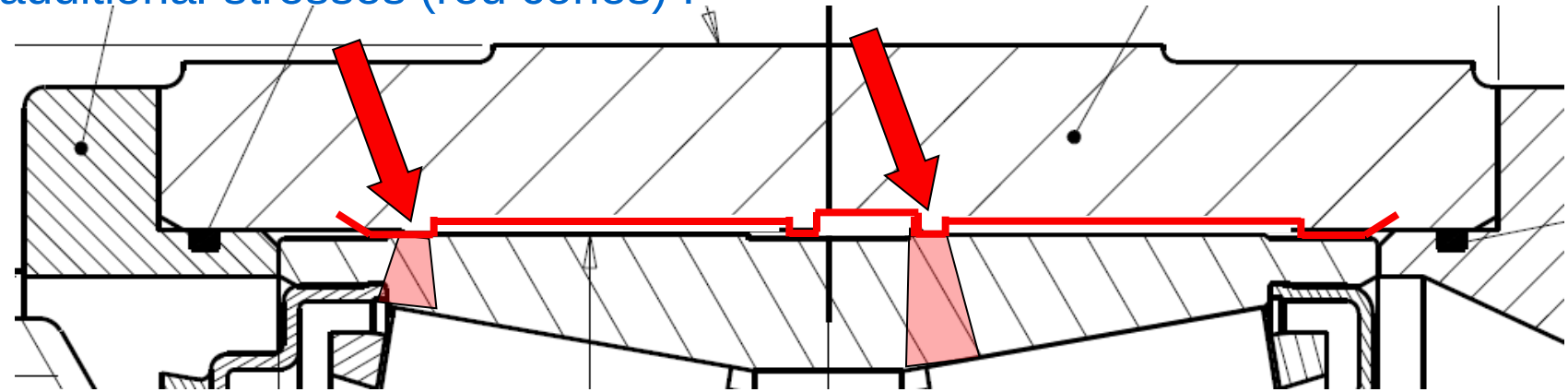


© SKF Group

What happens with axlebox with NOT correct recesses in the housing SECOND PERIOD OF SERVICE (REMOUNTING with worn housing) :

Re-mounting after the first period of service. Very likely the axial positioning of the axlebox is not exactly where it was before.

If this is the case, there is the possibility that there are extra-pressures: arrows show possible abnormal contact and additional stresses (red cones) :



It is therefore very important to provide the correct Manual in order to allow the Customer to follow the correct instructions on how to repair the housings

© SKF Group

How to check for the ridges, protrusions, steps :

- Need for a well-lit room

- In the housing bore, in the area of maximum vertical load, it must be dedicated lighting

- The following methods are recommended:

1. combined visual and tactile control
2. control with a "ruler" (dima) with built-in light
3. control with “contrast liquid” (Blu di Prussia)

© SKF Group

How to check for the ridges, protrusions, steps :

- The combined visual and tactile inspection is done by passing a small needle over the area with the supposed step. If the step is felt to at the touch, it must be repaired:







© SKF Group

How to check for the ridges, protrusions, steps :

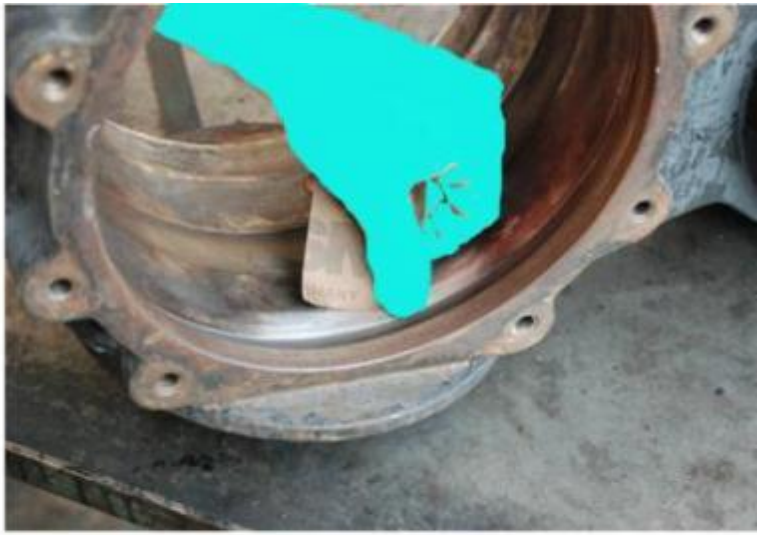
- The comparison with a "ruler" with built-in light it can be done by passing it with circular motion in the area at 120 ° across the area of maximum vertical load.
If the light will put in evidence steps at the edges of the contact area (light filters in the area adjacent to the step), the step must be repaired. See example here below:



© SKF Group

Repair of the housing :











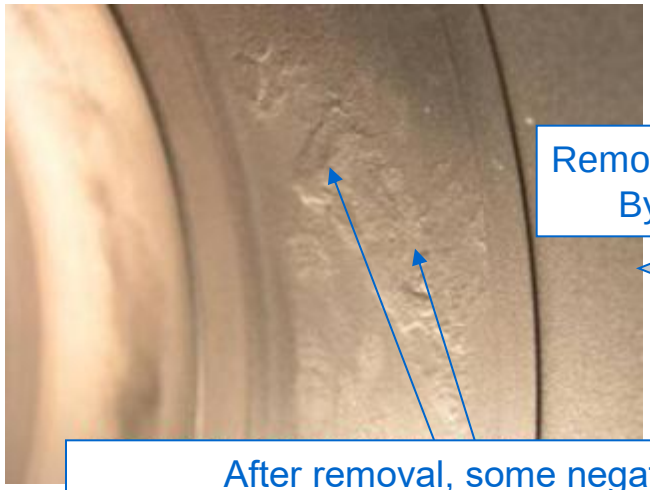
© SKF Group

6.1.b Check for minimal surface in contact



Disomunting of a “welded”
Housing from the TBU



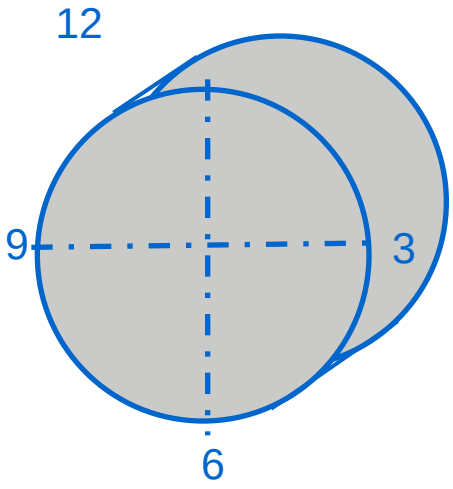


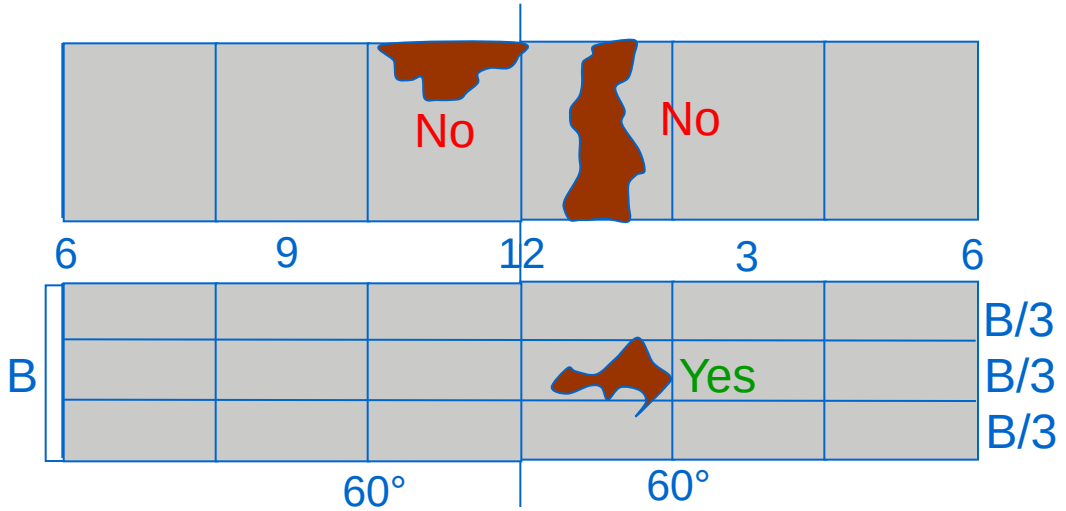
Removal of fretting corrosion
By the housing bore :



After removal, some negative “spot”
Remain on the housing bore,
which reduce the contact area with the TBU outer ring

6.1.b Check for minimal surface in contact



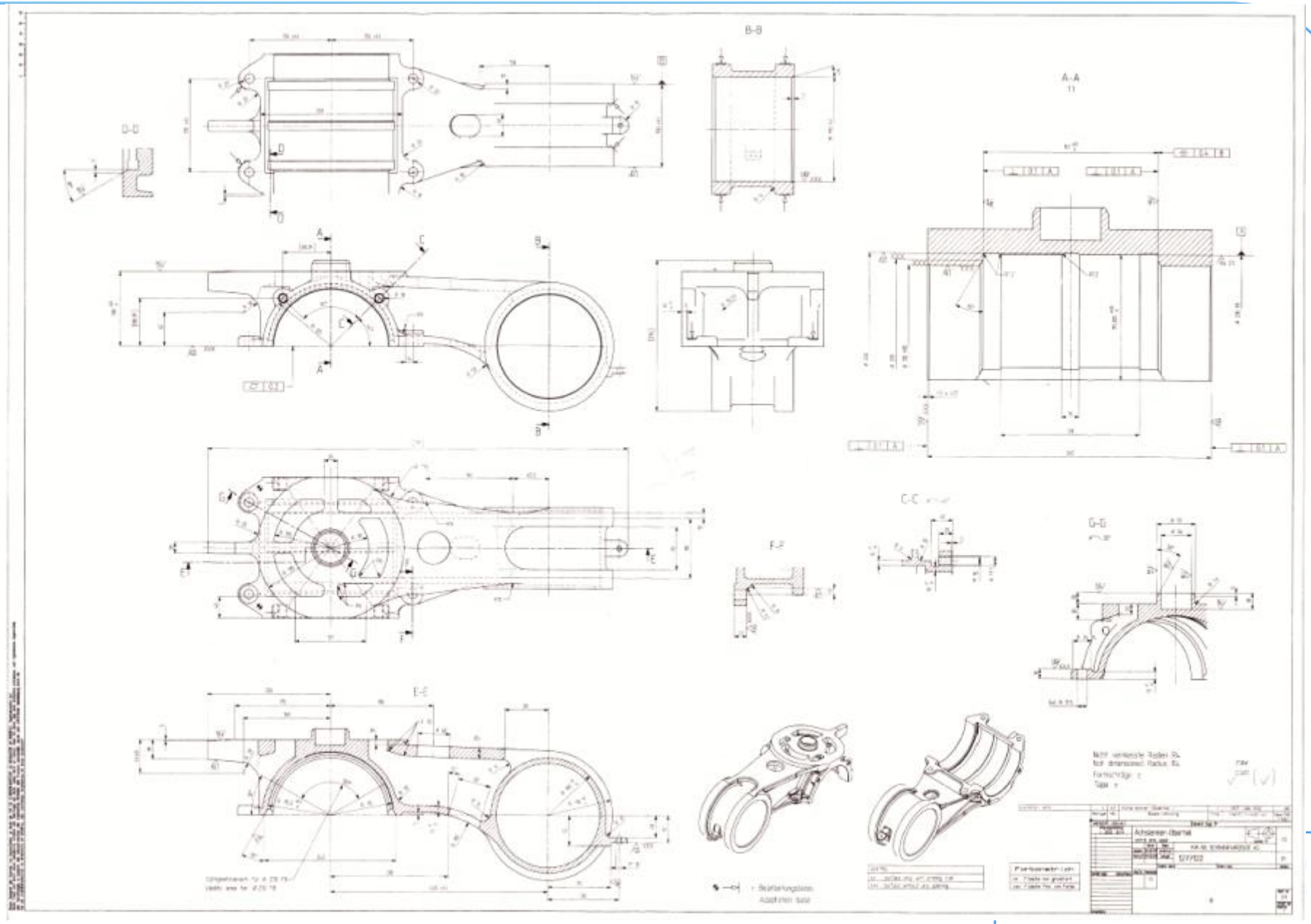


Examination of area from -60° to +60° from 12 o'clock
For depths > 0.2 mm : not acceptable across "B"
For depths > 0.2 mm : not acceptable at the edge of "B"
For depths > 0.2 mm : acceptable within the central "B/3"

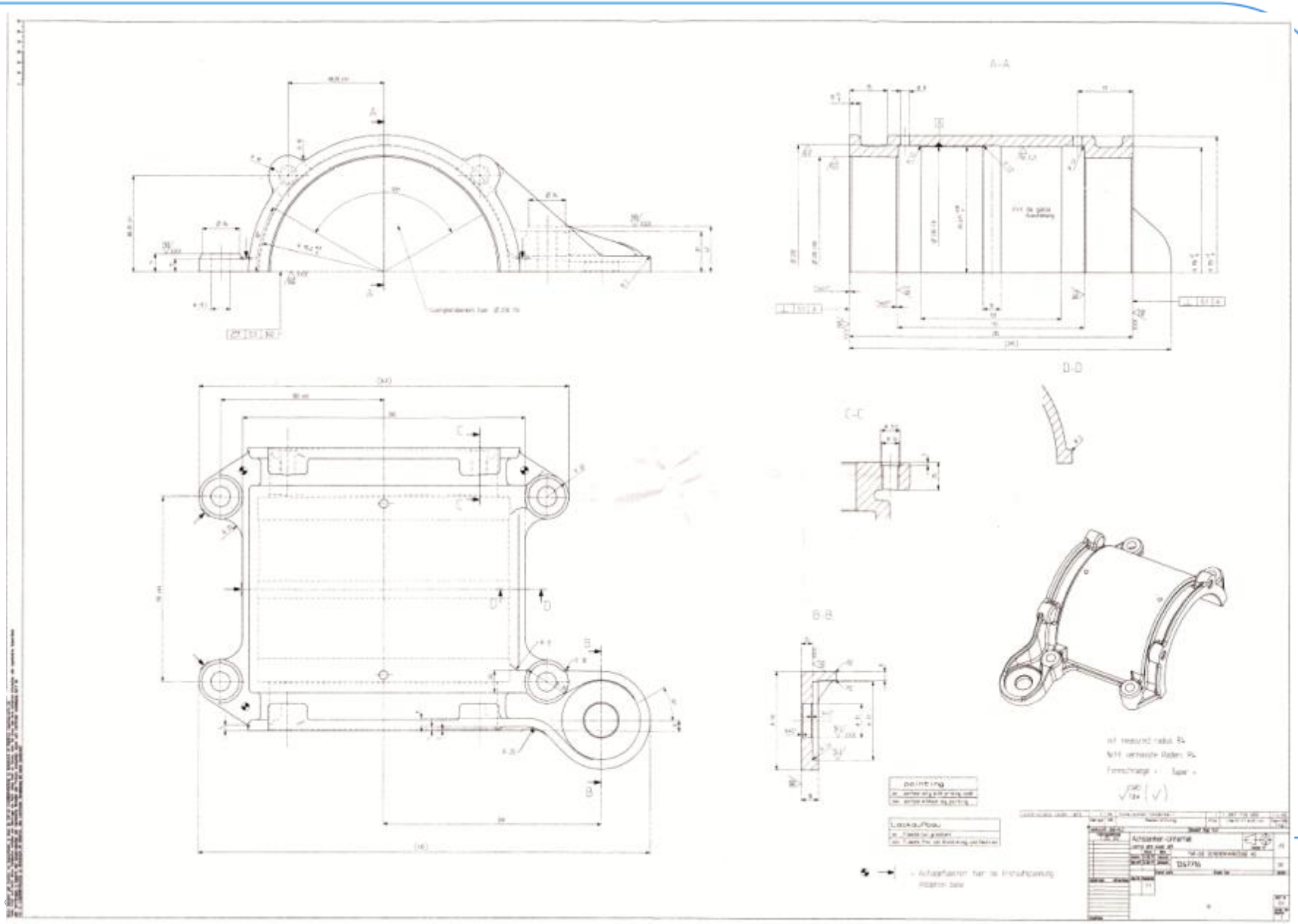
Being "B" each bearing row axlebox seating

Dimensional checks

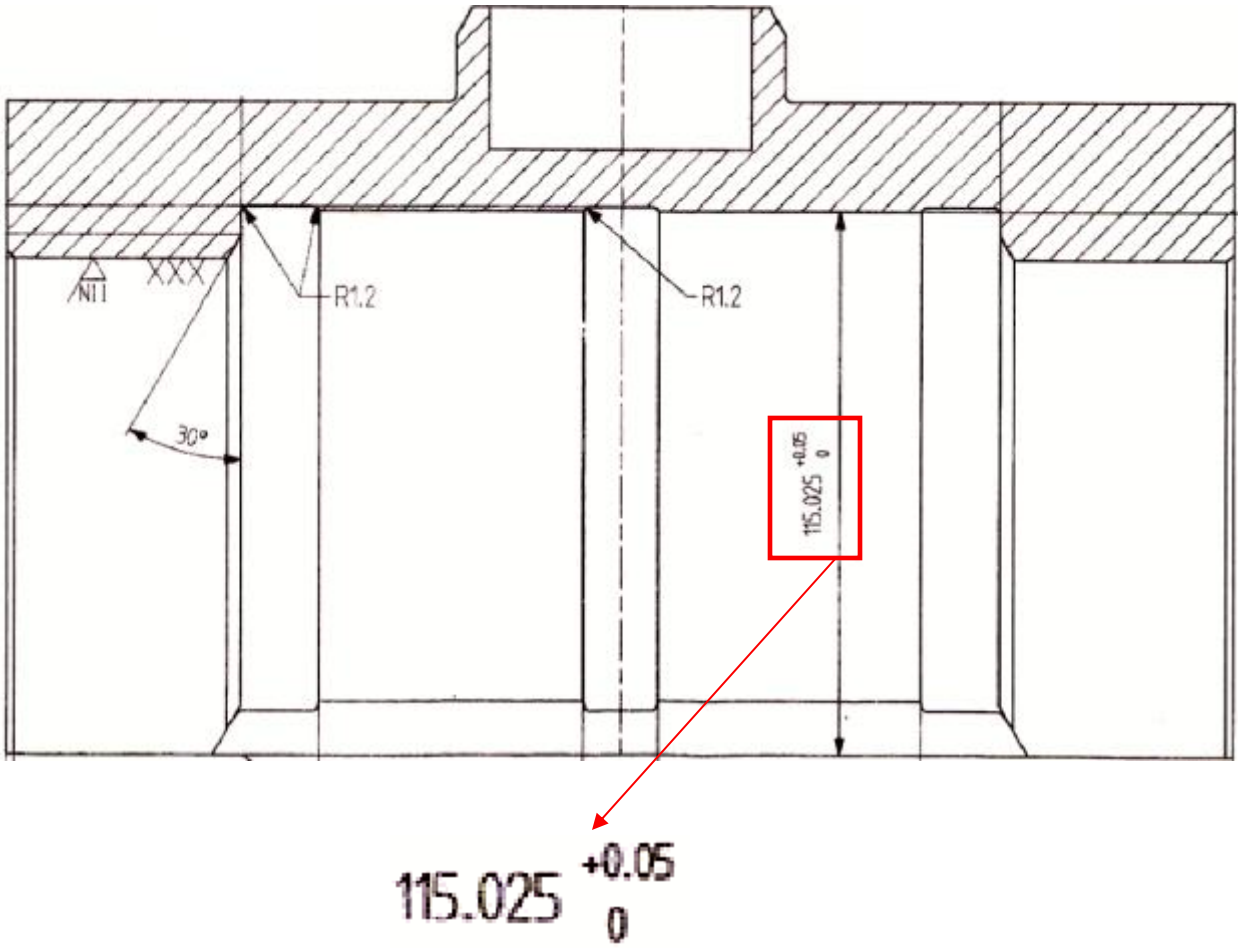
Control arm upper – drawing of Fiat-SIG



Control arm lower – drawing of Fiat-SIG



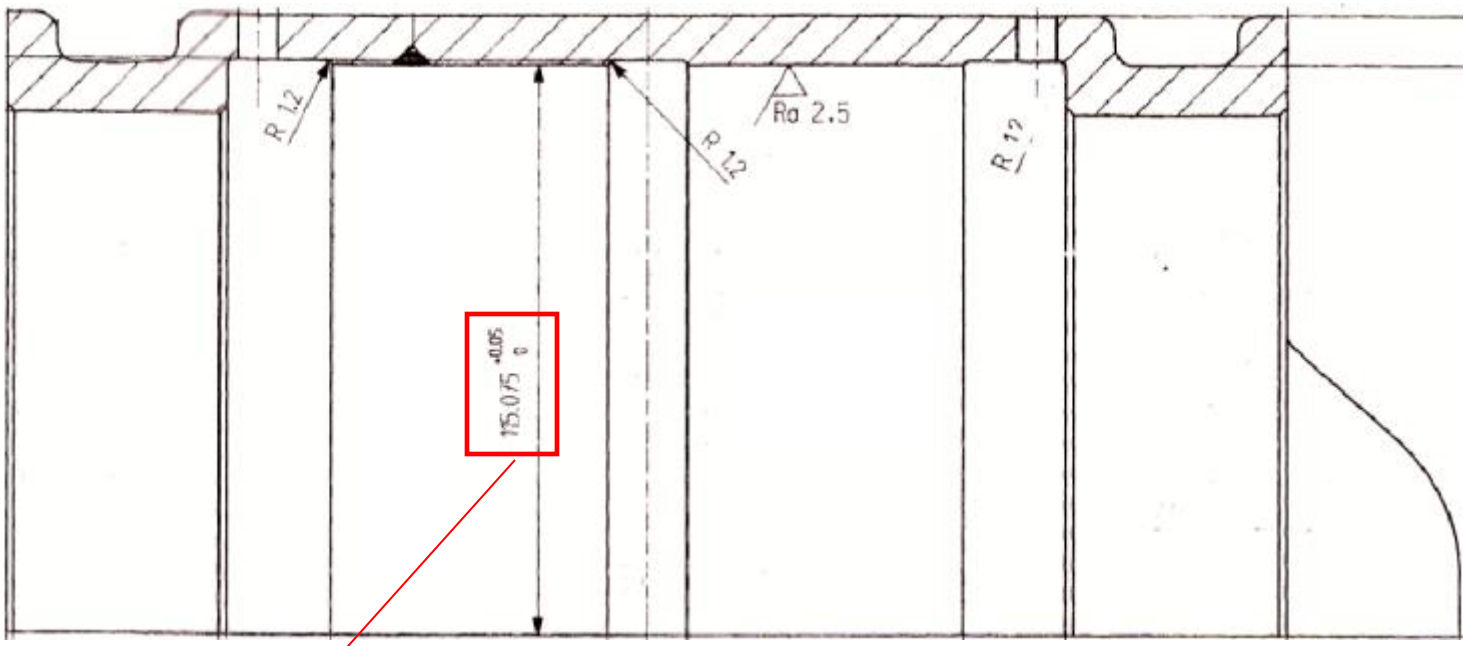
Upper part (smaller radius then the lower part)



(corresponds to min dia 130,050)

© SKF Group

Lower part (bigger radius then the upper part)

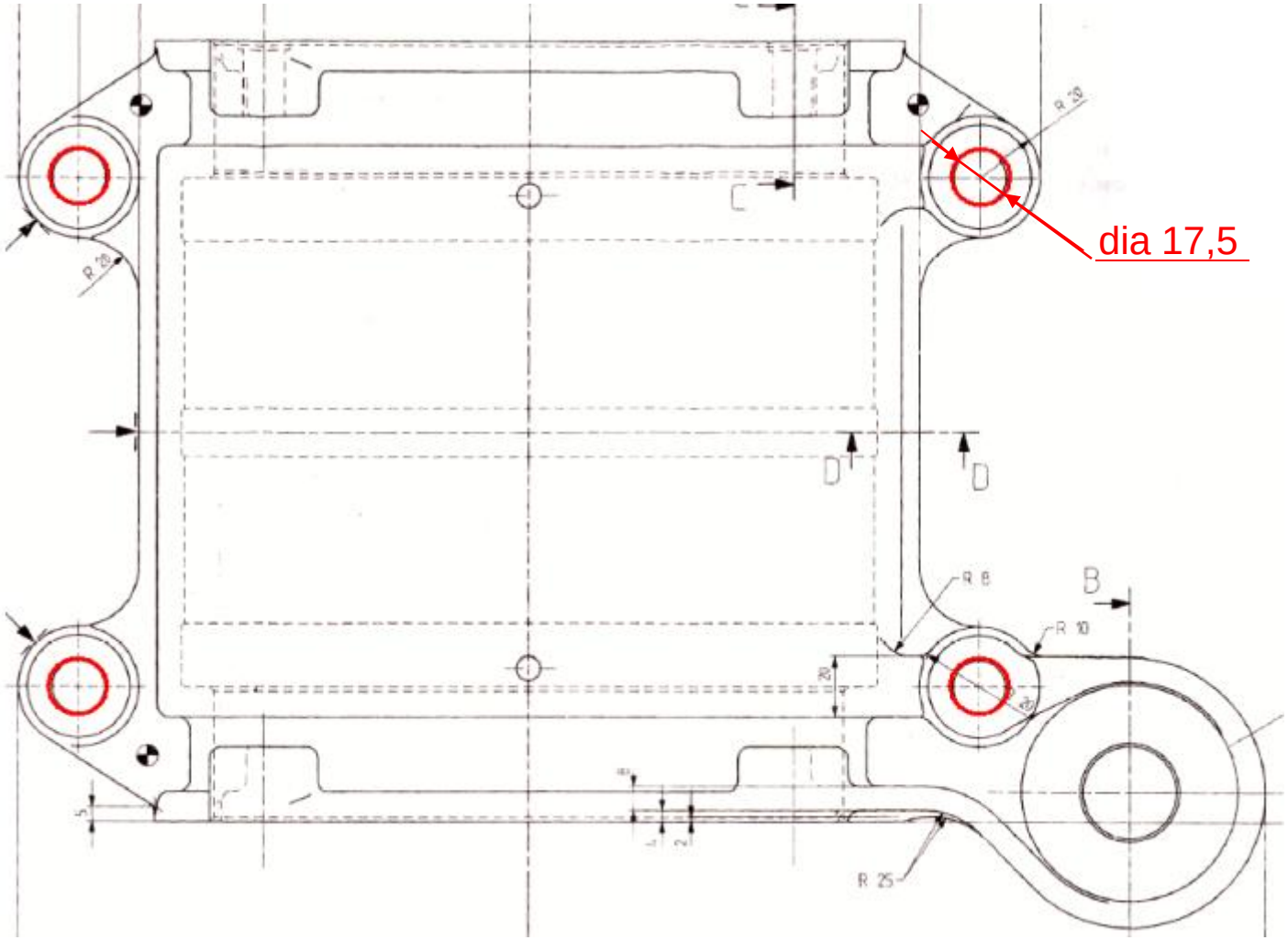


115.075 $^{+0.05}_{0}$

(corresponds to max dia 130,250)

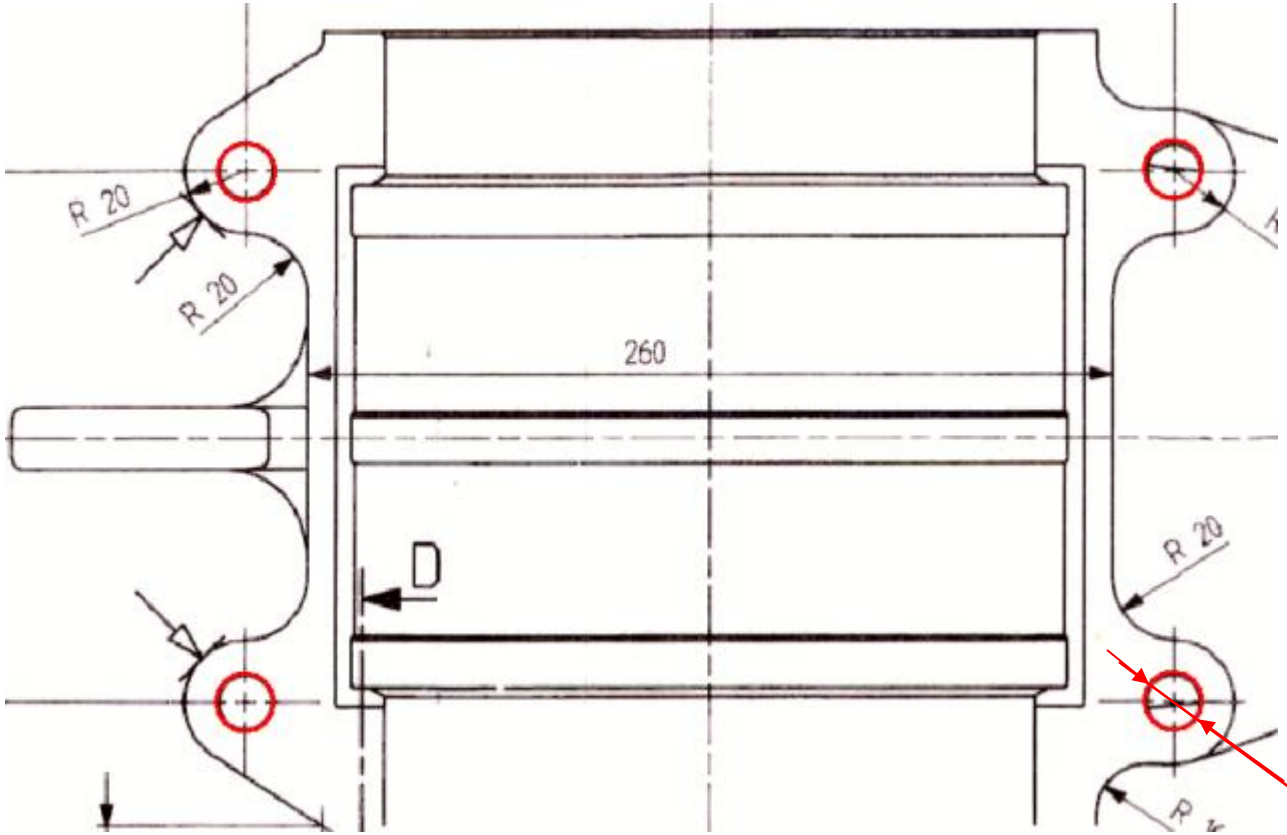
© SKF Group

4 holes for matching – lower part



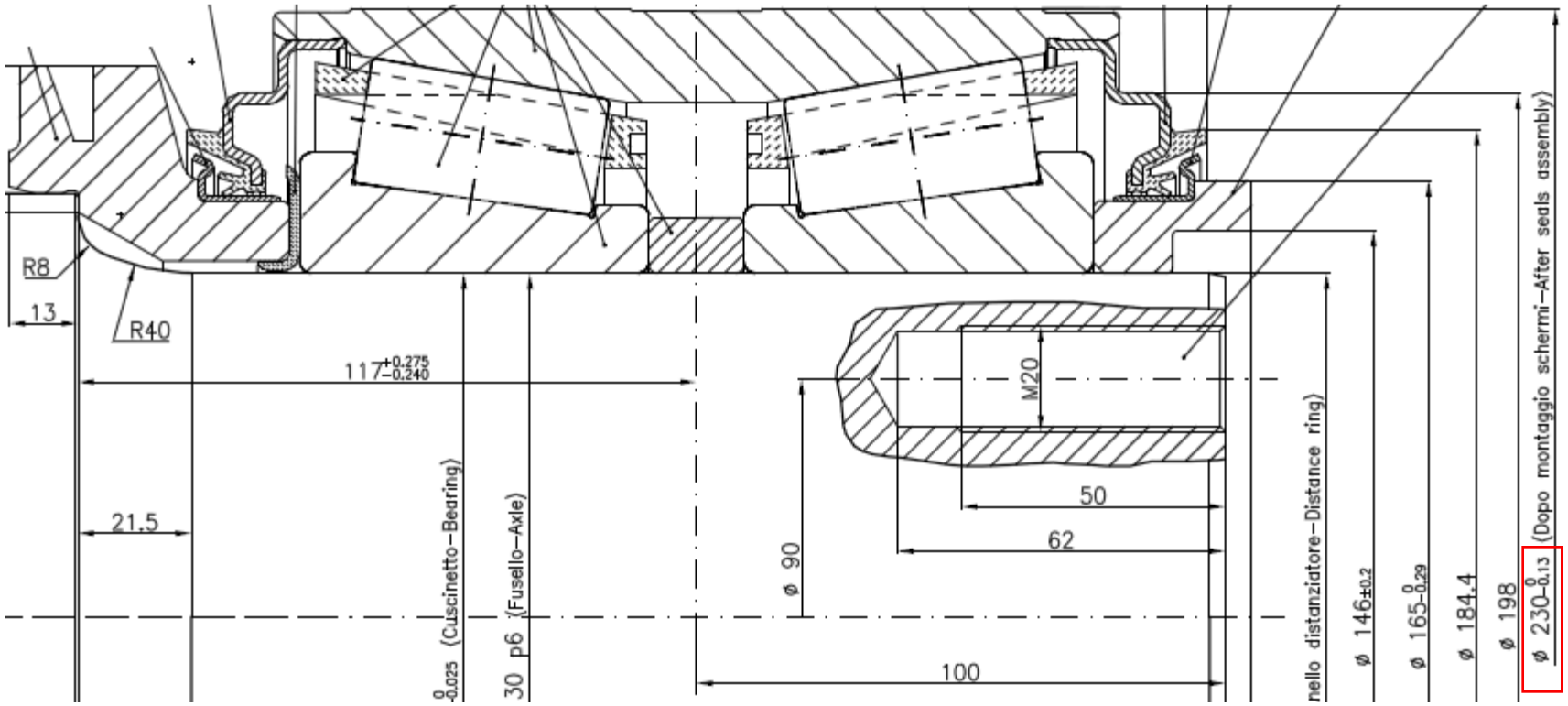
© SKF Group

4 holes for matching – upper part



© SKF Group

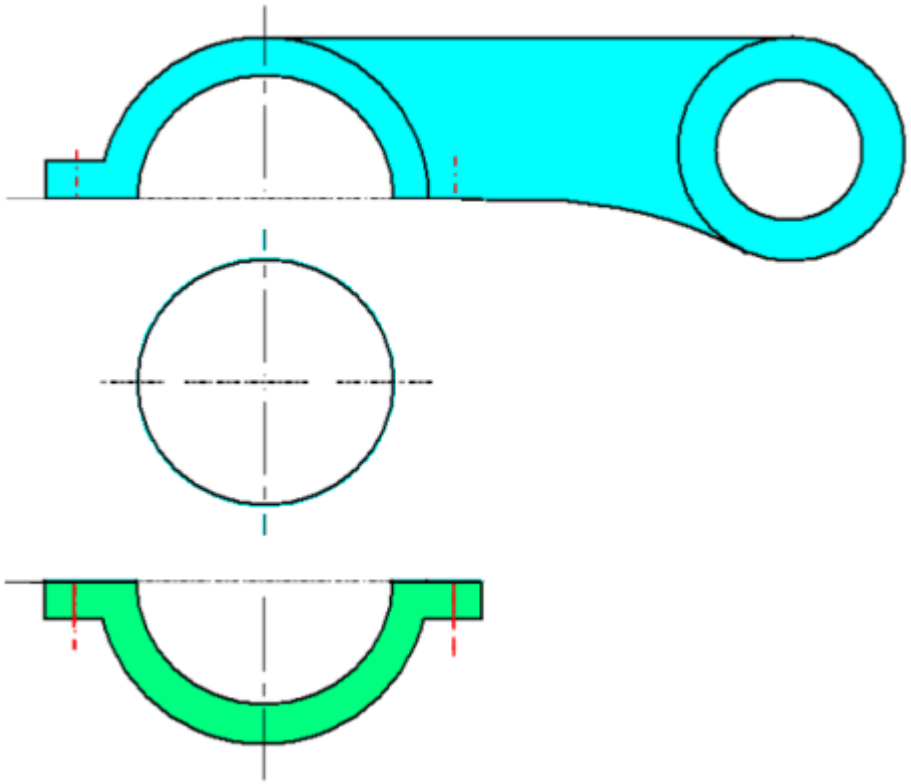
TBU 1639433 BC



ø 230 0 −0.13

© SKF Group

Extreme values of diameters



Upper part min dia 130,050

Upper part max dia 130,150

TBU OR min dia 229,870

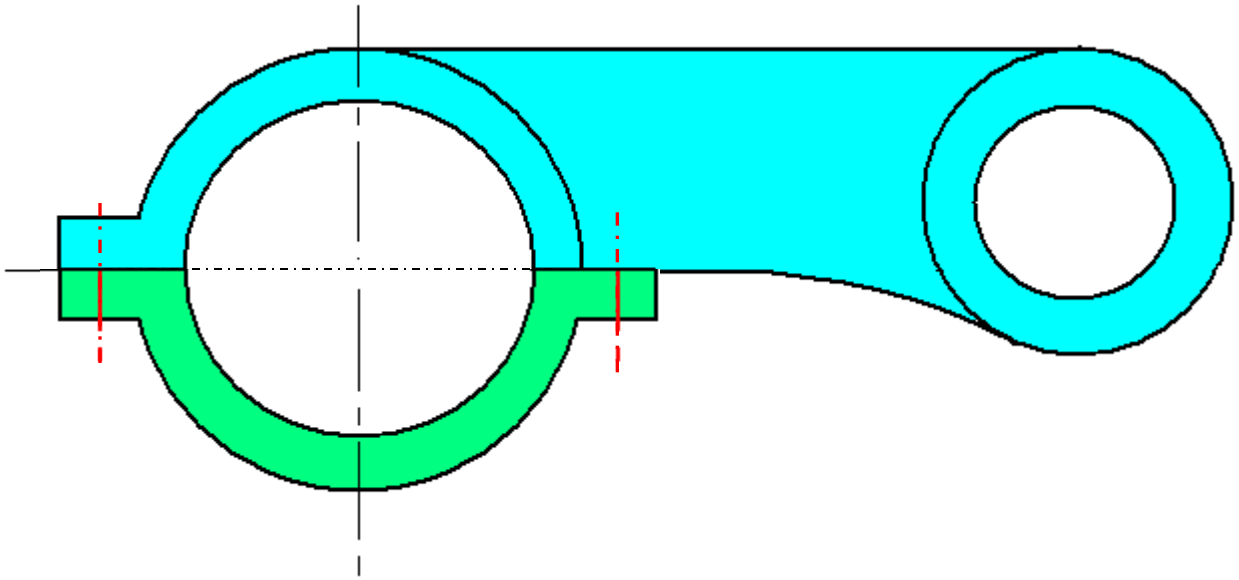
TBU OR max dia 230,000

Lower part min dia 130,150

Lower part max dia 130,250

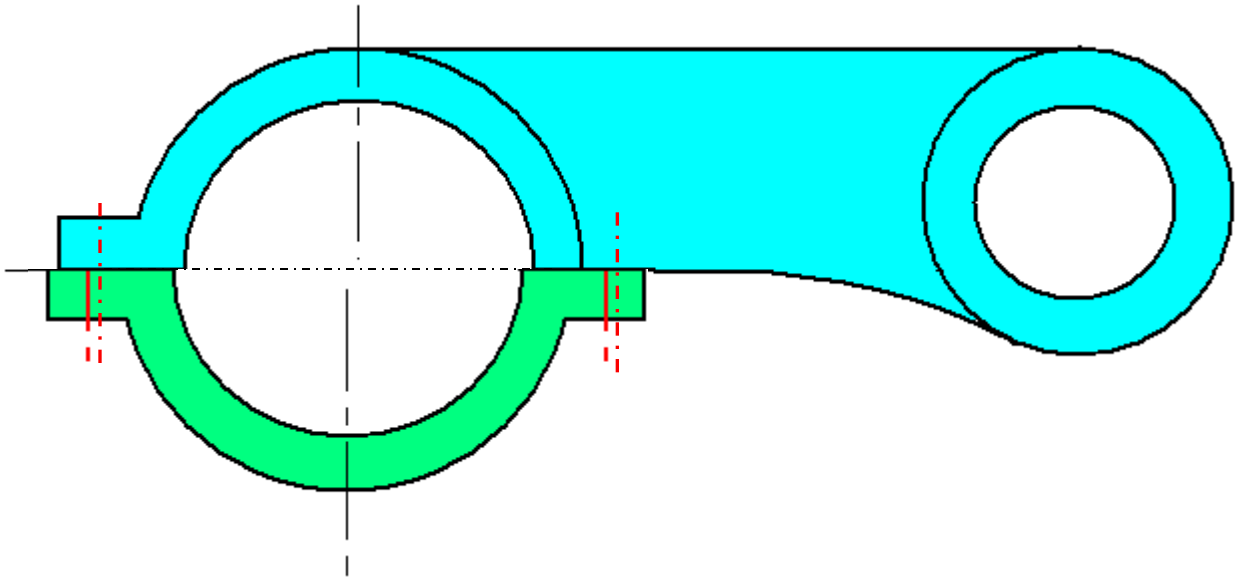
© SKF Group

Split housing machined separately – danger of misalignment



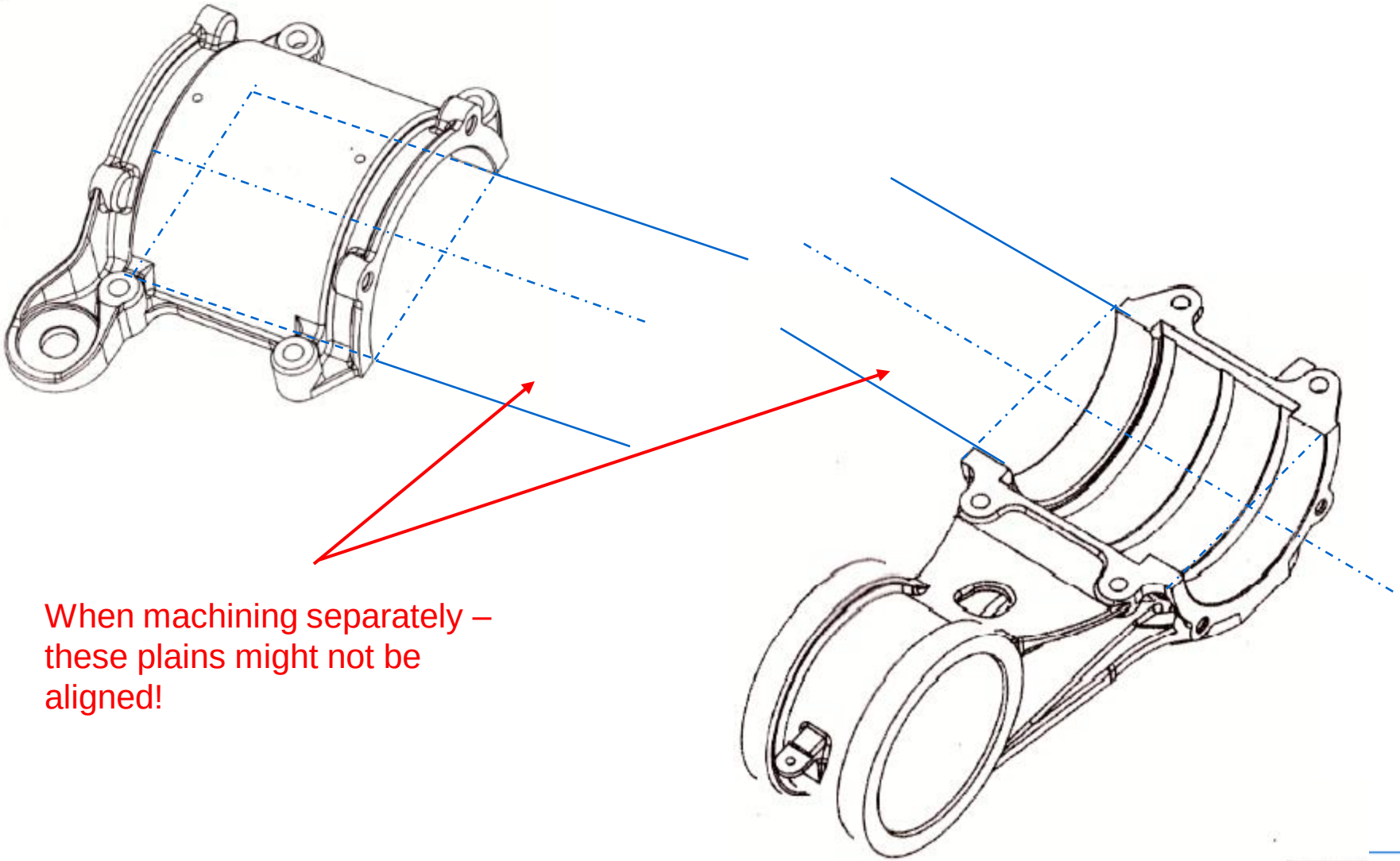
© SKF Group

Is it possible to get pinching in case of combination of extreme tolerance values?



© SKF Group

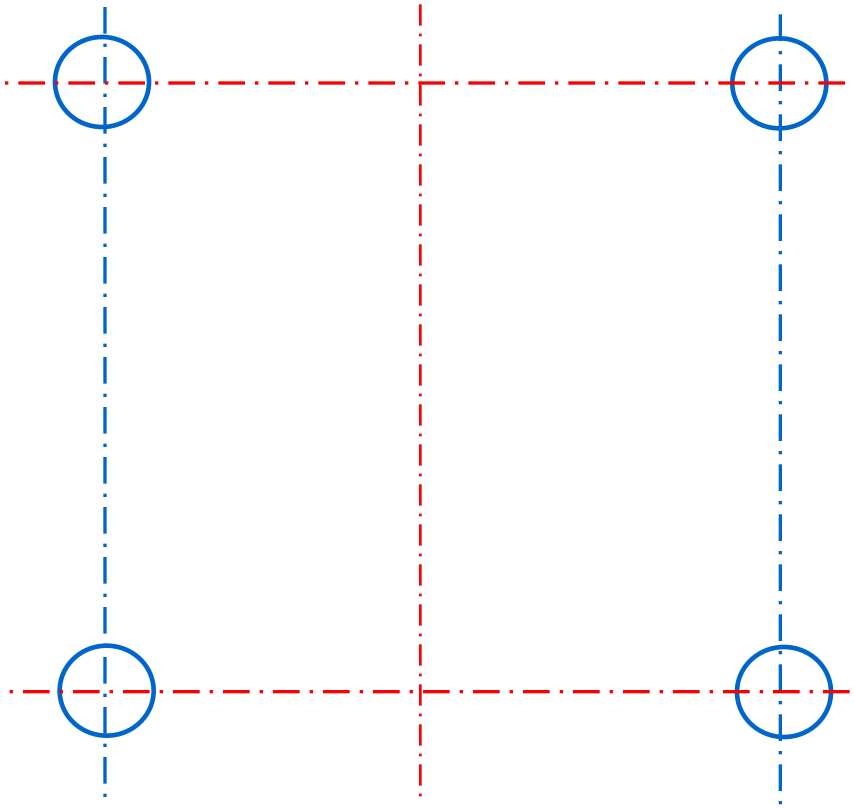
Is it possible to get pinching in case of plains misalignment?



When machining separately – these plains might not be aligned!

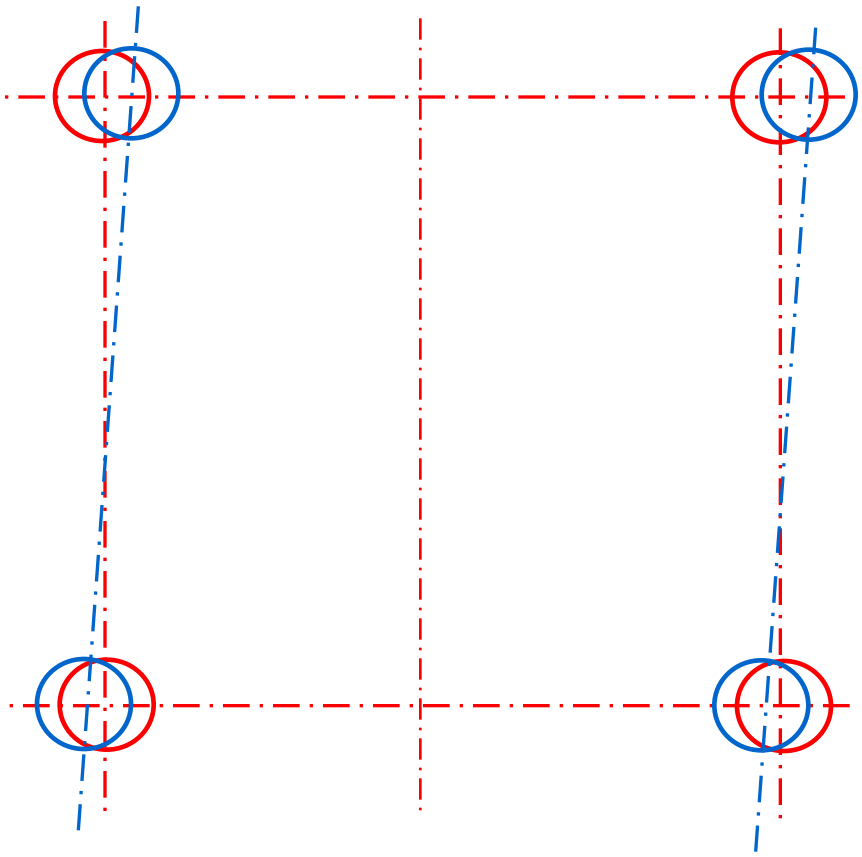
© SKF Group

Failed matching (due to misalignment)



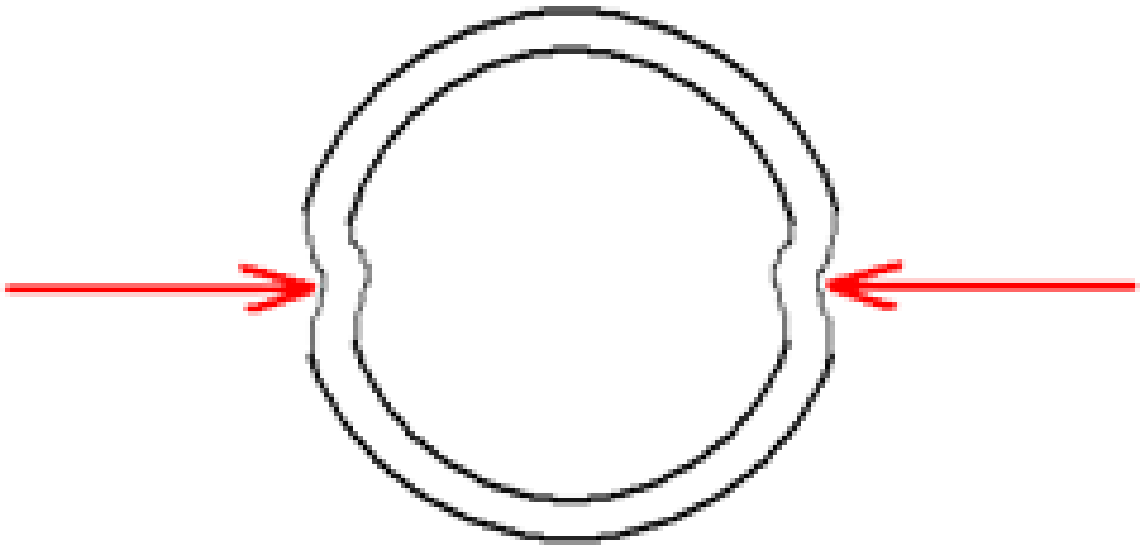
© SKF Group

Is it possible to get pinching in case of not exact matching of holes?



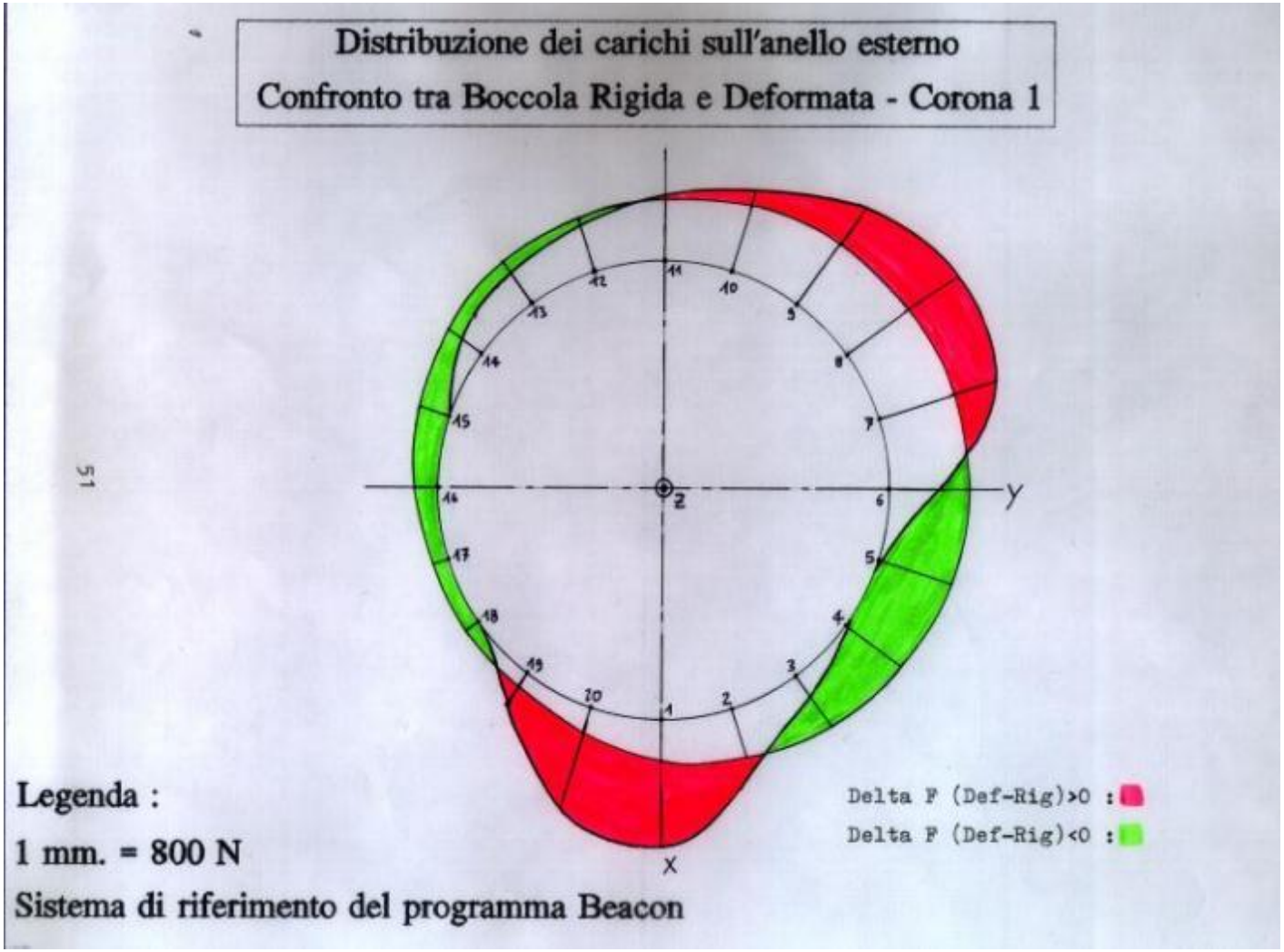
© SKF Group

Failed matching – pinching of the bearing



© SKF Group

Failed matching – pinching of the bearing



© SKF Group

Failed matching – pinching of the bearing



© SKF Group

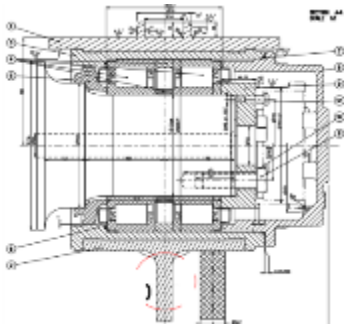
Axlebox improvement – possible ways

Improvement of existing design (2-pcs axlebox)

- dowel No place
- precision screws + matching system
  Precise production
  Matching in operation by workers?

Axlebox redesign

- 1-pcs axlebox Acceptable for maintenance?
- 3-pcs axlebox (+ matching system)
  Price? Acceptable higher price?
  Set with TBU + sensor + Gerken



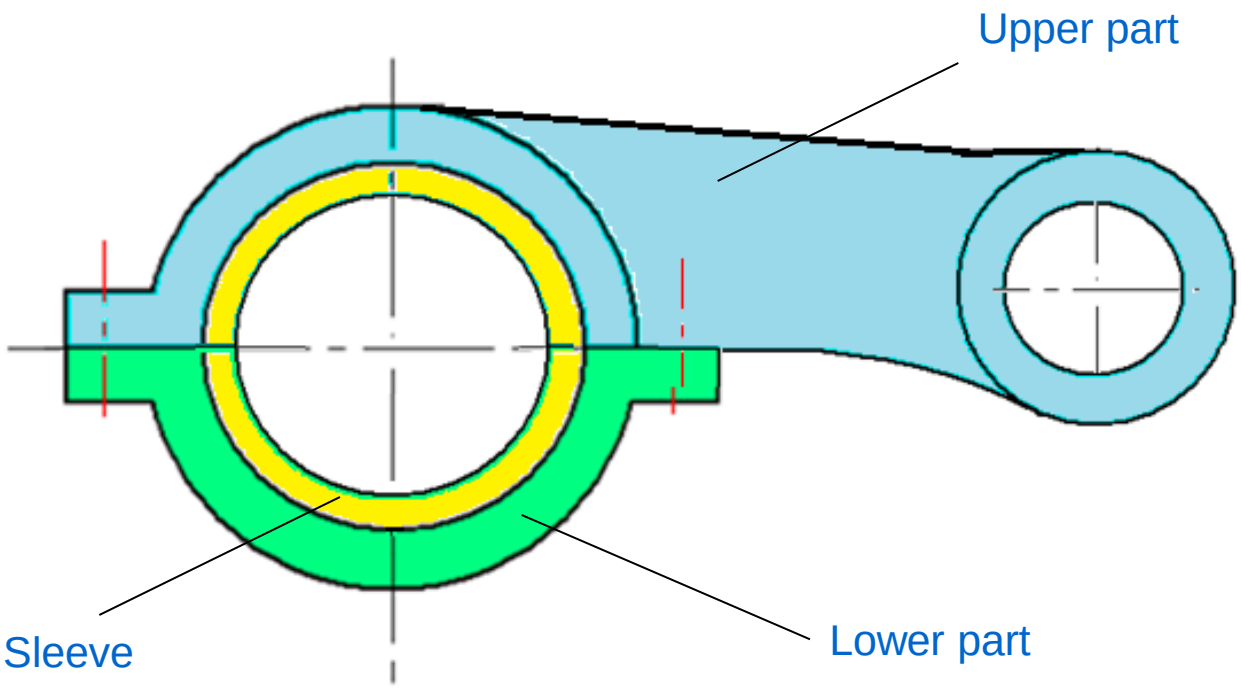
Measurement tool to be developed for checking of:

a) dimensional and form quality of both housing parts
b) Suitability of matching of given lower and upper part

Specialised tool does not exist on the market --> DEVELOPMENT

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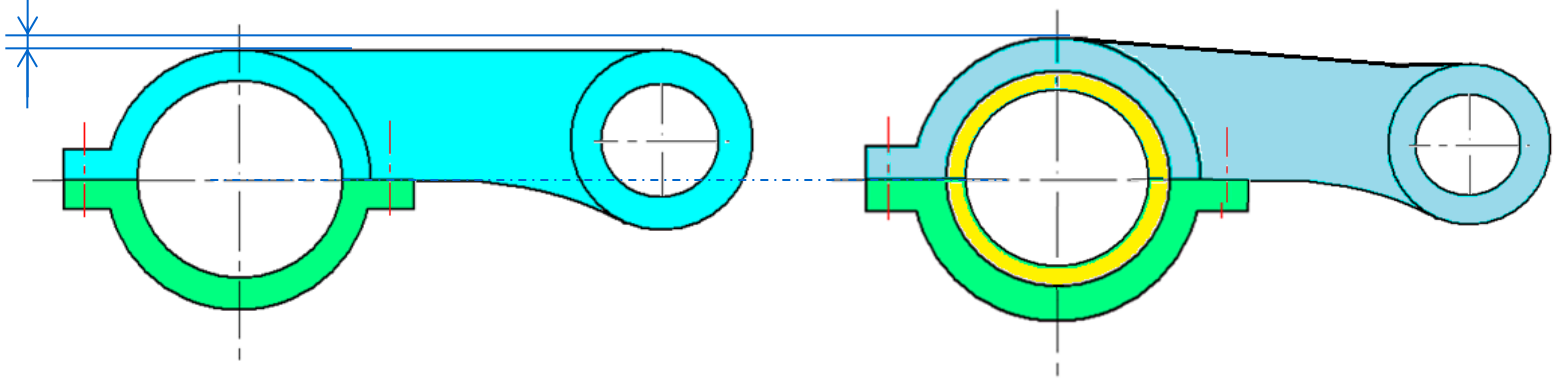
3-pcs axlebox design reducing or eliminating TBU OR pinching



© SKF Group

3-pcs axlebox – primary suspension modification

In order to keep the same housing wall thickness the primary suspension must be shifted by **12 mm** upwards.

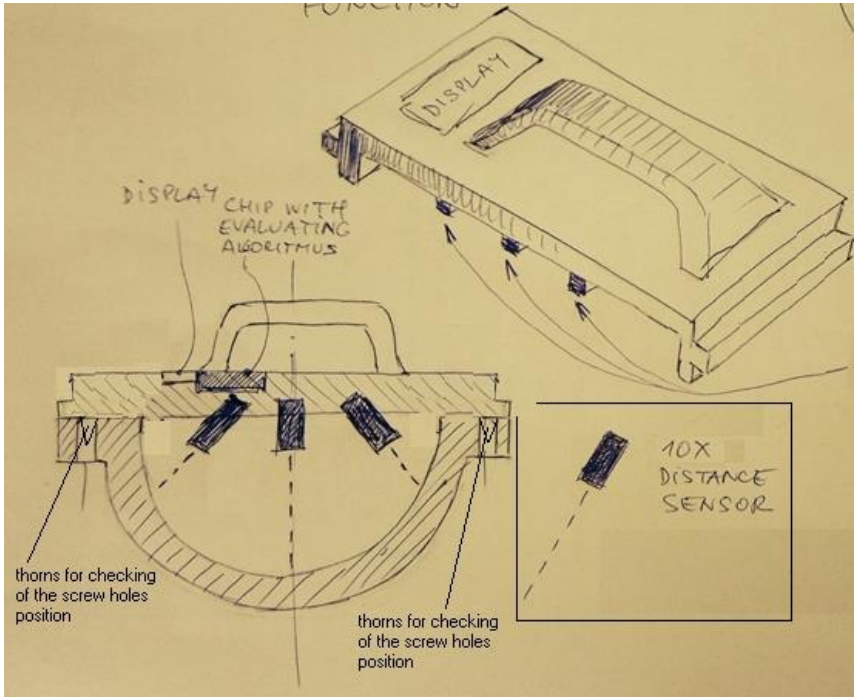


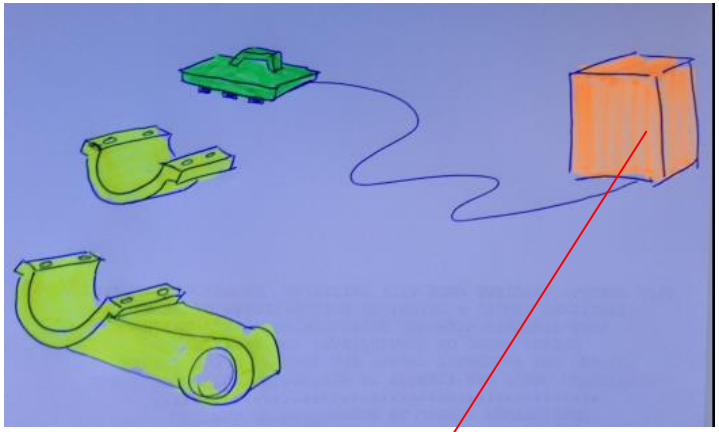
Current design with 2-pcs

Proposed new design with 3-pcs

© SKF Group

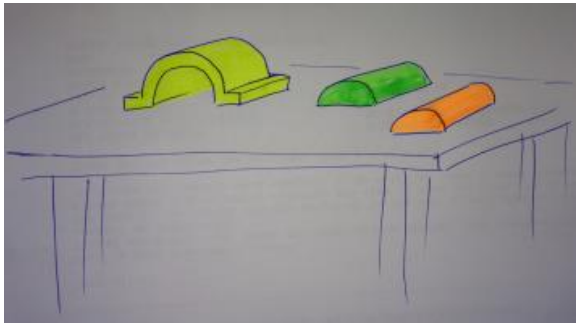
Indian axleboxes for LHB bogies - measurement tool development





Evaluation unit

Simplified alternative („good“ and „wrong“ calibre fixed on the table.):



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