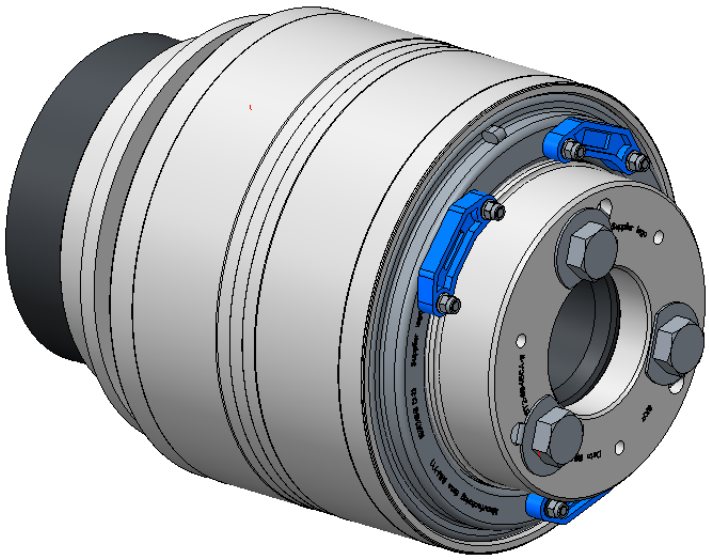
The Power of Knowledge Engineering

RAILWAY PRODUCTS
TBU MOUNTING MANUAL

Classic outboard applications



SKF Industrie S.p.A
A company belonging to the SKF Group
Site: Villar Perosa
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Tapered roller bearings are high precision products. Bad handling, mounting and dismounting can affect bearing life, leading to early failures. This manual is intended as a guide to correct handling, mounting and dismounting of SKF tapered roller bearing units. For convenience, only the term TBU is used in this document since all the instructions given in this manual are valid for both TBU and CTBU (see *"Terms and Definitions"* section).

Project: Medha Train 18

Product: BT2-8555 CA

Customer: Medha Servo

	Department	Date	Name	Signature
Prepared by:	SKF – RBU - Sales	3-10-2021	Deepak M	
Checked by:	SKF – PE - TBU			
Approved by:	SKF – PE - TBU			

We thank you for your interest in SKF products.

Contents

STRUCTURE OF THE MANUAL

This section describes the general organization of the TBU mounting manual.
The user will find details about conventions and symbols used in this guide as well as the statements which detail the rights and obligations that may be exercised and enforced by parties in a legally-recognized relationship.

Overview

The manual contains the following:

- **Disclaimer**
  Statement of responsibilities between SKF and the Recipient, in order to make the Customer aware of the legal risks involved in ignoring or not respecting the SKF procedures provided in this manual.
- **General Conditions**
  The General Conditions for the technical assistance, advice and other consultancy type services between SKF and the Recipient are reported.
- **Terms and Definitions**
  Definitions of the terms used and how and where to find more information and advice on the drawings.
- **Operation of TBU**
  This chapter describes the maintenance plan and the re-greasing details (if needed) for the TBU in the application.
- **Handling and storage of TBU**
  Describes the general precautions to be taken in order to prevent injury and to preserve the reliability and performance of the TBU in service by means of a correct storage and handling. The steps the user must follow to prepare the workbench in order to guarantee correct mounting and dismounting operations can be found at the end of the section.
- **Journal control before TBU mounting**
  Describes rules and procedures to be followed when checking the journal.
- **TBU mounting instructions**
  Describes the operations necessary for mounting the TBU on the journal.
- **TBU dismounting instructions**
  Describes the operations necessary to dismount the TBU from the journal.
- **Control of the axlebox**
  Describes the rules and procedures to be followed when checking the axlebox before it is remounted on the TBU.
- **Additional sections**
  Sections which may be added, depending on the applications.

List of symbols

WARNING: Information useful for preventing damage to components and people when trying to complete a task.

SAFETY RELATED TASK: a task that, if missed or not properly performed, can generate risks in service.

CONTACT US: Refers to the sources for additional information and for product and equipment updates.

FOCUS: examples that allow a better understanding of the topic.

Where to find more information

Refer to the following sources for additional information:

- **SKF resources**
  If the bearing has to be returned to the bearing manufacturer, please contact the local SKF engineer or sales representative.

- **Optional documentation**
  The product package may include optional documentation, such as drawings reporting technical information. The TBU drawings and customer drawings are always available at the SKF Sales Unit.

DISCLAIMER

Accuracy of the Contents

The SKF declines any responsibility for errors in the printing of the present manual. All the information is intended updated at the date of the manual indicated above.

Although care has been taken to assure the accuracy of the information in this manual, SKF provides this information “AS IS” and DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. You acknowledge that your use of this information of the manual is at your sole risk and that SKF shall not be liable for any direct, incidental, consequential, or indirect damages of any kind arising of use of the information of this manual.
Any warranties and representations for SKF products or services that you purchase or use will be subject to the agreed upon terms and conditions in the contract for such product or service.
In case SKF provides to you technical assistance and / or advice, you acknowledge that the rendering of such technical assistance and advice is subject to the SKF General Conditions for technical assistance and advice, which read as follows:

- SKF -
General Conditions for technical assistance and advice
valid from 2010-01-01

A complete understanding of the contents of this manual is fundamental to ensure not to damage people and products. Therefore, for any questions, doubts or concerns, it is strongly recommendable not take autonomous decisions, but to contact SKF that will provide adequate support.

Updated Technical Information

The Customer must be sure that, every time the product is to be mounted, they have the latest edition of the manual and of the required assembly and component drawings (drawings in the Manual are just for reference). SKF recommends the Customer to verify with the local SKF Sales Unit Application Engineer to have the most up to date technical information, the latest edition of the drawings and of the assembly drawings.

Product Modifications

PRODUCT MODIFICATIONS AND CHANGES AFFECTING SAFETY IN SERVICE ARE FORBIDDEN WITHOUT SKF AUTHORIZATION. The SKF keeps the right to apply any modification required to develop and evolve their products.

If customer identifies obvious differences between the product he has bought and the product as described in this document, the customer should inform SKF immediately.

Infringements of Prescriptions

ALL ACTIONS CONTAINED IN THIS MANUAL ARE SAFETY RELATED. In the interest of safety, each person authorized to perform SKF product mounting and dismounting must be fully aware of the contents of this manual.

The infringement of the prescriptions reported on this manual can result in serious damages to people and goods, causing the warranty to expire. In this case SKF declines every responsibility.
SKF is not responsible for damage to their product caused by misuse or non-observance of the rules stated in this manual.

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Only trained and skilled SKF people are authorized to perform mounting and dismounting of SKF products. In case of difficult mounting and dismounting, doubts or uncertainty, do not take actions. Contact SKF, which will provide adequate support.

Tooling

SKF shall supply mounting and dismounting tools. If the customer decides to use their own tooling, it is their responsibility to guarantee an appropriate mounting.

GENERAL CONDITIONS FOR TECHNICAL ASSISTANCE AND ADVICE

Applicability

These General Conditions shall apply in full on technical assistance, advice and other consultancy type services (including engineering consultancy services or application engineering services) ("Advice") provided by SKF to a third party ("Recipient") unless otherwise explicitly agreed in writing by SKF. No other provisions shall be applicable, regardless of whether they were explicitly rejected or not in any individual case. The services to be performed by SKF hereunder shall be conclusively deemed to be subject to these General Conditions, which shall supersede any provisions, terms and conditions contained in Recipient's purchase order or other communication from recipient to SKF. SKF's performance is expressly conditioned upon Recipient's acceptance of these General Conditions without modifications.

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The scope, purpose and the intended use of the results of the Advice shall be determined by SKF, unless otherwise is agreed in writing. SKF shall incur no liability or obligation to the Recipient arising out of any other use or application thereof by the Recipient.

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Dates or periods for the provision of the Advice are approximate and are given for information purposes only. A delay in provision of the Advice, including completion of the Advice later then the date or dates provided by SKF, shall not constitute a breach of contract and shall not entitle the recipient to any remedy unless SKF has guaranteed a date for completion of the advice in a written warranty which expressly modifies the provisions of these General Conditions. Fees and payment terms shall be agreed separately.

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Each party undertakes for itself and for its employees, agents and representatives to treat the other party's Confidential Information ("Confidential Information" shall mean any and all information related to the processes, product range, internal affairs and/or business of the parties (and their affiliates) – including but not limited to technical, practical and commercial information- that a party may disclose to the other party directly or indirectly in writing, orally, or otherwise) as strictly confidential and not disclose or communicate such Confidential Information to any third parties. Confidential Information may be disclosed only to those representatives and employees of a party to whom such disclosure is necessary for the purpose of the Advice. SKF shall, however, be entitled to communicate the Recipient's Confidential Information to another company within the SKF group. SKF shall see to it that such company adheres to the provisions in these general conditions.
Neither party may use the other party's Confidential Information for any other purpose that the intended use of the result of the Advice (see section 2 above). No obligation of use, disclosure or confidentiality shall apply to information which (i) was known by the receiving party (or an affiliate of the receiving party) prior to receipt from the other party; (ii) was known to the public prior to receipt by the receiving party from the other party or which becomes to the public subsequent to receipt from the other party through no fault of the receiving party or the receiving party's employees, agents or representatives; (iii) subsequent to receipt by the receiving party from the other party, is made available to the receiving party (or an affiliate of the receiving party) by a third party which is legally entitled to do so; (iv) if such disclosure is required by law, court order or stock regulations or

(v) is developed by the receiving party (or an affiliate of the receiving party) independently of the other party's Confidential Information. Each party shall provide proper and secure storage for the other party's written Confidential Information. All copies of the other party's Confidential Information will be returned to the other party immediately upon the request of the other party, unless such documents are required as a part of a party's internal decision making process or maintenance of company records.

Intellectual Property

SKF shall retain control and ownership of all inventions, designs and copyright and any other intellectual property owned, controlled or possessed by SKF. The Parties agree that SKF shall own at all right, title and interest in and to all results ("results" shall mean any ideas, inventions, discoveries, know-how, data, documentation, reports, materials, writings, designs, computer software, processes, principles, methods, techniques and other information, recorded in any form, that are discovered, conceived, reduced to practice or otherwise generated as a result of or in connection with any Advice performed under general conditions by or on behalf of SKF or the Recipient, and any patent, trade secret, copyright or other intellectual property rights pertaining to any of the foregoing). The Recipient shall make full disclosure of all results. If and to the extent the Recipient has generated results, the Recipient hereby assigns and transfers, without additional consideration, to SKF all right, title and interest in and to such Results. The Recipient shall, and shall cause its employees and agents to execute, or cause to be executed, all papers necessary to effect the foregoing, including assignments as necessary or useful to vest all right, title and interest in and to the Results in SKF, without additional consideration.

Recipient's Warranty

The Recipient warrants that use by SKF of designs or instructions provided by Recipient or on behalf of the Recipient shall not cause SKF to infringe any patent, registered trademark, copyright, design right or similar rights protected by law. Recipient shall defend, hold harmless and indemnify SKF against any claims of infringement and resulting damages and expenses (including, without limitation, attorney and other professional fees and disbursements) relating to the Advice covered by this Agreement.

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The obligations of SKF arising out of the provision of the Advice are strictly limited to the professionally competent performance of the Advice. SKF cannot and does not make any promises, guarantees or warranties, express or implied, that the Advice will have any influence on the product or process performance or that it will improve Recipients profitability or that the product or process will be fit for a particular purpose. SKF further does not guarantee attainment of the intended result of the Advice. This is a commercial agreement between business entities, and, except as otherwise specifically provided herein, ALL WARRANTIES, EXPRESS AND IMPLIED, ARE SPECIFICALLY DENIED AND EXCLUDED BY SKF TO THE FULL AND MAXIMUM EXTENT PERMITTED BY LAW. This is an agreement for the commercial sale of services and any transfer of goods by SKF to the Recipient is incidental to that commercial purpose. This is not a contract for the sale of goods nor should it be interpreted as such in any court, arbitration panel, government agency or legal tribunal. If SKF fails to provide the Advice in a professional manner then the Recipient shall promptly notify SKF thereof in writing, specifying the problems, and SKF shall promptly carry out an investigation.

SKF shall at its own expense use reasonably endeavor to remedy a defective Advice. SKF's obligations shall not extend to defects which are due to the Recipient not complying with instructions

given by SKF or which are caused by improper or abnormal use or by events outside the control of SKF or which are due to the Recipient having provided SKF with incorrect or incomplete information. The above mentioned obligation of SKF to remedy a defective Advice is the only remedy available to Recipient. IN NO EVENT SHALL SKF BE LIABLE FOR MONETARY CLAIMS OF ANY KIND, WHETHER BASED UPON CONTRACT, TORT LIABILITY (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE, FOR ANY LOSS OR DAMAGE (INCLUDING, BUT NOTLIMITED TO, LOSS OF USE, PROFITS OR REVENUE OR CLAIMS OF RECIPIENT CUSTOMER, OR SPECIAL, INDIRECT OR CONSEQUENTIAL LOSSES, OR PENAL DAMAGES OF ANY NATURE), ARISING OUT OF, CONNECTED WITH, OR RESULTING FROM ANY USE OR RELIANCE BY RECIPIENT OF ADVICE. Recipient shall reimburse SKF for all costs and damages paid or payable by SKF to a third party as a consequence of SKF providing Advice to the Recipient, unless such cost and damages are due to SKF having been grossly negligent.

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All disputes arising in connection with the provision of Advice shall be finally settled under the rules of Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with the said rules supplemented as necessary by the procedural rules of law of the country of SKF’s place of business most closely connected with the Advice. All such disputes shall be governed by the substantial law of the country of SKF's place of business.

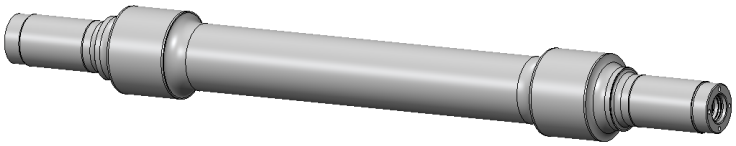
TERMS AND DEFINITIONS

This chapter provides definitions of specific terms used in the following manual and in the Railway segment.

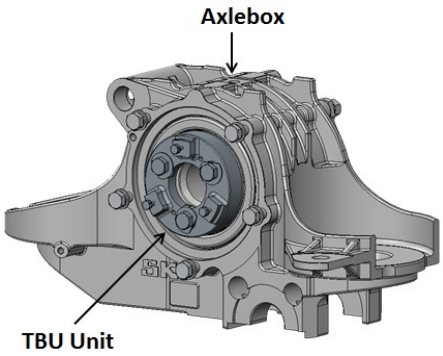
Abutment
A flat surface between the axle collar diameter and journal. Usually the backing ring leans on the abutment.

Axial clearance
The internal axial clearance of a bearing is the total possible displacement between its rings in the axial direction. Usually the axial clearance of an unmounted bearing is higher than the one of a mounted bearing. This difference is due to the mounting with interference between the bearing and the journal.

Axle
An axle is a shaft for a rotating wheel. On railway vehicles the axle is fixed to the wheels, rotating with them. Bearings are provided at the mounting points where the axle is supported.



Axlebox
The journal box of the railway axle that hosts the TBU bearing unit. It is the linking element between the rotating wheelset and the quasi-static bogie frame or running gear of a railway vehicle.

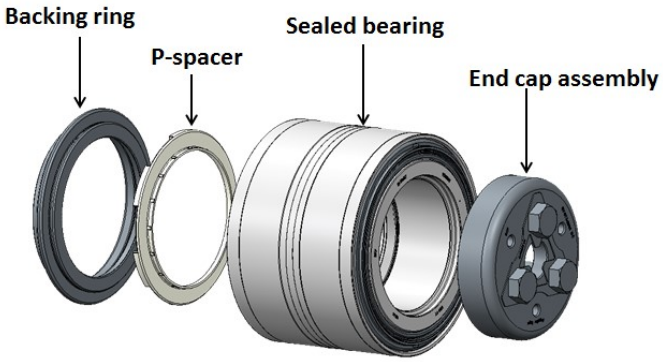


Cage (EN 12080:2011-01)
Component which partly surrounds the rolling elements and moves with them. It can be made in steel or in polymeric material.

Cartridge bearing (EN 12080)
Rolling bearing with two or more rows of rolling elements within a single outer ring, greased and equipped with integral seals.

Compact Tapered Rolling Bearing Unit (CTBU)

Pre-lubricated, sealed bearing and ready-to-mount units with a predefined axial clearance. CTBU assembly is made by sealed bearing, the backing ring, the grease and additional components can vary from application to application. Examples of additional components are: the polymer spacer, the end cap, the impulse wheel, etc.



Customer (EN 12080)
Railway undertaking, manufacturer or buyer of railway rolling stock or subassemblies, or they representative.

EN 12080/12081/12082
Set of Europeans norms providing prescriptions for bearing manufacturing and storage, grease manufacturing and storage, bearing homologation testing.

Final Seating Force
The final seating force is an extra force that must be applied at the end of the mounting phase to guarantee an optimal seating of the bearing. The maximum values of the final seating force are reported on SKF TBU drawings. The bearing unit may be damaged if these values are exceeded.

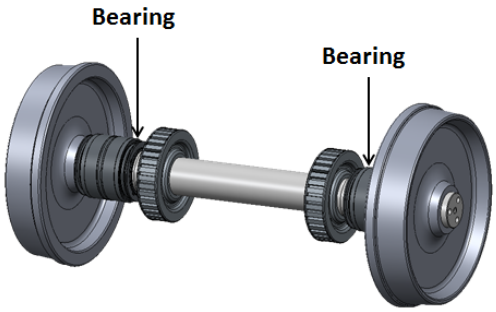
Fretting corrosion
Fretting is a complex phenomenon which takes place whenever two mating surfaces are subjected to cyclic loading. The cyclic loading causes micro slips at the interface which, ultimately, lead to fretting corrosion. Fretting corrosion can develop fatigue cracks which propagate through the material. At a later time, the crack will cause premature component failure. Fretting is a common source of failures in bearing, in particular, it forms on the spacers and at the bearing / shaft interface. Fretting is influenced by: displacement amplitude, applied load, temperature, surface roughness, surface hardness and frequency.

Grease (EN 12081)
Semi-solid lubricant, that consists of a thickener and additives dispersed in lubricating oil.

Grease batch (EN 12081)
Entire content of a single production of grease from a finishing vessel.

Inner ring assembly
The assembly composed by inner ring, cage and rollers.

Inboard layout
Layout of the wheelset in which the bearings are mounted on the inner side of the wheels.



Journal
Part of the axle where the bearing is mounted.

Maintenance interval
The frequency in time or kilometers at which the TBU must be refurbished.

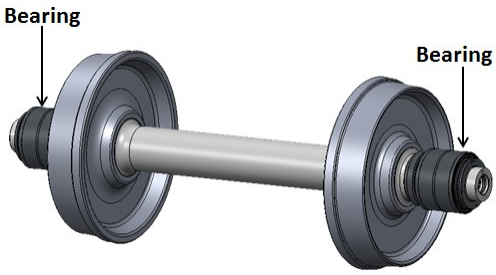
Metric ton
The metric ton or tonne is a non-SI metric unit of mass equal to 1,000 kilograms. Although not part of the SI, the tonne is "accepted for use with" SI units and prefixes by the International Committee for Weights and Measures. The S.I. symbol for the metric ton is t.
1 metric ton =1,10231 short ton.

The tonne gave rise to a force unit of the same name, the tonne-force, equivalent to the force produced by a mass of 1000 kg. One unit of tonne-force is equivalent to 9810 N.
For example, a final seating force of 45t is equivalent to 441,45 KN.

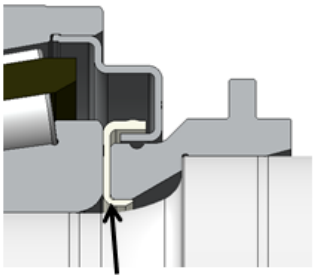
Network (EN 12080)
Infrastructure, on which any railway undertaking can operate rolling stock.

OEM
Acronym of Original Equipment Manufacturer. It is a term used when one company makes a part or subsystem that is used in the end product of another company.

Outboard layout
Layout of the wheelset in which the bearings are mounted on the outer side of the wheels.

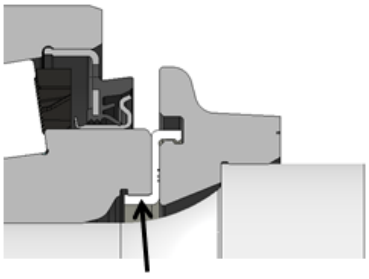


Polymer seal
Polymer component placed between the backing ring and the inner ring to reduce fretting corrosion and retain backing ring. The polymer seal, as the name suggests, has also a sealing function when combined with labyrinth seals.



P-seal

Polymer spacer
Polymer component placed between the backing ring and the inner ring to reduce fretting corrosion and retain backing ring. The polymer spacer has no sealing function.



P-spacer

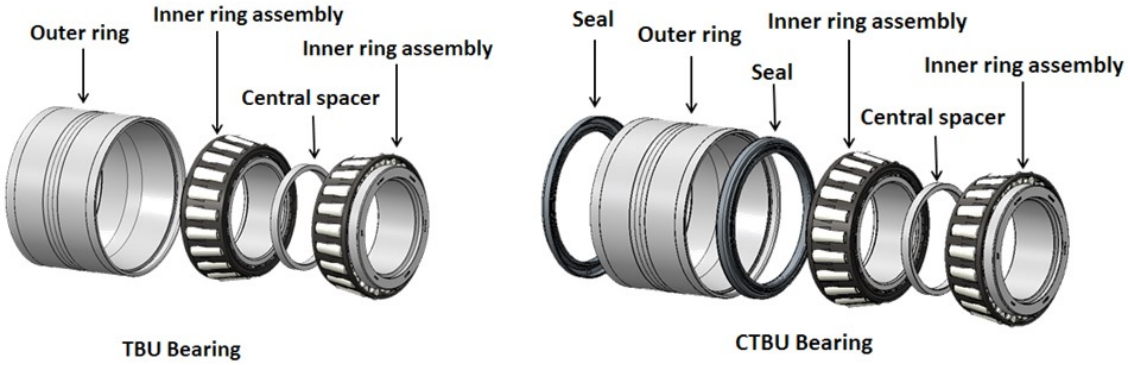
Railway undertaking (EN 12080)
Organization or its representative, whatever status it has, which is responsible of the registration of the rolling stock.

Raceway
The part of the bearing rings that is in contact with the rolling elements, tapered rollers in case of TBU.

Refurbishment
Activity of bearing reconditioning. The bearing is dismounted, cleaned, inspected. The parts which are no more suitable for service are substituted by new ones. Bearing is then reassembled, greased and its axial clearance is measured. Finally, it is packaged and shipped to the customer for reuse.

Relubrication
An optional operation to increase the life of the TBU, which consists of pumping fresh grease into the bearing unit (regreasing).

Rolling bearing
A rolling bearing is a bearing which carries a load by placing rolling elements (such as balls or rollers) between two rings and guarantees the relative motion between rotating and static parts. SKF has two types of bearings: TBU-Bearing and CTBU-Bearing. Both of them are composed of inner and outer rings, rollers, cage, grease and central spacer. The CTBU bearing also includes the seals.



Sand blasting
Abrasive blasting is the operation of propelling a stream of abrasive material, under high pressure, against a surface in order to smooth a rough surface, roughen a smooth surface, shape a surface, or remove surface contaminants.
A pressurized fluid, typically air, or a centrifugal wheel is used to propel the blasting material. When performing sand blasting the worker must wear full protective equipment in order to be protected by particulate.

Seal
Component that prevents water and dust from entering the bearing and retains the grease in the rolling bearings. Seals can include sensors, typically for speed and temperature mapping.

Service life
Maximum life (in kilometers) of the bearing in service. When service life is reached, the bearing must be scrapped and substituted by a new one. Typically, service life is a multiple of maintenance interval.

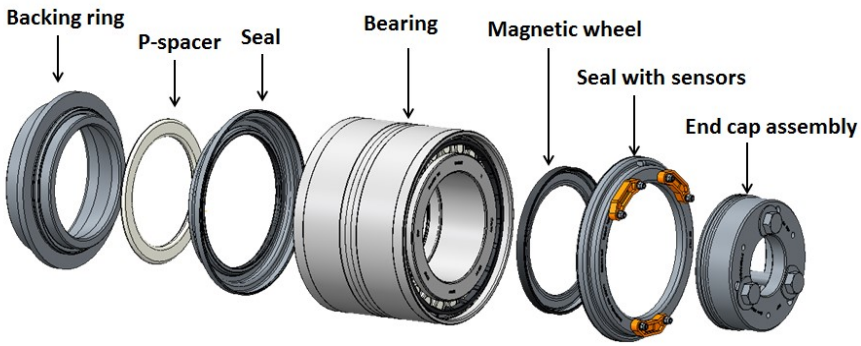
Short ton
The short ton is a unit of weight equal to 2,000 pounds (907.18474 kg), that is most commonly used in the United States where it is known simply as the ton.
1 short ton=0,90718 metric ton
The short ton can be also used as a unity of force. For example, a final seating force of 45 ton is equivalent to 400,474 KN.

Shot peening
A cold working process used to produce a compressive residual stress layer and modify mechanical properties of metals. It consists in impacting a surface with shot (round metallic, glass, or ceramic particles) with force sufficient to create plastic deformation.

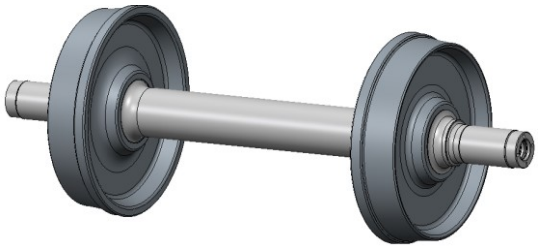
Supplier (EN 12080)
Suppliers of axlebox rolling bearings manufactured under his responsibilities.

Tapered Rolling Bearing Unit (TBU)

Pre-lubricated, sealed bearing and ready-to-mount units with a predefined axial clearance. TBU assembly is made by the bearing, the seals, the grease, the backing ring and some additional components that can vary from application to application. Examples of additional components are: the polymer spacer, the end cap, the impulse wheel, etc.



Wheelset
The wheelset is the wheel-axle assembly of a railroad vehicle.



OPERATION OF TBU

TBU/CTBU maintenance is a delicate operation which, if not correctly performed, can lead to failures in service, resulting in damages to people or goods and liability issues. For these reasons, it should be always performed by SKF or in certified refurbishment centres. Responsibility of maintenance process lies with the Customer whenever he decides to perform this operation autonomously in a workshop not certified by SKF. The maintenance interval for this application is:

Maintenance interval
1.4 Millions of Km or 3 years whichever comes first.

SKF bearings have to be completely overhauled every time they are dismounted from the axle for any reason (i.e. change brake disk, etc.) even if they have not reached the maintenance interval. It is always necessary to replace both the TBUs on an axle when one of these TBU is dismounted before having reached its maintenance interval. The warranty on the TBU will expire when it is dismounted from the axle. The polymer cage must be replaced every 12 years for high speed bearings and every 16 years for bearings in other applications. Contact SKF for further details.

The Service Life for this application is:

Service Life
4.2 Millions of Km or 9 years whichever comes first.

SKF bearings must be scrapped when the service life is reached.

The maintenance plan for this project is the following:

Maintenance Plan	
Type of Operation	Frequency
1st Overhaul	1.4 Million Km or 3 years
2nd Overhaul	2.8 Million Km or 6 years
Scrap of the bearing	4.2 Million Km or 9 years

For this application relubrication must be performed according to the table below:

Relubrication in service			
Grease type	Mileage [Million of km]	Relubrication quantity [g]	Tolerance [g]
See TBU drawing	*Not Applicable*		

Relubrication and overhaul are a safety related tasks because missed or badly performed operations can lead to TBU failure in service.

HANDLING AND STORAGE OF TBUs

This chapter describes the precautions to be taken when preparing a correct working environment and workbench.

The general rules for a correct handling and storage are also provided: such rules are mandatory to ensure reliability and durability of the components.

Safety information

The TBU is designed and manufactured according to high technical and safety standards. Despite this, safety issues may arise if the TBU is not correctly fitted, used or maintained by competent personnel. The mounting of the bearings and axlebox requires that the rules in force for heavy components handling are respected.

General and Local Health and Safety Regulations must be observed.

Where auxiliary products are used (hydraulic press, chemical products, etc.) refer to the safety rules stated by their suppliers.

Cleanliness of the workplace

It is responsibility of the customer to ensure the workplace where the SKF product will be stored, mounted and dismounted is ordered, clean, dry and sufficiently lit. Rooms where welding and metalworking operations are carried out are not suitable for storing, mounting and dismounting the bearings.

Handling of chemicals, lubricants and cleaning materials

In general, the lubricants (oil and grease) and solvents used for cleaning and mounting can generate skin irritations or can cause infections to small cuts or grazes present on the skin.
Some people are more sensitive to this aspect or can be allergic to the substances within such products. For these reasons, the lubricants and solvents must not come into direct contact with the skin.
The use of protective gloves and appropriate tools (grease gun, oil-can, etc.), which are in good conditions, is mandatory when handling these products. Toxic solvents must not be used for cleaning or removal of the grease. In general solvents are highly flammable, therefore they must not be used in places where naked flames or sparks are produced.
Chemicals which have a corrosive effect on bearings (acids, mists or aerosols of acids, ammonia, chlorinated lime, alkaline solutions, salts, etc.) must not be stored in the same room.

Heavy parts and equipment

During transportation, mounting and dismounting of heavy TBUs, proper tools in good working conditions must be used.
Special care must be taken when handling such items in order to avoid damage to people and objects. If cranes are used, the general rules for suspended loads must be observed and the personnel must be equipped with protective clothing.

Packing and storage

Two situations must be considered: handling of TBU not mounted on the wheelset and the handling of TBUs mounted on the wheelset. The following table summarizes the storage conditions for these two situations.

TBU Storage Conditions			
Item	**Location**	**Storage Time**	**Notes**
TBU in pallet box	Indoor -5°C÷40°C	24 months	Outside of these 24 months, a maximum period of 12 months shall be at the bearing manufacturer.
TBU mounted on Wheelset	Indoor/outdoor (covered area)	12 months	Rotate outer ring every 4 months. Minimum 20 rotations.

Table with storage conditions for TBUs

Storage, transportation and handling of TBUs not mounted on wheelset

"Whether delivered in bulk or singly, all rolling bearings shall be effectively protected by appropriate packaging such that they can be transported, handled and stored without any damage.

The packaging shall permit a minimum storage time of two years under normal storage conditions and provided that the original packing has not been opened. For rolling bearings delivered pre-lubricated, the storage time from manufacture to mounting the bearing on the axle is limited to 24 months indoor between -5°C and +40°C. Outside of this 24-month period, a maximum of 12 months shall be at bearing manufacturer's premises." [EN 12080]

If the storage time limit is exceeded, do not mount the TBU but contact SKF. The storage temperature should remain as constant as possible in order to avoid condensation. Pallet boxes containing TBUs must not be stored being exposed to direct sunlight.

TBUs not mounted on wheelset and stored by the Customer, must be handled with care: incorrect transportation can cause vibrations or impacts. If the boxes have fallen or they have come in contact with water, the bearings are not suitable for use: contact SKF for instructions.

The bearings, axlebox and accessories must be protected against moisture and dirt before and during mounting. TBUs, when stored, must remain sealed inside their pallet box until immediately prior to mounting. If any undesired condition is found on TBU when opening the pallet (condensation, sign of damage, missing components, etc.) do not use any TBU in that box, but contact SKF for further instructions.


Pallet boxes containing TBUs

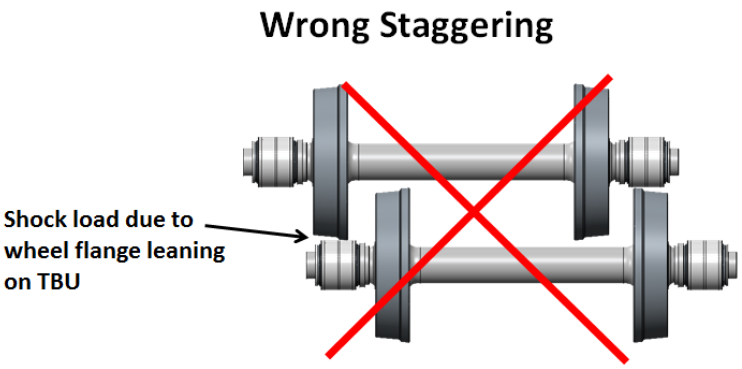
Storage, transportation and handling of the TBUs mounted on a wheelset.

Following fitment on a cartridge bearings 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 level, the grease contained in the bearing arrangement shall be agitated periodically to prevent oxidation. This may be undertaken by rotating the outer race of the bearing or the axlebox several times, or rotating the wheelset whilst the bearing outer races or axlebox 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 need to be agreed between the parties.

Unless otherwise documented, the elapsed time will be counted from the manufacturing date stamped on the TBU outer seal front side.

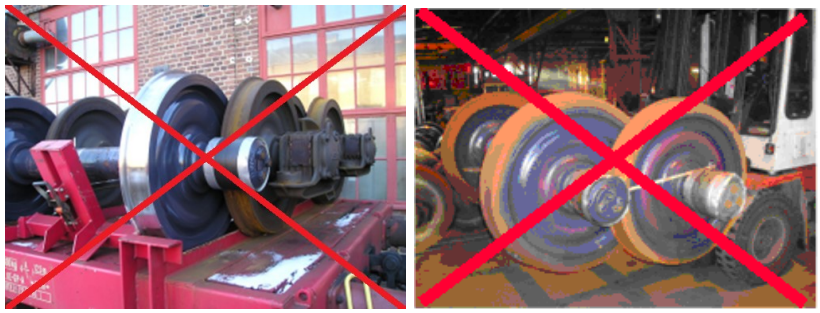
Extreme care must be taken during handling and transportation of the wheelsets, in particular (but not only) without axlebox. This in order to completely avoid shock loads on the bearings, which are extremely detrimental to the integrity of the product.

Staggering with the wheel flange in contact with the TBU is a wrong and dangerous way of storing/transporting the wheelsets because shock loads on the TBU can occur, damaging it.



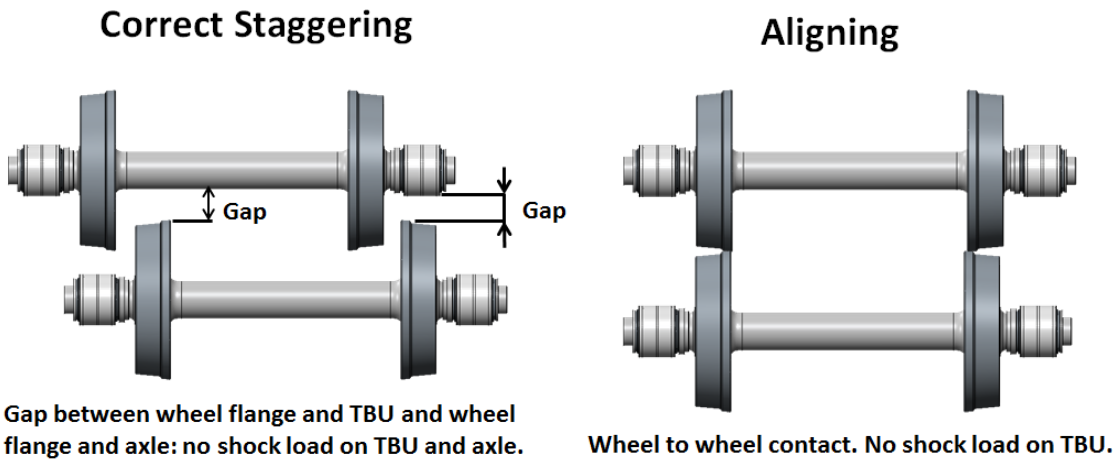
Wrong staggering, shock load on TBU

Figures below show some examples of wrong staggering while transporting wheelstes:



Incorrect wheelset transportation (wrong staggering)

Aligning is that correct way to store/transport the wheelsets since each wheel flange is directly leaning on the flange of the other wheel. This will not cause any shock load to the TBUs. It is also allowed to have staggering during storage and transportation in order to save space, provided that there is no contact between the two wheelset. Customer is free to adopt any solution to prevent contact between staggered wheelsets.



Correct ways of storing and transporting wheelset

A complete wheelset, mounted with SKF products, must be stored in a covered area, not exposed to direct sunlight and must be protected from bad weather conditions and other damaging agents. If water has entered in the TBUs during the storage and transportation of the wheelsets or if any other signs of bearing damage are detected, the TBUs are not suitable for use. Dismount them from the wheeset and contact SKF for further details. Bearings with labyrinth seals shall be with the final arrangement of the axlebox or with provisional protection approved by SKF.

Sealed plastic bags (like the ones shown below) wrapped around SKF TBUs are forbidden, as they promote condensation.

Plastic bags and staggering: not acceptable

Particular care has to be taken during transportation by ship. Vibrations at low frequency can occur, leading false brinelling on the outer ring and inner ring raceways through the rollers. In this case the main recommendations are:

- **Lift the wheelset or bogie in order to avoid the wheels being in contact with the deck of the ship.**
- **Apply an anti-vibration component (such as wood or rubber) between the axle or bogie and the deck of the ship so that it can absorb this vibration. An important point is that the axle or bogie has to be firmly secured to the anti-vibration system in order to avoid any movement, in axial direction, of the complete assembly between axlebox body and bearing inside it.**
- **Store in closed containers and the axles/bogies must not come into direct contact with water. It is recommended that they are protected with an air permeable fabric.**

Cleaning of the vehicles

The vehicles can be cleaned mainly using water, sand blasting and shot peening. Precautions must be taken with all methods in order to avoid damaging the TBU. The following sections deal with each cleaning method in detail.

Cleaning with water and detergents

It must be absolutely ensured that no water or solvents enter in the bearing arrangement. If these liquids enter the bearing, they destroy the lubricating effect of the grease and oxide the bearing steel, leading to bearing failures. When the vehicles/bogies are washed, the water jet must not be directed onto the seals. High pressure washing is forbidden when labyrinth sealing system is used on the rear side. The maximum allowed water temperature is 70 °C. Detergents used together with water may damage TBU components: in case of doubts, please contact the Sales Unit and the Application Engineering.

Cleaning with sand blasting

Sand blasting and shot peening destroy the seals and the phosphate coat on the inner, outer seals and on the outer ring. When using one of these cleaning methods it is therefore absolutely necessary to avoid that these particles come into contact with the bearing.

Electro welding on vehicles or bodies

If welding operations are carried out on the vehicle bodywork or the bogie, all precautions must be taken to prevent the passage of electric current through the bearing.

Ultrasonic control of the axle

When ultrasonic control is carried out on the axle, it must be ensured that no oil, or any other fluid used for UT, enters inside the bearing unit.

JOURNAL CONTROL BEFORE TBU MOUNTING

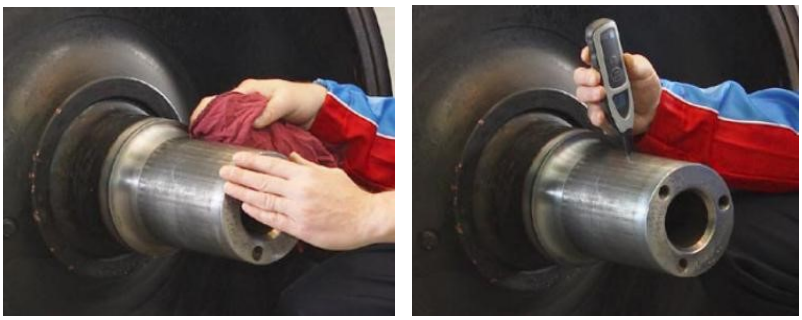
This chapter describes the steps to be followed to check the correct functionality of the journal. To obtain reliable measurements, the journal shall have the same temperature as the measuring instruments, approximately 20°C. The following tools must be available:

Tooling for journal control

The journal must be checked immediately before the bearing mounting in order to minimize the risk of damaging the bearing.

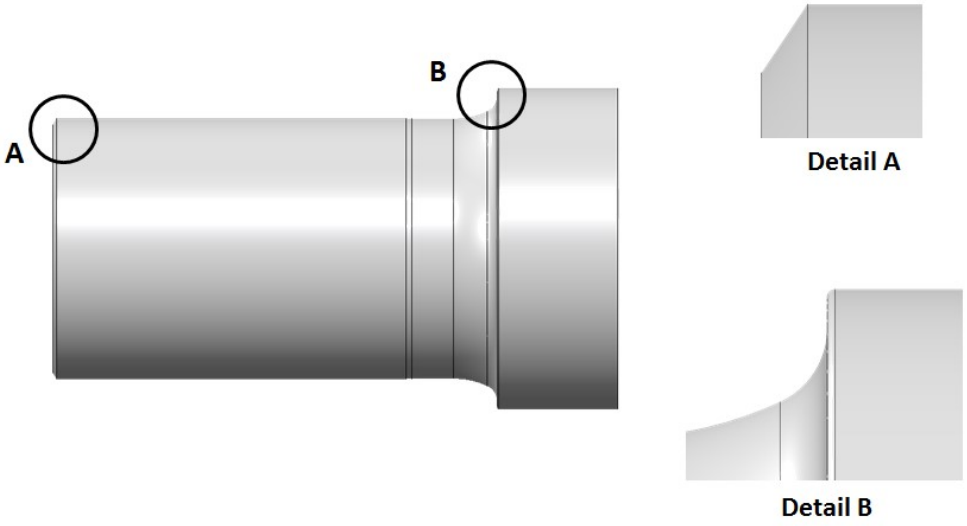
The procedure to perform a correct check of the journal is reported here below.

1) Clean the journal and measure the superficial temperature as illustrated below



Cleaning and temperature measurement of the journal

2) Examine the surface of the journal where the bearing will be fitted, fillet “A" and the vertical abutment “B” for the sealing collar: remove any burrs, scratches or dents. Check that the edge of the journal bearing is not sharp.
A chamfer must be present and its edges must be smoothened. The journal shoulder must be free from pre-existing paint and/or antirust coating. Ensure that the threaded holes for the end cap screws are clean and not burred. Clean the holes by blowing compressed air into them.



Journal detail

3) If some edges are protruding outside the journal cylindrical shape where the bearing will be fitted, these must be carefully removed. In this case, a honing stone or emery cloth is recommended. Sometimes, in workshops, sandpaper is used to clean-up surfaces that have been affected by fretting corrosion or any other kind of surface change. In many cases, the result is that the correct diameters are change as too much material is removed. In order to prevent this type of damage, SKF recommends using sandpaper with the correct grit size, according to the following table.

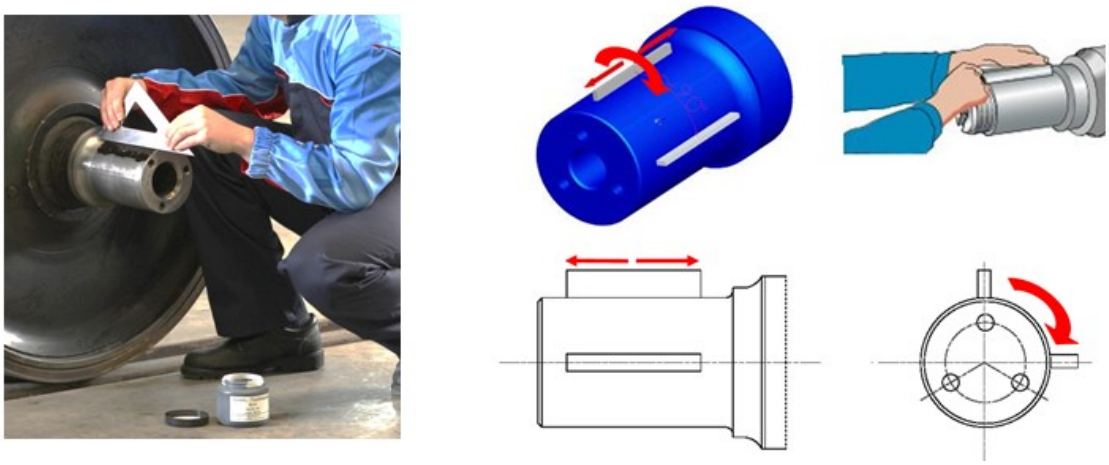
Grit size table			
General Grits Dimensions	**ISO/FEPA Grit Designation**	**CAMI Grit Designation**	**Average particle diameter relative to FEPA Designation (μm)**
MACROGRIT	P220	220	68.0
MICROGRIT	P320	240 or 320	46.2

Table with grit size recommended by SKF

Different standards have been established for the grit size. The two most common are the United States CAMI (Coated Abrasive Manufacturers Institute) and the European FEPA (Federation of European Producers of Abrasive) “P” grade. The FEPA system is the same as the ISO 6344 standard.
The following procedure must be applied to remove edges using sandpaper:

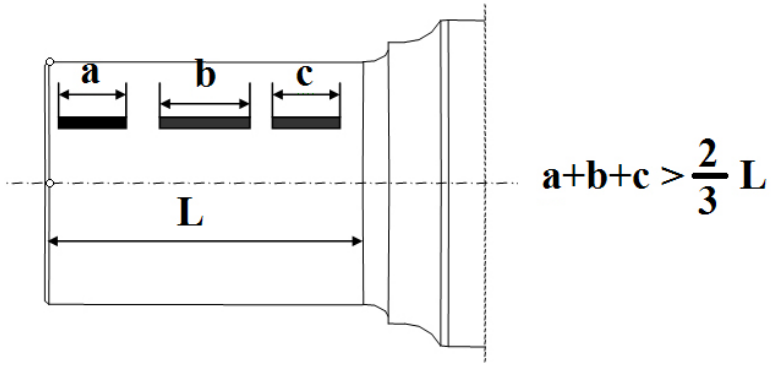
- Firstly the coarser sandpaper (grit size P220 or P320) is passed to remove greater surface indentations.
- Secondly the finer sandpaper (grit size P400 or P800) is wiped to obtain a is polished and smooth surface of the journal.

4) The journal must not have waves on its surface. This aspect can be checked by mean of a metal ruler smeared with Prussian blue by moving it forwards and backwards on the journal in the axial direction, several times. This inspection shall be carried out at least in two planes at 90° as showed in figure below.



Procedure to control journal

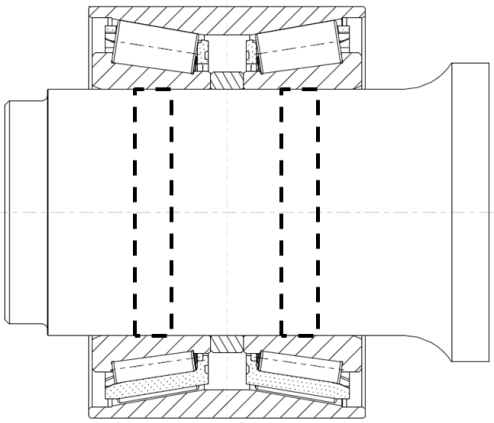
If there is an unbroken line on the surface plate, the journal is good and suitable for use. If a dashed line is left on the journal, as shown below, and the length of its parts is less or equal than 2/3 of the total length**, the journal must be repaired or scrapped**. The following rule shall be respected:



Acceptance criteria for journal scratches

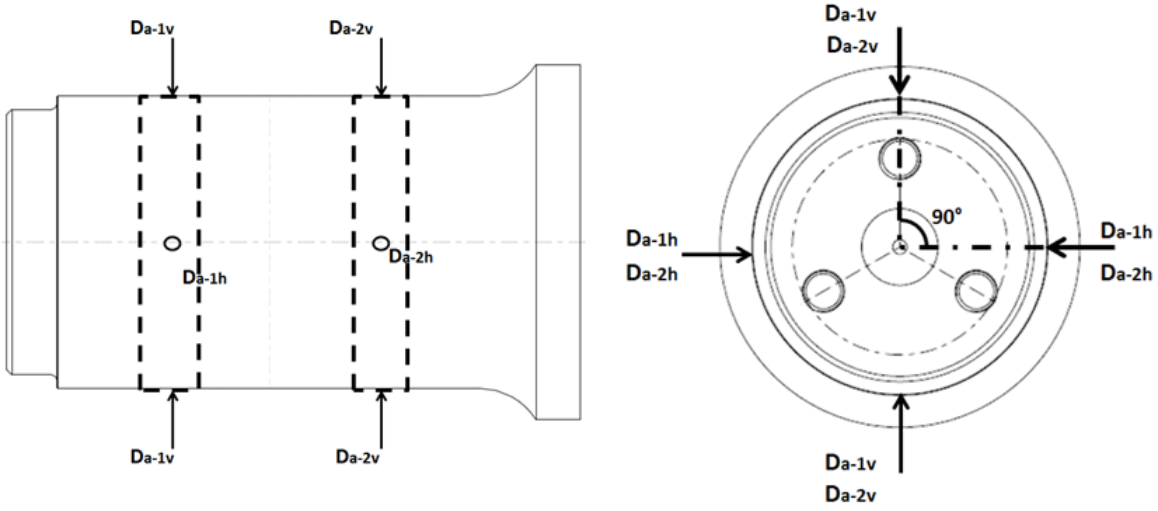
If several short undulations are detected on the journal, the surface where the bearing will be fitted must be reground over its entire length. The reground journal must be within the specified tolerance limits.

5) Verification of diameters Da and Db.
Diameter Da is the diameter of the journal at which the bearing bore is fitted.
"**Da**" should be measured in two planes at 90° each other, approximately where the middle of the two inner rings will be placed (dashed lines):



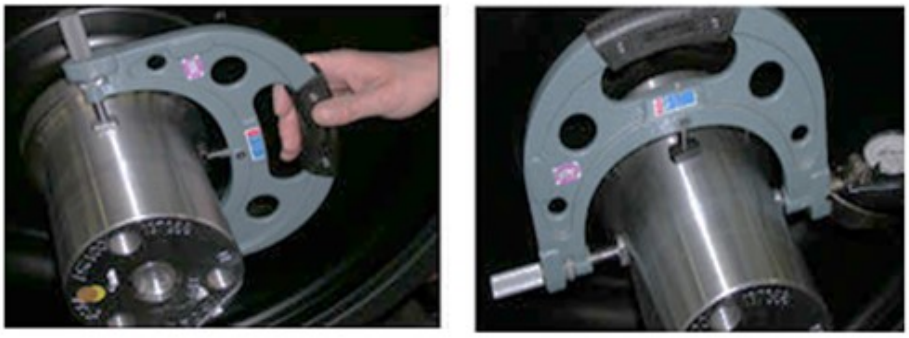
Bearing seat diameter

Values $D_{a\text{-}1v}$ and $D_{a\text{-}2v}$ are the values of D_a measured in the vertical position while $D_{a\text{-}1h}$ and $D_{a\text{-}2h}$ are the values of D_a measured in the horizontal position (i.e. measured in a plane rotated of 90° with respect to the one in which $D_{a\text{-}1v}$ and $D_{a\text{-}2v}$ are measured). These values must be within the tolerance prescribed for the journal.



How to measure Da

It is strongly recommended to measure Da by mean of a stirrup type gauge with three points.



Stirrup gauge with three points used to measure Da

Once the diameters have been measured, the verification of the journal deviations of conicity and ovality must be verified. Ovality is evaluated in the sections of the journal where inner rings are fitted:

Ovality_1 = $|D_{a\text{-}1v} - D_{a\text{-}1h}|$ **Ovality_2 = $|D_{a\text{-}2v} - D_{a\text{-}2h}|$**

Conicity is measured both on the vertical and on the horizontal planes:

Conicity_v= $|D_{a\text{-}2v}-D_{a\text{-}1v}|$ **Conicity_h= $|D_{a\text{-}2h}-D_{a\text{-}1h}|$**

The deviations of journal diameter (ovality, conicity) must not be greater than the tolerance of ISO class 5, unless otherwise specified by the Railway Network. The table below provides the most common ISO tolerance classes for linear dimensions from 50 to 250 mm:

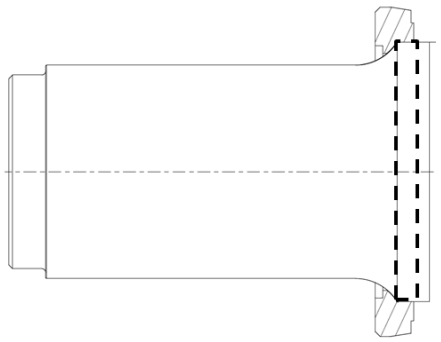
Basic size [mm]		Standard tolerance classes						
		IT4	IT5	IT6	IT7	IT8	IT9	IT10
Above	Up to and including	Tolerances [µm]						
50	80	8	13	19	30	46	74	120
80	120	10	15	22	35	54	87	140
120	180	12	18	25	40	63	100	160
180	250	14	20	29	46	72	115	185

Table with ISO IT tolerance classes

Example:
A journal with diameter 120 mm is given. If no other specifications are prescribed by the Railway Network, the deviations of ovality and conicity must not be greater than ISO class 5. It can be seen from the table above that the class 5 tolerance is 15 µm for diameter of 120 mm. This means:

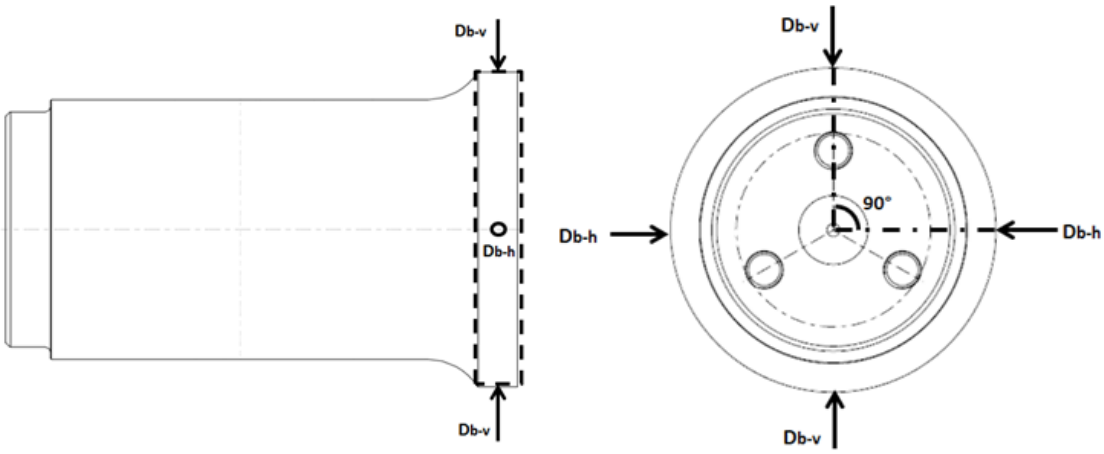
- **Ovality_1 ≤ 15 µm**
- **Ovality_2 ≤ 15 µm**
- **Conicity_v ≤ 15 µm**
- **Conicity_h ≤ 15 µm**

Diameter Db is the Backing Ring Seat Diameter, i.e. the diameter of the journal at which the backing ring is fitted.
"**Db**" must be measured in two planes at 90° each other, approximately where the middle of the backing ring will be placed (dashed line), and it must be within the values prescribed for the journal:



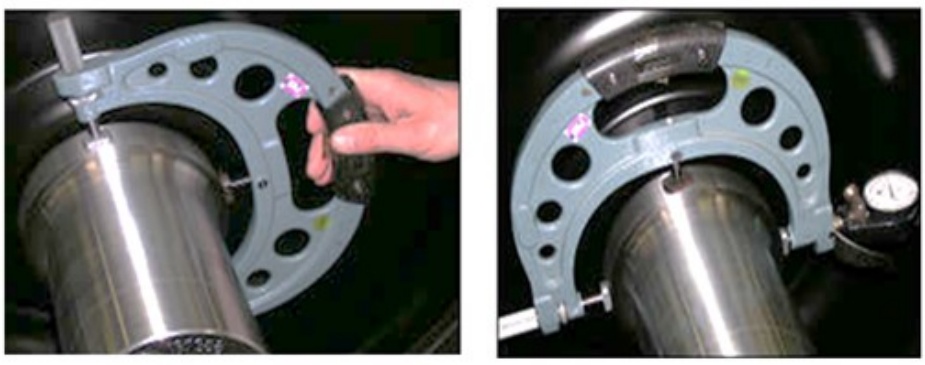
Backing ring seat diameter

Values $D_{b\text{-}v}$ and $D_{b\text{-}h}$ are the values of D_b measured in the vertical and in the horizontal position (i.e. measured in a plane rotated of 90° with respect to the one in which $D_{b\text{-}v}$ is measured).



How to measure Db

Again, it is strongly recommend to measure the backing ring seating diameter using a stirrup type gauge with 3 points.



Stirrup gauge with three points used to measure Db

Once the diameter values have been measured, the ovality must be verified. Ovality is evaluated in the section of the journal where backing ring is fitted:

$$\textbf{Ovality} = |D_{b\text{-}v} - D_{b\text{-}h}|$$

Ovality must not be greater than the tolerance of ISO class 5, unless otherwise specified by the Railway Network.

Example:
The tolerances of ISO class 5 for diameter 120 mm is IT5 = 15 µm. If no other specifications of the Railway Network are prescribed, ovality of the backing ring seat diameter must be smaller than 15 µm. This means:

$$\textbf{Ovality} = |D_{b\text{-}v} - D_{b\text{-}h}| \leq 15\ \mu m$$

6) Magnetized axles must be demagnetized before mounting the SKF bearings.

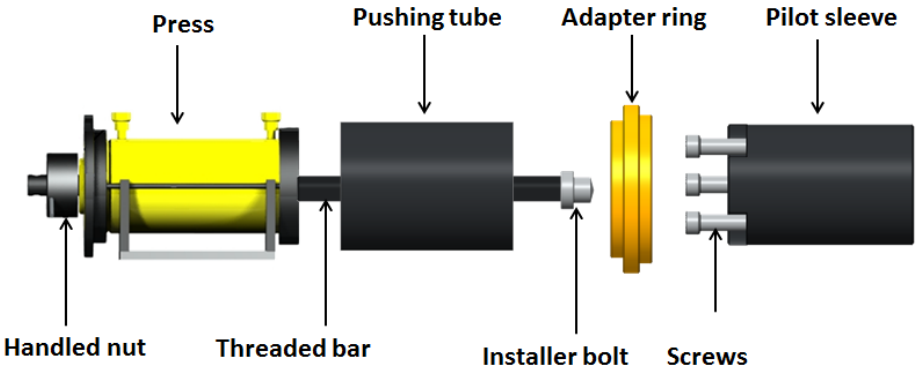
TBU MOUNTING INSTRUCTIONS

The procedure described in this chapter is applicable to the mounting process in which SKF tools are used. Nevertheless the safety instructions as well as the technical prescriptions are also applicable when mounting with other tools, e.g. when the reaction to the press force is obtained by a bar passing through the journal.

After the dimensional controls and geometric verifications of journal and axlebox, proceed with the assembly of the SKF bearing. Before mounting the TBU by press, verify that all the necessary tooling is available as shown in figure below:

Tools for TBU mounting

The mounting press supplied by SKF includes the following components:



SKF mounting press

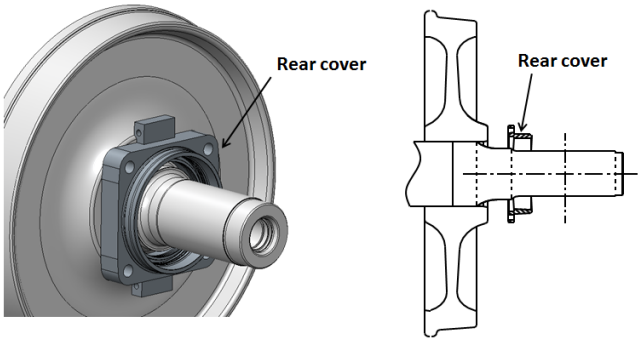
The TBU mounting procedure is divided in the following steps:

- Mounting of the TBU on the journal
- Mount of the end cap on the TBU
- Measurement of axial clearance

Mounting of the TBU on the journal

The following operations must be followed:

1) When the backing ring of the TBU is mounted together with the TBU bearing using the press, make sure to place the rear cover, if present, on the journal before the mounting of the TBU, as figure below shows:



Rear cover mounting

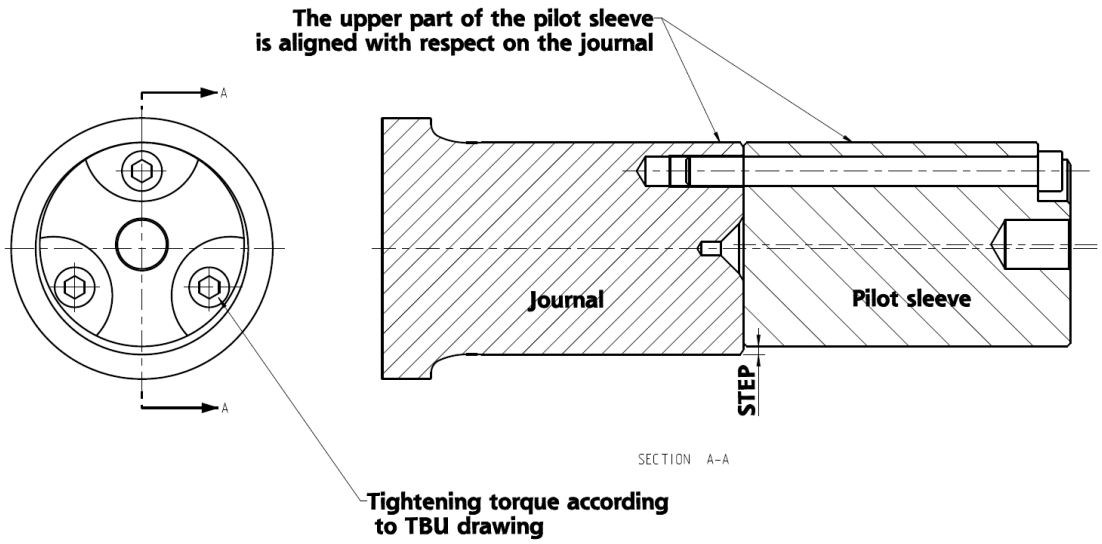
The provisionally placed rear cover must not interfere with bearing mounting.

2) Mount the pilot sleeve onto the journal with the screws, in order to hold and guide the TBU during the mounting.

Pilot sleeve mounting

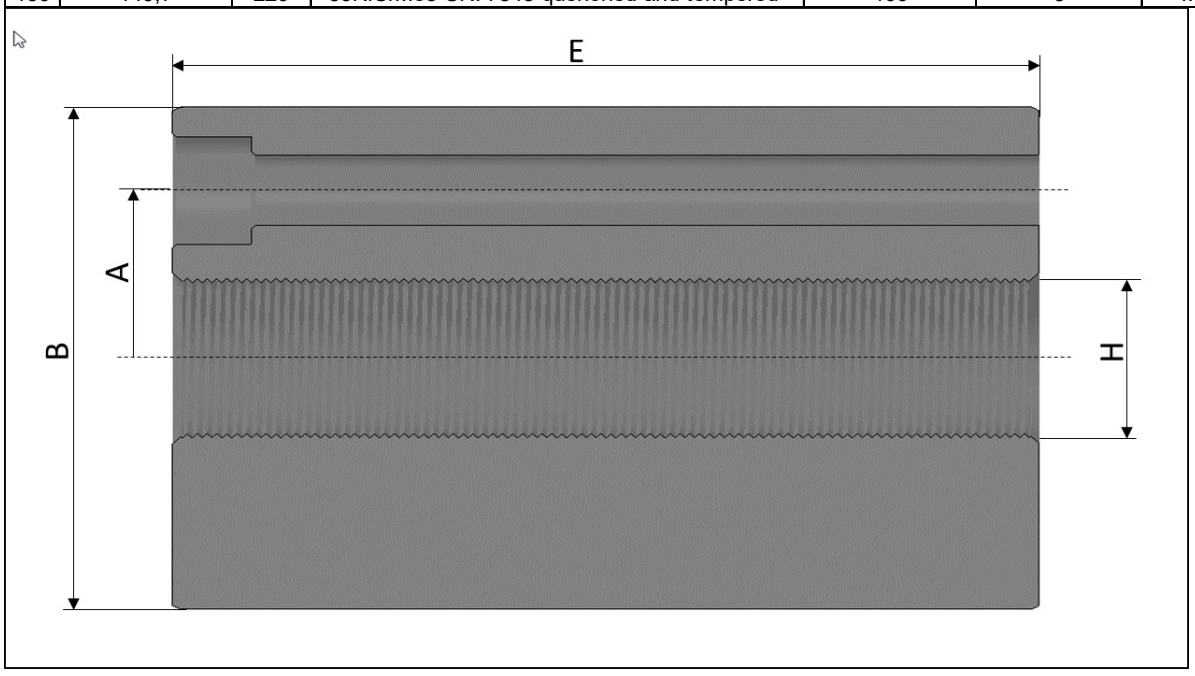
Tighten the screws with the tightening torque specified in the TBU assembly drawing for the end cap screws; if it is not indicated, please contact SKF.
The operator must be sure that the female thread of the journal is able to withstand, without damage, the effects of the force generated by the screws plus the final seating force.

The pilot sleeve must be mounted in a way that its upper part is aligned with the journal. The step must be located in the lower part in order to avoid possible damages to the TBU and journal.



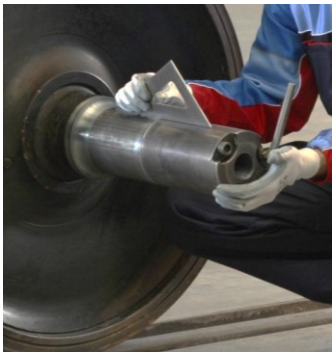
Pilot sleeve alignment

TBU size	outer diameter B (0 / +0,1)	length E	Material	pitch diameter A	no. Holes at 120 °	through hole H
90	89,7	150	39NiCrMo3 UNI 7845 quenched and tempered	60	3	M30x2
100	99,7	170	39NiCrMo3 UNI 7845 quenched and tempered	60	3	M30x2
120	119,7	200	39NiCrMo3 UNI 7845 quenched and tempered	80	3	M48x3
130	129,7	220	39NiCrMo3 UNI 7845 quenched and tempered	90	3	M48x3
150	149,7	220	39NiCrMo3 UNI 7845 quenched and tempered	100	3	M48x3



Example of pilot sleeve dimensions and material

3) 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.



Alignment control

4) When present, mount the installer bolt on the pilot sleeve.

Installer bolt detail

5) Apply a thin and uniform layer of the most suitable lubricant agent to the journal and to the collar journal.

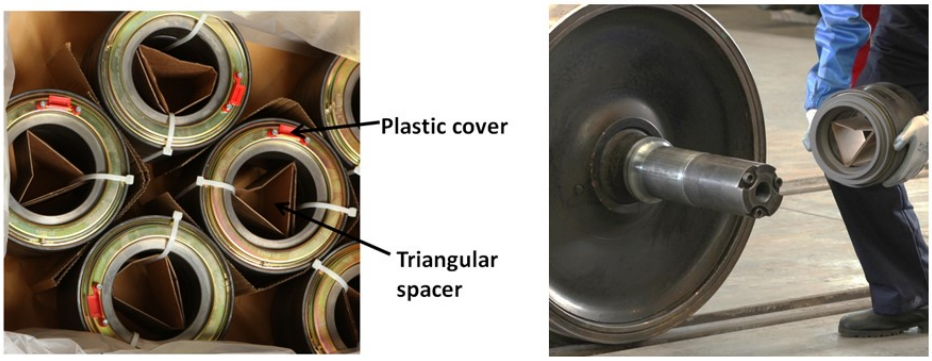
Coating with lubricant agent

The layer of the agent must be very thin and applied with a paint brush/cloth. High quantity of agent is detrimental for smooth mounting.

SKF recommends followings agents:
- Molikote DX
- Molikote G-n plus

Possible other agents:
- Thick mineral oil (SAE 30)
- Oil and molybdenum disulphide mixture (70%-30%)
- Anti stick-slip oil

6) Pick up the TBU from the pallet box; do not remove the triangular retainer placed in the TBU bore in order to avoid any movements of the central spacer. If the TBU is a sensorized one, do not remove the protecting plastic cover on the end cap side.

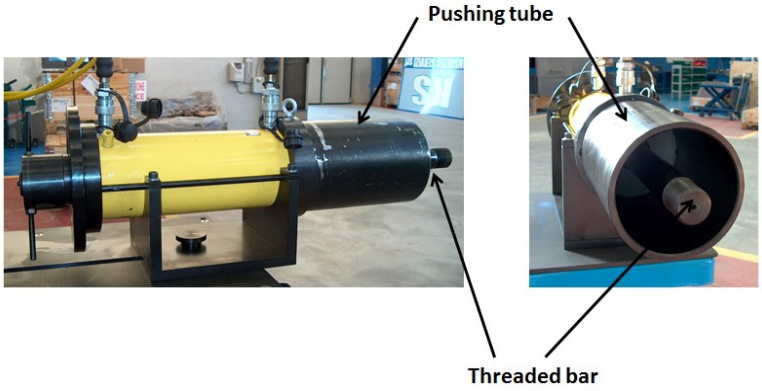


TBUs with plastic retainer and plastic cover

7) Place the TBU on the pilot sleeve by hand. The retainer will be automatically pushed out, as shown in figure below (left). After the removal of the retainer, the TBU placed on the pilot sleeve looks like the one in figure below (right).

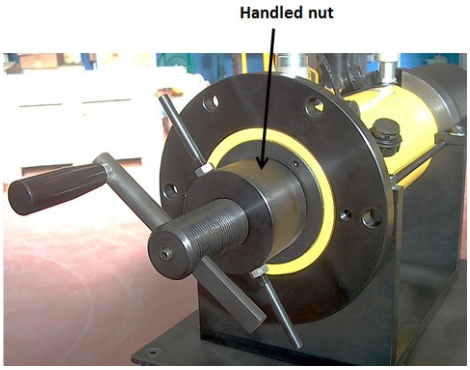
Placement of the TBU on the journal

8) Assemble the threaded bar and the pushing tube with the press



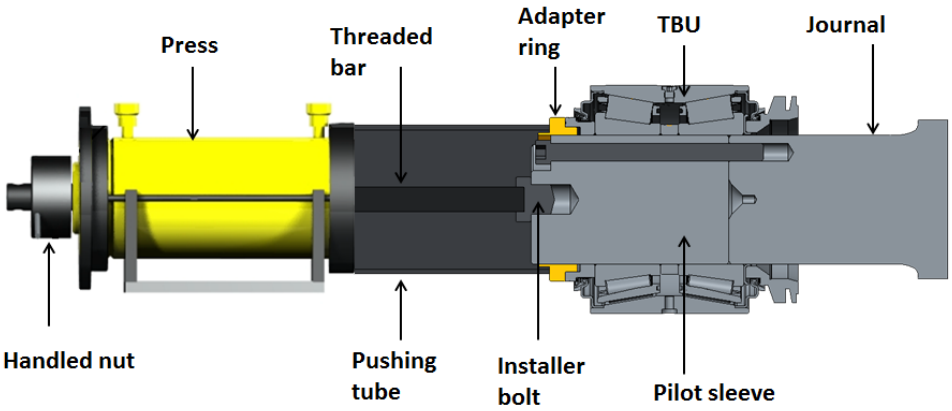
Threaded bar assembling

9) Lock the hydraulic press against the threaded bar using the handle nut.



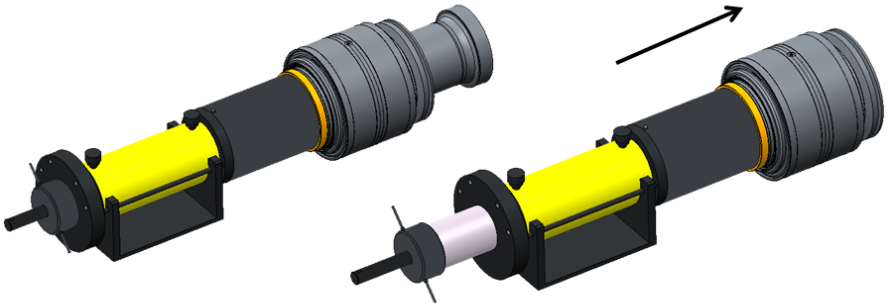
Handle nut assembling

Proceed by fixing the press assembly to the pilot sleeve. The assembly of all the components in shown below:



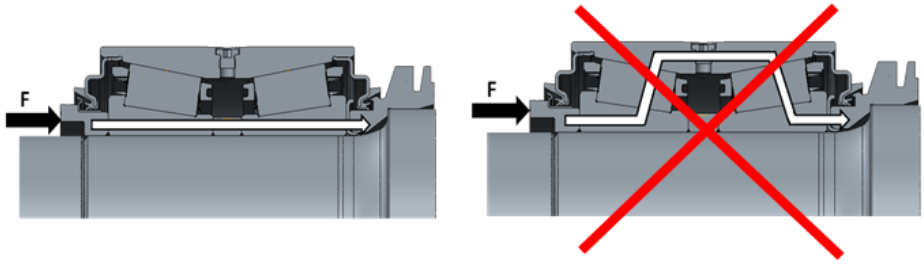
Mounting press and TBU assembly

10) The TBU is now ready to be mounted. Switch on the hydraulic press: the TBU starts to slide along the journal as a consequence of the applied hydraulic force.



Mounting scheme

The mounting force should be transmitted via inner rings and not via the roller set. It is forbidden to mount the TBU by applying the mounting force on the outer ring.



Transmission of mounting force inside TBU

To verify that the load is properly transmitted, the outer ring must be free to rotate during all the mounting phase. As a consequence, the outer ring must be kept in rotation during mounting. If it jams, discontinue the operation, dismount the bearing and contact SKF for inspection.

If the TBU is equipped with p-spacer, it must not be detached and mounted separately. It must be mounted together with the TBU. No components must be detached.
In case, during mounting, some components are detached (for example the backing ring from the bearing, etc.), the mounting process must be stopped and the TBU dismounted. Then contact local application engineer on how to proceed.
Stick-slip phenomenon is not normal during mounting as it can damage the TBU and the journal. If stick-slip occurs, stop the operation and contact the local application engineer on how to proceed.

Keep under control the dial indicator of the manometer in order to get the right seating force. During the mounting pressure will slowly increase. At the final seating phase, when the backing ring gets in contact with the journal abutment, a very quick pressure increase will be noted. The final value of pressure the dial indicator corresponds to the “final seating force” (see SKF drawing). Keep the press force applied for few seconds.

The correct final seating force is indicated on the TBU assembly drawing. Please contact the SKF Sales Unit Application Engineer if such indication cannot be found on the drawing. If the final seating force exceeds the maximum limit it is possible that some TBU components are permanently damaged, e.g. the polymer spacer. In this case it is strongly recommended to contact SKF. It is also recommended to use a press with a pressure relief valve which acts whenever the final seating force is exceeded.

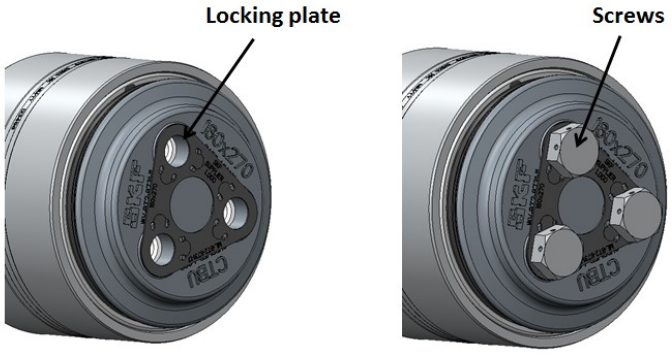
11) Once the bearing is mounted, release the pressure until the adapter ring comes free, unscrew the handled nut, roll the hydraulic press away, remove the threaded bar, the installer bolt and dismount the pilot sleeve.

Mounting of the End Cap

1) Once the bearing is mounted and the pilot sleeve dismounted, place the end-cap in position.

End cap assembling

2) Place the locking plate in front of the end-cap and then insert the screws.



Locking plate and screws assembling

3) Tighten the screws at the tightening torque specified in the assembly drawing, using a torque wrench. If tightening torque is not indicated in the drawing, contact SKF.

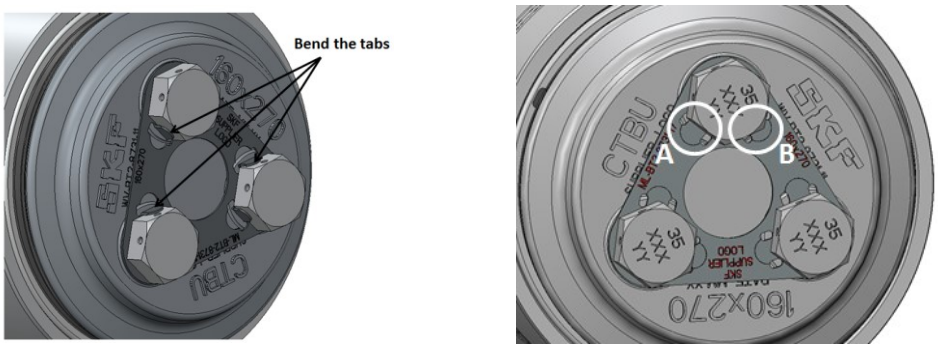
The screws shall be tightened in two loops:

- **1st loop: 50% of the final torque**
- **2nd loop: final torque**

If the end cap has four screws, in addition to the above mentioned instructions, it is recommended to tighten them following a crossed sequence, as shown in the figure below:

Correct sequence for tightening screws

4) Bend the tabs of the locking plate against the screws in order to avoid unscrewing:



Bending of locking plate tabs

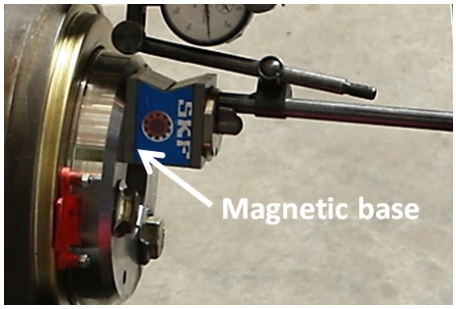
It is possible that the screw head faces are not aligned with the locking plate tabs after the screw is tightened. Locking plates are manufactured to have at least one tab that can be almost aligned with one face of the screw head. In this case it is sufficient to bend this tab. Consider the situation showed in the figure above (right): after screw tightening, the tab B is on the edge of two faces of the screw head, therefore it is difficult to bend. In this case, tab A must be bent because it is the one better aligned with screw head face.

Measurement of internal axial clearance

The internal axial clearance must only be measured when the bearing is completely mounted, with end cap fitted and tightened screws.

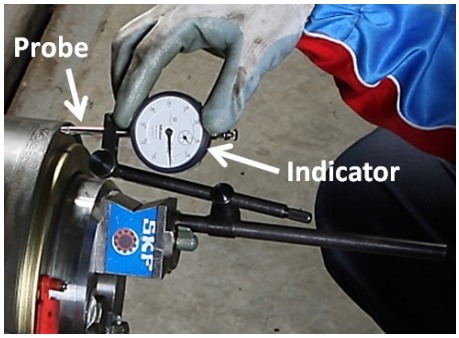
The procedure to measure axial clearance is reported below:

1) Apply the magnetic base of SKF tool on the end-cap face.



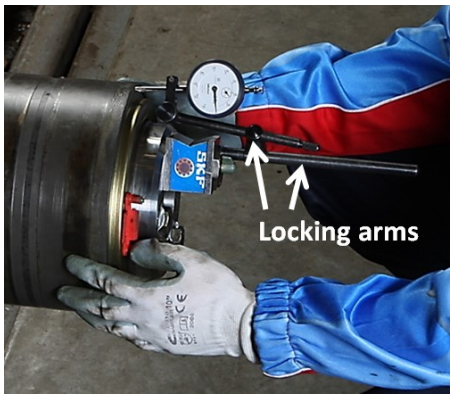
Detail of SKF tool for axial clearance

2) Place the probe on the flat face of the outer ring so to measure axial movements.



Detail of SKF tool for axial clearance

3) Secure the probe position through the locking arms.



Detail of SKF tool for axial clearance

4) Check the internal axial clearance of the TBU moving the outer ring (cup) by hand. In this operation, apply an oscillating movement to the outer ring during the pushing as well as during the pulling phase. The excursion between maximum and minimum value measured is the axial clearance and can be read on the indicator. See picture below:

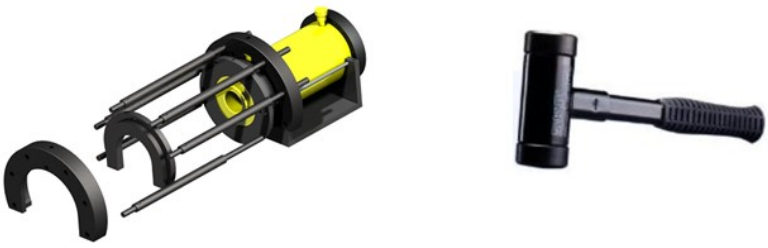
Movements to be applied to the outer ring to check the axial clearance correctly

5) The value of the theoretical residual axial clearance of the TBU is indicated on the drawing**. It may happen that, due to the grease thickness and the applied method itself, the actual value measured is lower than the one indicated on the drawing. In this case contact SKF**. Free rotation of the TBU outer ring must be guaranteed at any time.

TBU DISMOUNTING INSTRUCTIONS

The procedure described in this chapter is applicable to the dismounting process in which SKF tools are used. Nevertheless, the safety instructions as well as technical prescriptions are applicable also to dismounting operations performed with other tools.

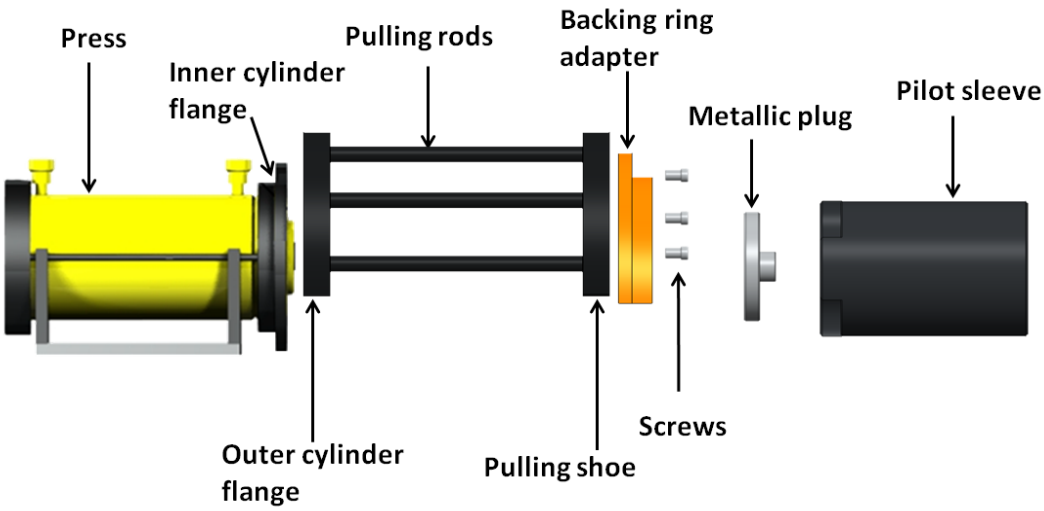
The following tools are needed to correctly dismount a TBU:



Dismounting press **Dead-blow hammer**

Tools for TBU dismounting

The SKF press in dismounting configuration has the following components:



SKF dismounting press

In order to perform a correct dismounting, follow the procedure below:

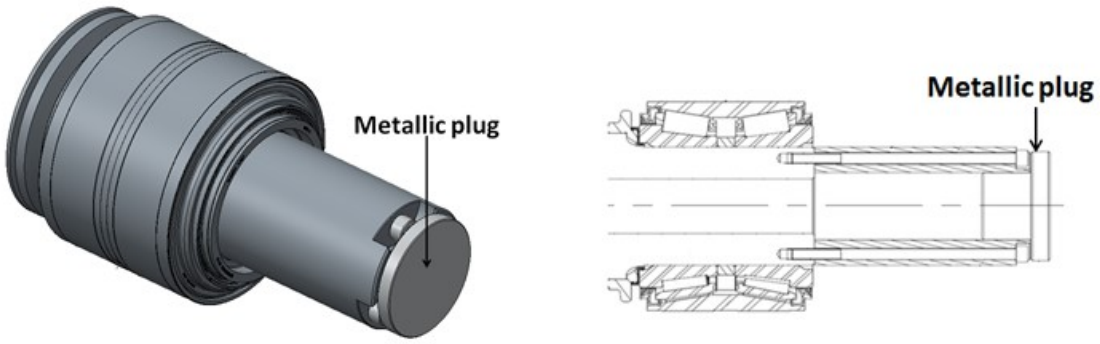
1) Dismount the outer additional equipment (e.g. shock absorber, axlebox, sensors, etc). A dead-blow hammer can be used if needed.

2) Make sure the surrounding TBU components have been cleaned to avoid contamination in the bearing arrangement.

3) Unlock the locking plate. Dismount the screws and remove the end-cap.

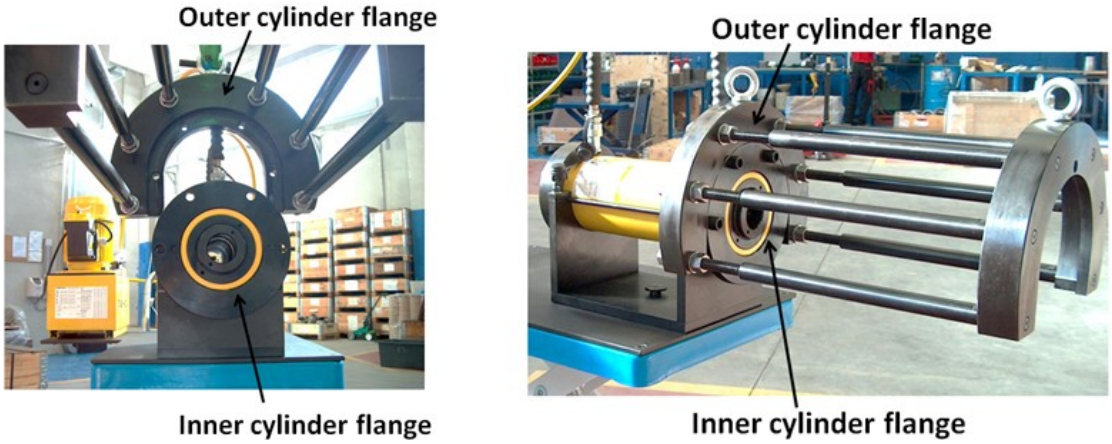
4) Mount the pilot sleeve: this is needed to support the TBU preventing it from falling to the ground once it is dismounted from the journal.

Mount the metallic plug (when delivered by SKF) onto the pilot sleeve. It will be the interface of the press piston during the dismounting.



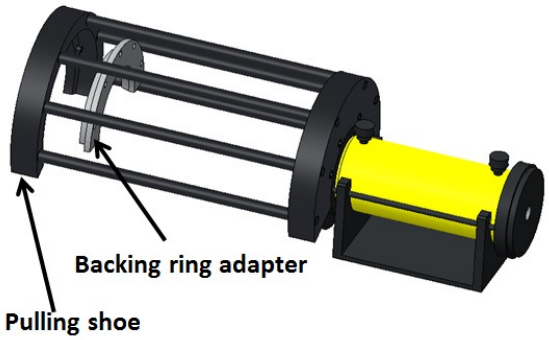
Metallic plug assembling

5) Assemble the pulling shoe on the press using a crane, as figure below shows. The distance between the pulling shoe and the outer cylinder flange ram side is obtained by the position of the pulling rods. This position must be strictly the same for all the pulling rods.



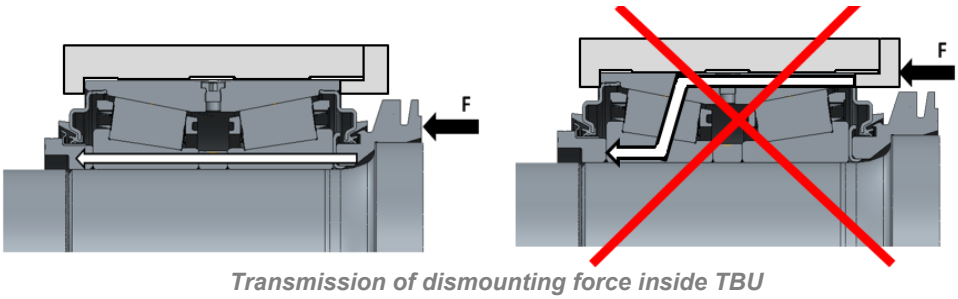
Pulling shoe assembling

6) Align the press so that the pulling shoe is over the back side of the backing ring of the TBU, then lock the pulling flange just behind the backing ring. In some cases an adapter (depending on the TBU size) can be mounted on the pulling shoe in order to guarantee a correct matching with the backing ring, see figure below:



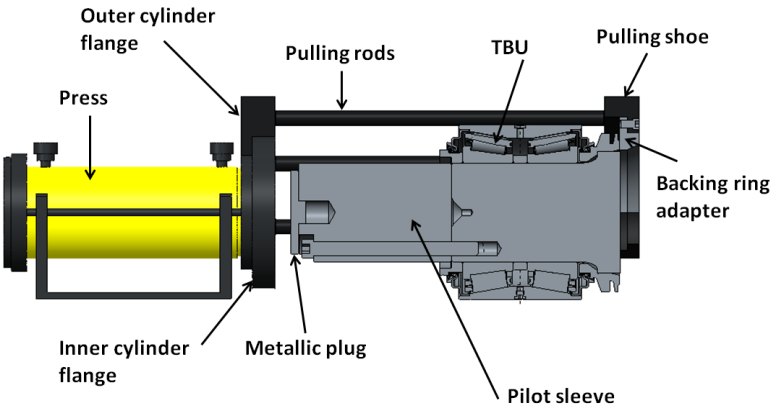
Backing ring adapter

The pulling shoe must engage only the backing ring and must not touch the rear cover or the housing, when present. This condition is necessary to ensure the dismounting force is transmitted via inner rings and not via the roller set



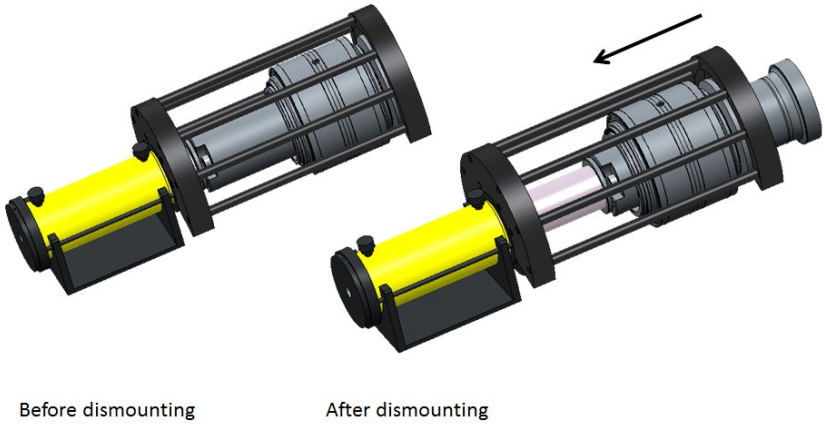
Transmission of dismounting force inside TBU

Figure below shows the final assembly configuration of the dismounting tool:



Dismounting press and TBU assembly

7) With the pulling shoe in position, apply the pressure. The pressure of the piston will be applied through the metallic plug to the end of the pilot sleeve and will allow the removal of the TBU.



Dismounting scheme

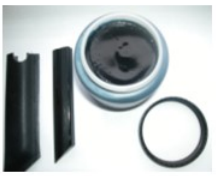
Maintain the manometer of the press under control during all the operations.

CONTROL OF THE AXLEBOX

In the case of any disassembly of the bearing from the wheelset after one or more periods of service, it is essential to have an accurate control of the axlebox before it is reassembled and put into operation. The axlebox control is divided into four steps:

- Rust removal
- Visual control
- Dimensional control
- Check of housing integrity

In order to perform a correct check, the following instruments are needed:



Contrast liquid

Abrasive flap wheel

Ruler

Solvent

Tools for axlebox control

Rust removal

After one or more periods of bearing service, when dismounted from the wheel-set, the railway axlebox looks like the one in figure below. The housing bore is covered with "fretting corrosion" caused by the hammering of the outer ring of the TBU against the housing bore. It is important to clean the contact areas affected by the fretting corrosion (mainly the housing bore, but also other parts of the axlebox) before making the further controls.

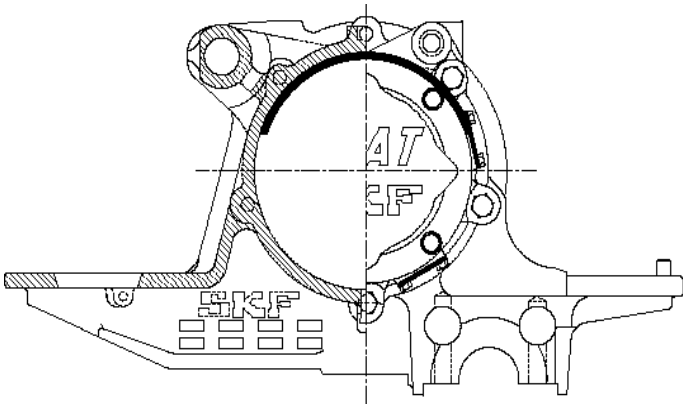
Fretting corrosion on an axlebox back from service

The procedure for cleaning the axlebox is reported below:

1) Clean the housing and the axlebox components (covers and other elements) by washing. After washing, remove any rust particles detached and traces of washing liquid with rags and air. Remove the "rust of contact" from the cover faces in contact with the covers. Clean the holes of the covers.

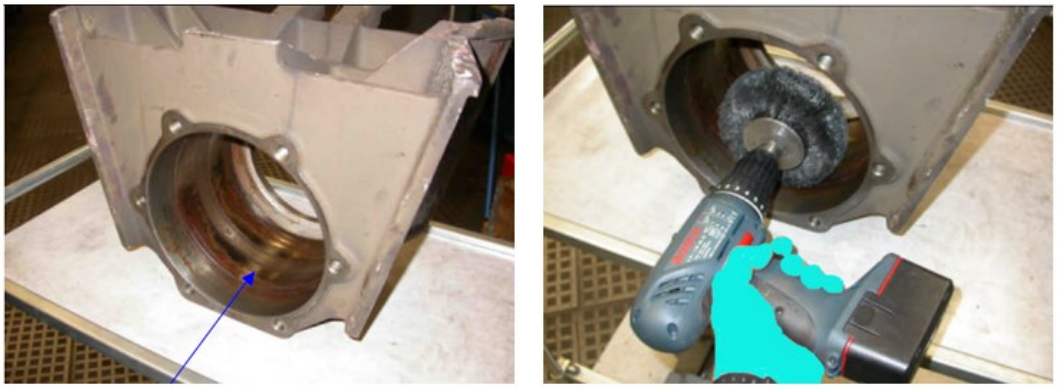
Please note: when you do not proceed immediately to the next step, protect the axlebox housing and components from possible oxidation (by using for example, Dinitrol 41 or equivalent)

2) Proceed with the mechanical removal of the "fretting corrosion" in the bore of the housing where the bearing is fitted. Typical areas affected by the "fretting corrosion" are shown below (thick black line):



Area of concentration of fretting corrosion

It is recommended to place the housing with the loaded area on the bottom, since the fretting corrosion is more evident in the loaded zone:



Removal of fretting corrosion

The "mechanical cleaning" from the fretting corrosion can be carried out using a "flap wheel" or rotating brush mounted on a mandrel machine. Utilize grit size correspondent to sand paper with "grit size" 180-200. Alternatively, the cleaning can be executed with sand paper, grit size 180-200.

3) Protect the axlebox and its components from a possible oxidation using a solvent (Dinitrol 41), as shown below. Compressed air shall be used to clean the screw holes and regreasing holes of the housing.

Use preferable a solvent in connection with the cleaning surfaces

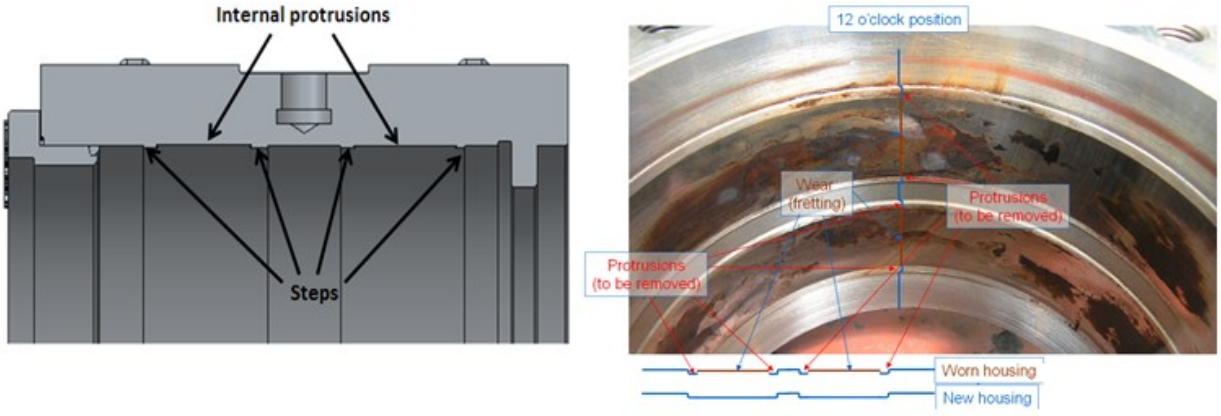
Wipe dry thoroughly all around the bore.

Application of anti-oxidation solvent

Visual Control

The visual control is fundamental to ensure that the axlebox, even if already used, will guarantee a performance of the TBU as if it was new. The procedure to perform a proper visual control is the following:

1) Check of the housing.
The bore of the housing must be completely free from steps, ridges, internal protrusions of material in respect to the bearing seat, and other localized defects that could have been created by the use of the axlebox in service. In the rest of the document, all these defects with be called “steps”. Check carefully for any "dimples” and steps on the axlebox housing, especially in the proximity of the contact areas such as central recesses of the TBU outer ring and outer ring "end-drops”. Here below an example of possible housing wear and steps (the picture does not exhaust all the possible cases, anyway it offers a good example; it remains the operator’s duty to foresee similar situations)



Examples of steps and internal protrusions

If these defects are not removed before the re-mounting of the “used” axlebox, they may come in contact with the outer diameter of the TBU bearing and generate localized stresses and deformations at very high level which may lead to failure of the outer ring itself.

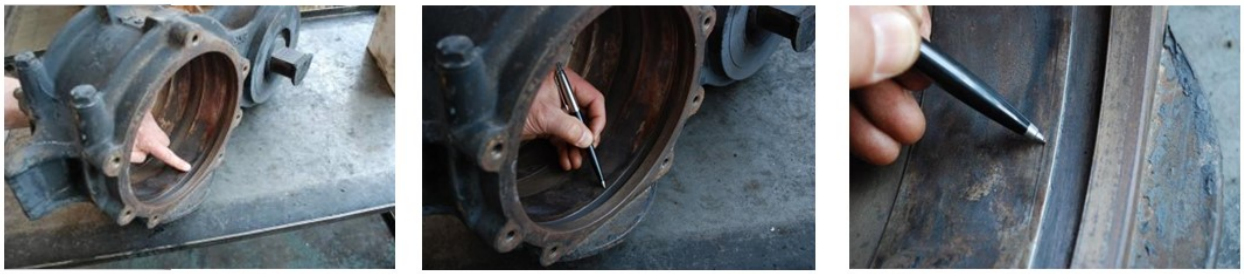
The steps, when present, are more pronounced at “12 o’clock” position, where the vertical loads are highest. The following is an example of used housing, where the area with fretting corrosion, wear and steps (ridges, internal protrusions) are present:

In order to proceed at the identification of the steps, the room must be adequately lit. Dedicated lighting must be available for the inspection of the housing bore surface, in the area of maximum vertical load.

The following methods are recommended:

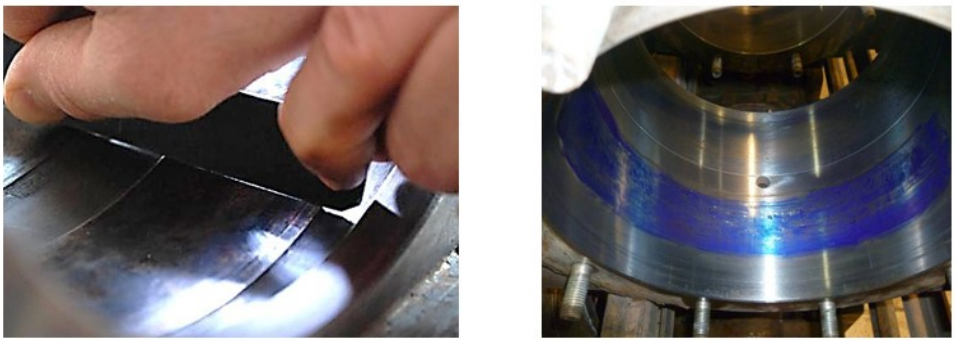
- combined visual and tactile control
- control with a "ruler” (template) with built-in light
- control with “contrast liquid” (Prussian blue)

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.



Tactile inspection with a needle

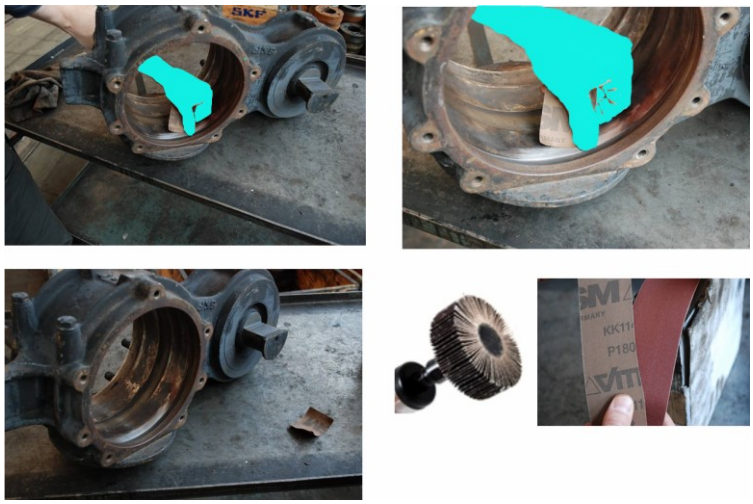
The comparison with a "ruler" with built-in light it can be done by passing it, with circular motion, in the area at 120° across the area of maximum vertical load. If the light highlights steps at the edges of the contact area (light filters in the area adjacent to the step), they must be repaired.
The check with “contrast liquid” is carried out by by "smearing" the area of the housing bore in contact with the outer ring of the TBU bearing along an arch on the area of maximum vertical load: the “ruler” will then be passed on the bore surface and it must be carefully observed if the trace left has revealed steps. If so, the steps must be repaired.



Inspection with ruler (left) and with contrast liquid (right)

The controls above are complementary. If housing steps were found with the above controls, it is necessarily to have them removed by repairing the housing bore.

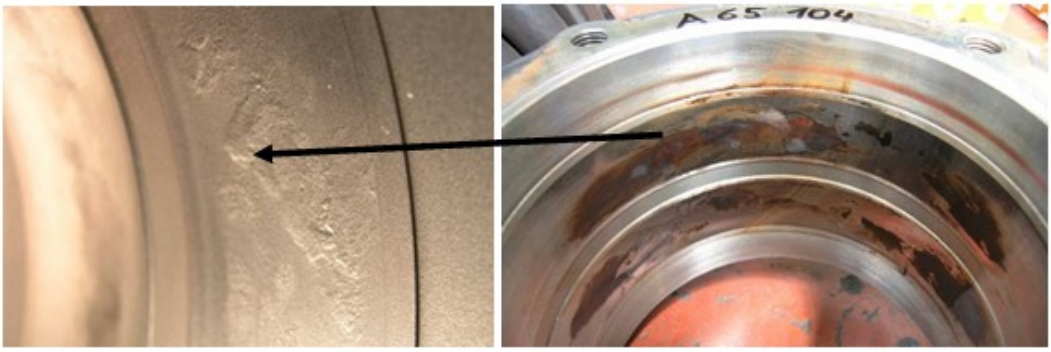
The repair can be done using abrasive stones or emery cloth, by hand or with rotary elements using a “flap wheel” or “rotating brush” mounted on a mandrel machine (utilize grit size correspondent to sand paper with “grit size” 180-200) and must completely remove the step. However, the operation must not compromise the structural integrity of the axlebox and must not produce defective geometry:



Repair of axlebox

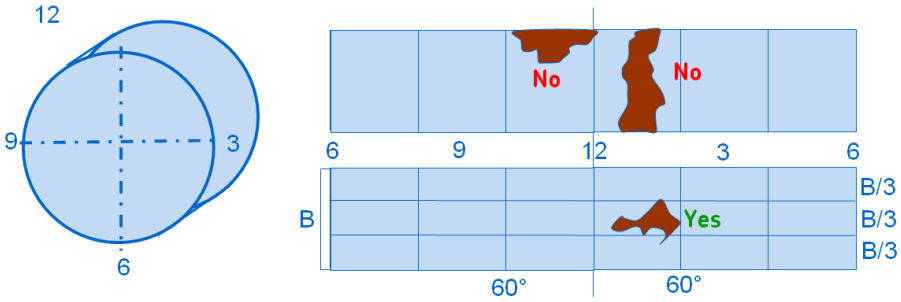
When the fretting corrosion that is present in the housing bore is significant, it is possible that its mechanical removal will leave evident dimples and irregular valleys in the area facing the outer ring of the TBU bearing.

One example is shown here below shown:



Dimples and irregularities due to fretting corrosion removal

If the area affected by these depressions is wide, the outer ring of the TBU will work with a highly irregular surface, which again leads to stress and deformations on the outer ring that can lead to its failure. It is therefore necessary to assess the entity and the position of these depressions and dimples carefully. Acceptance/rejection criterion is indicated here below (the depression areas are in brown colour):



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

Acceptance criteria for surface irregularities

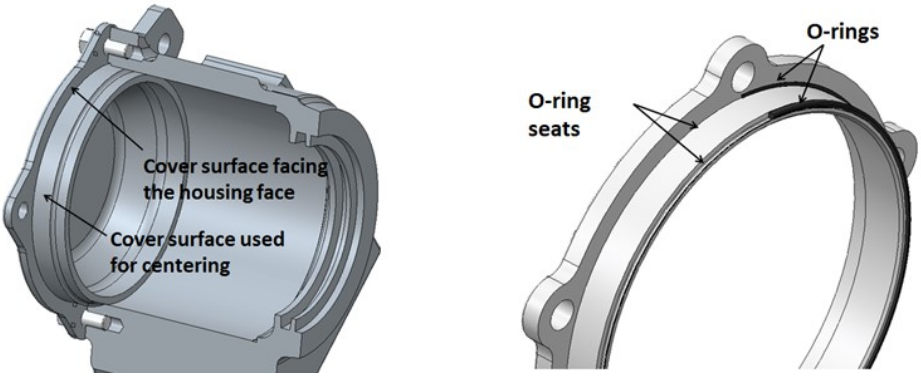
2) After the bore of the housing the following areas must be controlled:

- the area connecting the boogie frame
- One or more areas of support for primary suspension
- One or more areas connecting dampers
- Connection with covers

All these areas must be checked visually on 100% of the axlebox. A well-lit room is necessary for this visual inspection. All checked areas must be free from cracks, breaks, deformations, dents and other defects.

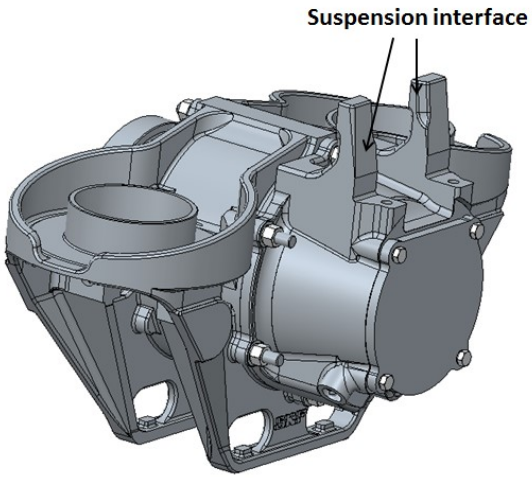
Whenever a doubt persists that a possible crack is found, it is necessary to use the most appropriate NDT technique (see related paragraph). Only some of the axlebox, the number is agreed between customer and supplier, must be checked with technical NDT anyway.

3) Control of the covers (front cover, back cover).
Remove any rust or fretting corrosion from all the cover surfaces facing the housing face and housing centring by using sand paper grit 180-200. Smooth any burrs which may appear. Make sure that the covers do not show cracks, breaks, deformations, dents and various damages. Check that the seat for the O-ring seat is not damaged. If the covers are made of aluminium material, use cloths for cleaning and not sand paper as it could remove the anodizing treatment.



Control of the covers

If the cover has a zone of connection with suspensions, shock absorbers or “lifting truck” (see picture below), check that these areas do not show cracks, breaks, deformations, dents and various damages.



Control of suspension interface of the cover

Whenever a doubt persists that a possible crack is found, it is necessary to use the most appropriate NDT technique (see related paragraph). If necessary, replace it.
Make sure the threads for the screws for the front cover and that screw studs for the connection of the back cover are not damaged. Check mounting centring diameters and external devices seating, measure diameters at least on 2 angular positions: circularity and ovality, normally have not to exceed 0,1 mm.

4) Control of end cap.
Verify that the end cap does not present cracks, breaks, deformations, dents and various damages. Whenever a doubt persists, it is necessary to use the most appropriate NDT technique (see related paragraph). Examine with care the appearance of the surfaces in contact with the axle and the bearing. Remove any heavy marks of contact corrosion with smooth glass paper and smooth any burrs which may appear. Make sure that the threads of any middle hole are not damaged.
Make sure the threaded holes for connecting the current return plate are not damaged. In this case, replace the component.
Verify that the force application surface of the screws is not permanently deformed or cracked.

5) Verify screws, washers, locking plates and other components, the spring washers (of the screws).

The locking plates and the O-rings must always be replaced by new ones.

Control the threaded surfaces of the nuts and the screws carefully before reusing; if they show damages or dents, scrap them. The nuts and the screws surfaces have not to be oiled. Strictly respect tightening torques of the screws recommended on the assembly drawing. Close them in a progressively, crossed way.

6) Control the contact plates for Earth return. Examine the contact surface with care, check that the wear is not too deep and extended. The brush furrows must not exceed 0.2 mm.

Dimensional Control of the housing bore

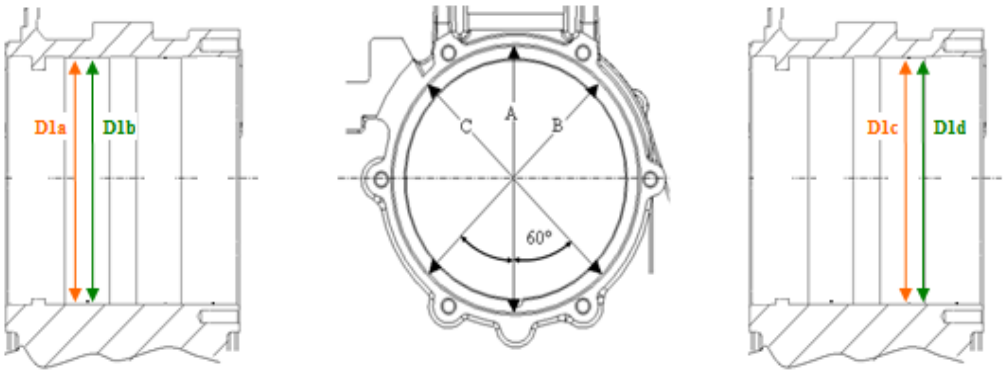
After completing all the visual controls, the axlebox considered serviceable and those ones that have been repaired are ready for dimensional control. The dimensional control is critical to ensure that the axlebox, even if already used, will enable the performance of the TBU like if it was new.
The following parameters must be verified:

- Geometric tolerance of the housing bore
- Ovality of the housing bore
- Cylindricity for each housing bearing seat
- Concentricity of the housing bearing seats

The Customer can choose the tools considered most suitable for a correct measuring of the abovementioned parameters.

The procedure for dimensional control is the following:

1) Measure the average housing bore diameter. Measure it in two points along each bearing housing seat, both for the inboard side (D_{1a},D_{1b}) and for the outboard side (D_{1c},D_{1d}). These two points should be chosen close to the extremities of the bearing seat. Each average diameter is an average between the values of diameter measured in three different positions A,B and C, at 60° from each other.



Measurement of average housing bore diameter

Example:
D_{1A} is the average of the diameters calculated in three positions at 60° from each other, A, B and C. Let us suppose that the values measured in these three positions are D_{1a_A}, D_{1a_B}, D_{1a_C}. D_{1a} is calculated as:

$$D_{1a} = \frac{D_{1a\_A} + D_{1a\_B} + D_{1a\_C}}{3}$$

The same for the other average diameters:

$$D_{1b} = \frac{D_{1b\_A} + D_{1b\_B} + D_{1b\_C}}{3} \qquad D_{1c} = \frac{D_{1c\_A} + D_{1c\_B} + D_{1c\_C}}{3}$$

$$D_{1d} = \frac{D_{1d\_A} + D_{1d\_B} + D_{1d\_C}}{3}$$

2) Measure the ovality of each housing bearing seat.
First of all, calculate the ovality for each diameter D1a, D1b, D1c, D1d, as the difference between their maximum and minimum value.

Then, for each of the two bearing seats, the biggest value is taken; The acceptable tolerances will be provided in later in this manual.

Example:
Calculation of the maximum ovality of the housing bearing seat on the inboard side. The first step is to calculate the ovality of the two average diameters D_{1a} and D_{1b}.

$$OVALITY\_D_{1a} = MAX(D_{1a\_A}; D_{1a\_B}; D_{1a\_C}) - MIN(D_{1a\_A}; D_{1a\_B}; D_{1a\_C})$$

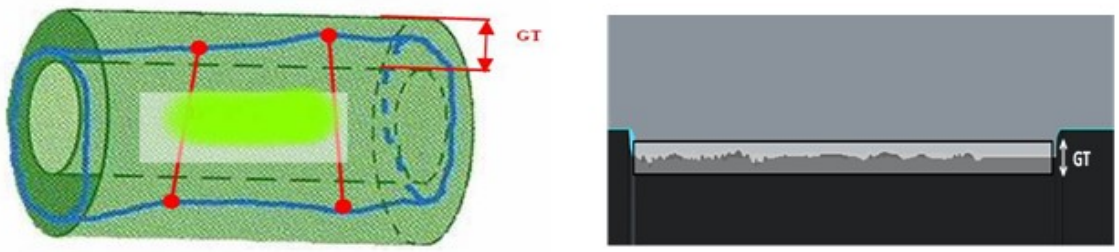
$$OVALITY\_D_{1b} = MAX(D_{1b\_A}; D_{1b\_B}; D_{1b\_C}) - MIN(D_{1b\_A}; D_{1b\_B}; D_{1b\_C})$$

The ovality on the housing bearing seat (inboard side) is the maximum between the two values of ovality calculated before:

$$OVALITY_{bearing\ seat} = MAX(OVALITY\_D_{1a}; OVALITY\_D_{1b})$$

The same procedure is used to calculate the ovality of the housing bearing seat outboard side.

3) Check the cilindricity
For each housing bearing seat, it is possible to define two cylinders coaxial with two different diameters:

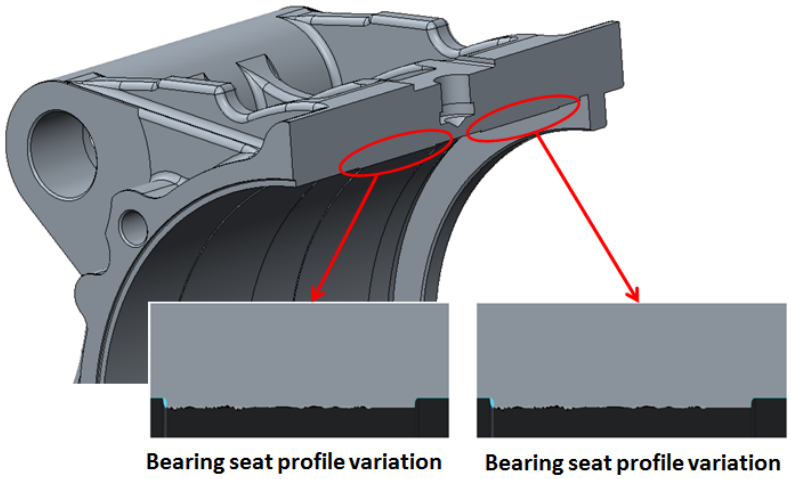


Cilindricity error

The real profile of the housing bore (blue line in figure above left) is contained within these two coaxial cylinders. The difference of the radii of the two coaxial cylinders is the error of cilindricity admitted.

Cilindricity must be evaluated at 12 o'clock, i.e. in the axlebox most loaded zone:

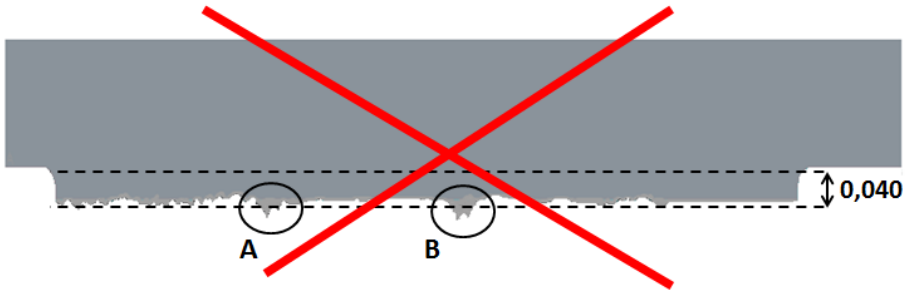
Measure the variation of the profile along all of each bearing seat.



Profile variation along the bearing seat

The variation of the profile, **measured along all the housing bearing seat**, must be inside the acceptable tolerance GT.

Example:
With the assumption that the maximum error of cilindricity admitted is 0,040 mm, if the variation of the profile along all the bearing housing exceeds 0,040 mm (areas A and B), the result cannot be accepted.

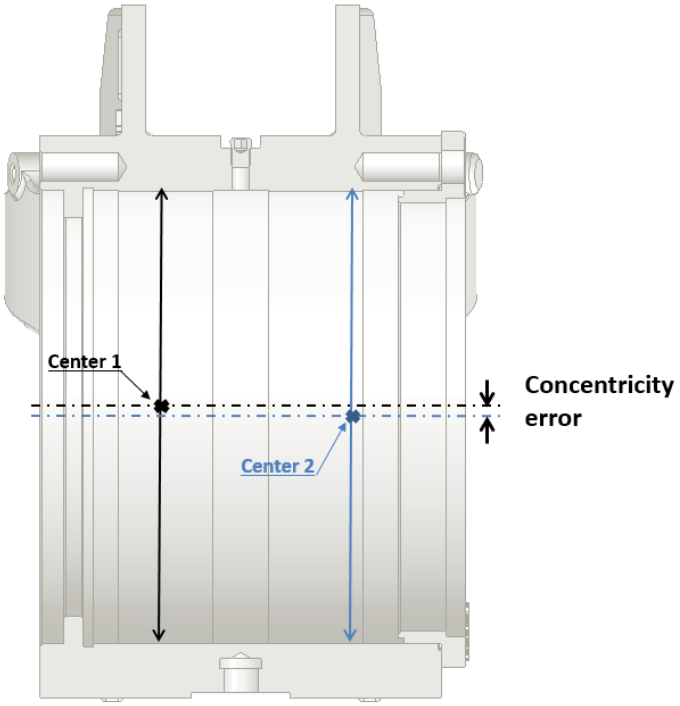


Example of a profile exceeding the limits of cilindricity

If the variation of the profile along all the bearing housing does not exceed 0,040 mm (areas A and B), the result is accepted.

Example of a profile in the limits of cilindricity

4) Concentricity of the housing bearing seats.
Measure the position of the center of each bearing seat using a proper device:



Concentricity measurement

The concentricity error is the distance between the two centres, as figure above shows.

5) Verify that the measured values are in the range of admissible values for housing bore shape errors. **The extra tolerance admissible for the bore of the housing must be within two IT classes (for example, if the new housing is IT7 up to IT9 is allowed for a used housing)**. However, this tolerance must be viewed together with the ovality error, which is mentioned below.
Table below shows the ISO tolerance classes according to the housing diameters:

Basic size [mm]		**Standard tolerance classes**						
		IT4	IT5	IT6	IT7	IT8	IT9	IT10
Above	**Up to and including**	**Tolerances [µm]**						
50	80	8	13	19	30	46	74	120
80	120	10	15	22	35	54	87	140
120	180	12	18	25	40	63	100	160
180	250	14	20	29	46	72	115	185
250	315	16	23	32	52	81	130	210

ISO tolerance class values

Here below the maximum allowed values for shape errors:

Geometric tolerance	Admissible value (mm)
Ovality	0.050
Cylindricity	0.040
Concentricity	0.040

Tolerance values for shape errors

Example:
Consider a new axlebox with IT7 tolerance, for example 230 H7. This means a minimum diameter of 230,00 mm and a maximum diameter of 230,046 mm.

For the used axlebox we can accept an increase of the tolerance field of two IT classes. In this case it means we can consider an increase of tolerance class up to IT9. Therefore, we can accept a used axlebox with diameter 230 H9, meaning a minimum diameter of 230,00 mm and a maximum diameter of 230,115 mm.

Control of the Housing integrity

Non-destructive testing (NDT) is a wide group of analysis techniques used in industry to evaluate the properties of a material, component or system without causing damage. The NDT controls allow putting in evidence with good reliability the presence of cracks and fissures. Two examples of NDT used in the railway industry are:

- *Dye Penetrant Inspection (DPI)*, also called *Liquid Penetrant Inspection (LPI)* or *Penetrant Testing (PT)*, used to detect casting, forging and welding surface defects such as hairline cracks, surface porosities and leaks in new products, and fatigue cracks on in-service components.

- *Magnetic Particle Inspection (MPI)*, used to detect surface and slightly subsurface discontinuities in ferromagnetic materials

The user must refer to dedicated guidelines to apply in the best way the proper DPI technique.

The NDT are very useful to detect defects in the surface and/or sub-surface of axlebox, in particular in the most stressed areas, such as:

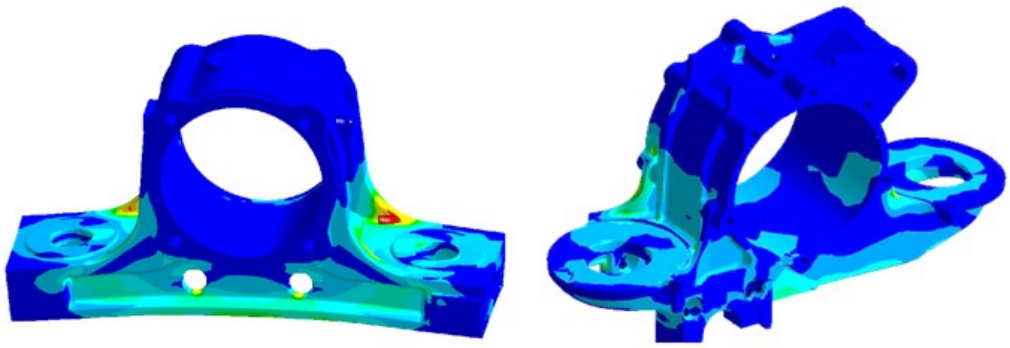
- Areas highlighted by the FEM (Finite Element Method) analysis with critical stress concentration
- The areas connecting the housing body to the bogie frame
- One or more areas of support for primary suspension
- One or more areas connecting dampers
- Areas of interface with rod link

The housing is whole a safety item therefore in case of detection of any type of defect related to material integrity, it must be checked with NDT techniques also if the defect is not included in the critical area.

Areas of particular stress are usually indicated by the axlebox manufacturers. In case of doubts regarding their location, please contact the axlebox supplier.

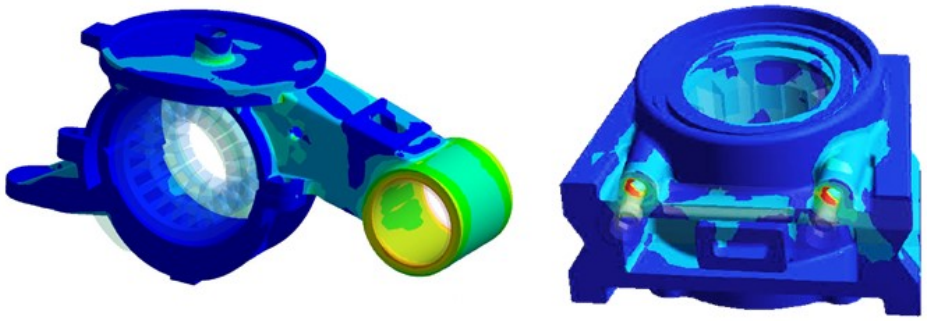
The following figures show some examples of critical areas highlighted by FEM analysis, for different types of Axlebox.

Example of critical areas (Von Mises stress) in a Y25 and a two plates axlebox body



Critical areas highlighted by FEM

Example of critical areas (Von Mises stress) for a link arm and a Chevron axlebox:



Critical areas highlighted by FEM

Contacts

Internet:
www.skf.com
www.skf.com/group/industry-solutions/railways

For any other issue contact your local SKF Sales Unit: