BEARING TECHNOLOGY

AXLE BOX BEARINGS FITTED IN ICF, FIAT AND CASNUB BOGIES

A BRIEF HISTORY

Wheel is considered an important invention

Bearings have helped exploit this invention

Bearings “Bear” load

Permits Relative Motion between Components

Load can be radial and axial

Rolling Contact Bearings

- Load Transfer through
  - Elements in rolling contact
- Starting Friction about twice of Rolling Friction
- Starting Friction is negligible as compared with that of Plain Bearing
- Frictional Characteristics affected by
  - Load
  - Speed
  - Viscosity of Lubricants

- Rolling Resistance
  - Application of Load – Contact Area
  - Caused by Non-Elastic Effect
    - Hysteresis Plastic Deformation
    - Slippage
  - Rubber Tire on Paved Road
    - More Rolling Resistance than
      - Steel Wheel on Steel Rail

DESIGN CRITERIA

Rolling Contact Bearings

- Space Available
- Load with Characteristics
- Life
- Specific Operating Condition
- Friction
- Heat
- Machining Tolerance
- Cost
- Material Property
- Lubrication

DESIGN CRITERIA

Rolling Contact Bearings

Life is defined as

No. of Revolution

or

No. of Hours of use at

Standard Angular Velocity

until first Tangible Evidence of Fatigue

Tangible Fatigue Creteria

Spalling or Pitting - 6.5 mm^2

DESIGN CRITERIA

Rolling Contact Bearings

Rated Life a term by AFBMA

L_{10} Life

No. of Revolutions that

90% will achieve before

Failure Criteria develop

Average Life or Median Life about

4-5 times of L_{10} Life

DESIGN CRITERIA

Rolling Contact Bearings

L_{10} Life = $(C/P)^{10/3}$ Million revolution

C = Basic Dynamic Load Rating
P = Equivalent Dynamic Load Rating

$(\text{Load})^{3/10} \times \text{Life} = \text{Constant}$

$\Sigma\ (\text{Load})^{3/10} \times \text{Life} = \text{Constant}$

DESIGN CRITERIA

Rolling Contact Bearings

Trade off between Life and Reliability

$L_5 = L_{10} \times 0.62$

$L_4 = L_{10} \times 0.53$

$L_3 = L_{10} \times 0.44$

$L_2 = L_{10} \times 0.33$

$L_1 = L_{10} \times 0.21$

ROLLING CONTACT BEARING

Rolling Contact Bearings used in C&W

- Spherical Roller Bearing
  - Fit for Heavy Radial Load
  - Outer Raceway a portion of Sphere
  - Internally Self Aligning
  - Permit Angular Displacement of Shaft
  - Because of Non-Zero Contact Angle
    - Can takes Axial Load – Double Row
  - Two Rows inclined to Axis of Bearing

ROLLING CONTACT BEARING

More Conformity of Rollers with Raceways

Suitable for Heavy Radial Load

True Rolling Motion cannot be achieved

Higher Friction as certain amount of

Sliding Friction present between

Rolling Element and Races

Not Suitable for High Speed

ICF Coach

ROLLING CONTACT BEARING

Rolling Contact Bearings used in C&W

- Cartridge Taper Roller Bearing
  - Fit for Heavy Radial and Axial Load
  - Rolling of Cone over another
  - Different Angle of Inner and Outer Raceways
  - Inner Raceway Outer Raceway and Rollers
    - Converge at Common Apex Point
    - In Axis of Rotation
  - Sliding Motion between Collar and Roller

ROLLING CONTACT BEARING

Rolling Contact Bearings used in C&W

- Cartridge Taper Roller Bearing (Contd…)
  - Inclination of Taper affects
    - Axial Load Carrying Capacity
  - Long Roller Raceway results in
    - High Load Carrying Capacity
  - Used in Pair to achieve desired End Play
  - FIAT Bogie
  - CASNUB Bogie

ROLLING CONTACT BEARING

Rolling Contact Bearings used in C&W

- Bearing Material
  - Max Stress – 4000 MPa
  - Rockwell Hardness – 58-65
    - To withstand High Contact Pressure
- Thorough Hardened
  - High Carbon
- Case Hardened
  - Low Carbon
  - Surface Hard and Core Soft
  - Fit for Shock Resistance

ROLLING CONTACT BEARING

Rolling Contact Bearings Performance

- Combined Radial and Thrust Load
- Pre-loading or Minimum Load
- Operating Temperature
  - Case Hardened Material lose its Hardness
- Misalignment
  - For CTRB
- Max Speed of Bearing governed by
  - Heat Generation
  - Centrifugal Force

TYPES OF BEARINGS USED IN C&W

Coach Type	Bearing Type	Nomenclature	Axle journal Dia	Mounting Procedure
ICF	Spherical Roller Bearings	22326/C3	130 mm	Induction Heating
LHB (FIAT)	Cartridge Taper Bearing Unit (CTBU)	UIC-130	130 mm	Hydraulic Pressure
Wagons (CASNUB)	Cartridge Taper Roller Bearings (CTRB)	Class-E CTRB	144.539 mm 144.564 mm	Hydraulic Pressure

TYPES OF BEARINGS USED IN C&W

Coach Type	Bearing Type	L_{10} Life	Interference
ICF	Spherical Roller Bearings	22.5 Lakh KM	
LHB (FIAT)	Cartridge Taper Bearing Unit (CTBU)	30 Lakh KM	
Wagons (CASNUB)	Cartridge Taper Roller Bearings (CTRB)	12 Lakh KM	

PERFORMANCE OF BEARINGS USED IN C&W

Coach Type	Hot Axle 2017-18	Hot Axle 2018-19
ICF		
LHB (FIAT)		
Wagons (CASNUB)	453	572

BEARINGS USED IN C&W

Prevention is better than Cure

General Precautions

- In Handling/Transportation to avoid Impact
- No Interchange of Parts
- No Unpacking till Mounting is Ready
- Recommended tools only
- No Mixing of Grease of Two Brands
- Clean Dry Place for Storage
- Storage Area protected from
  - Heat Dust Moisture Sunlight Vibration

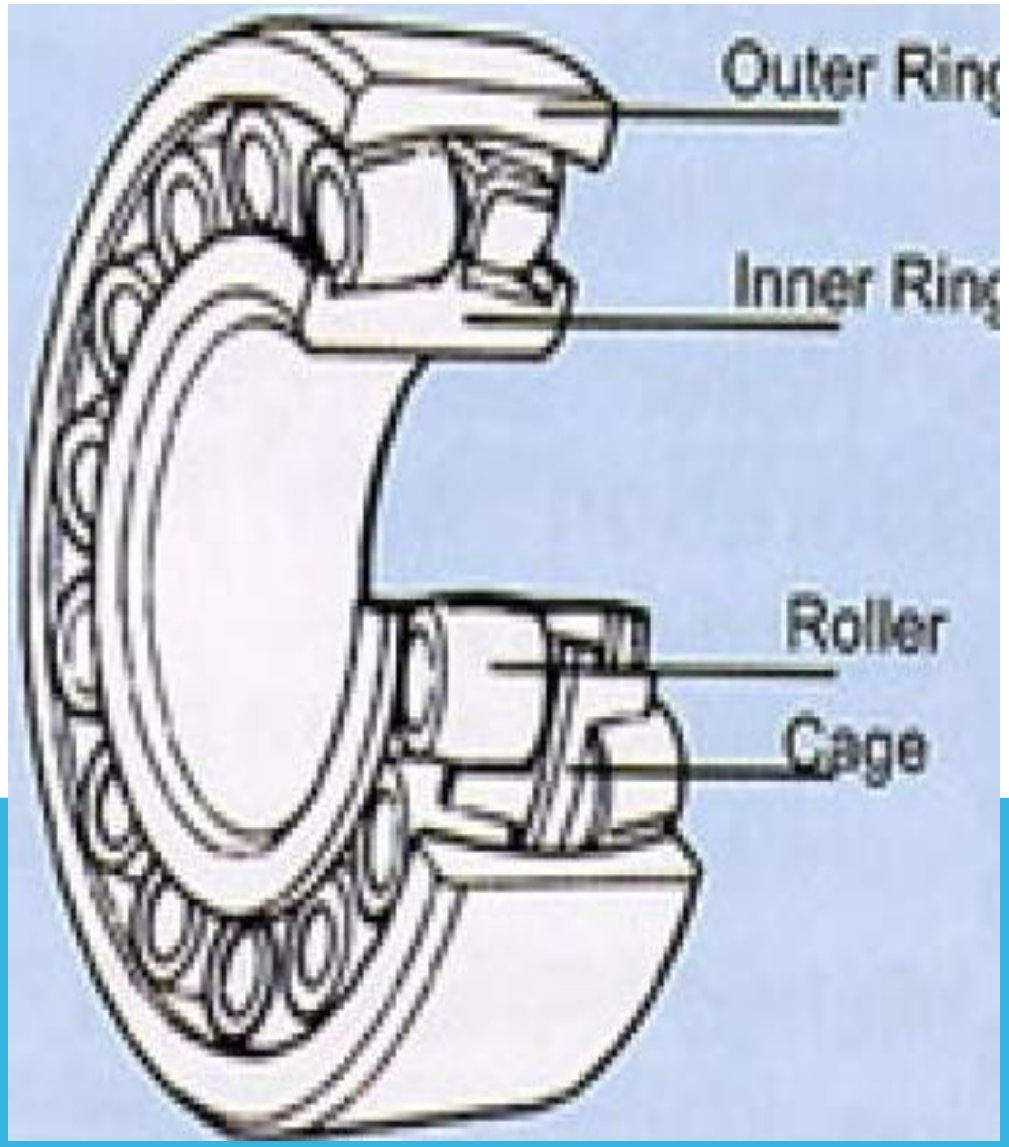
BEARINGS USED IN C&W

General Precautions (Contd…)

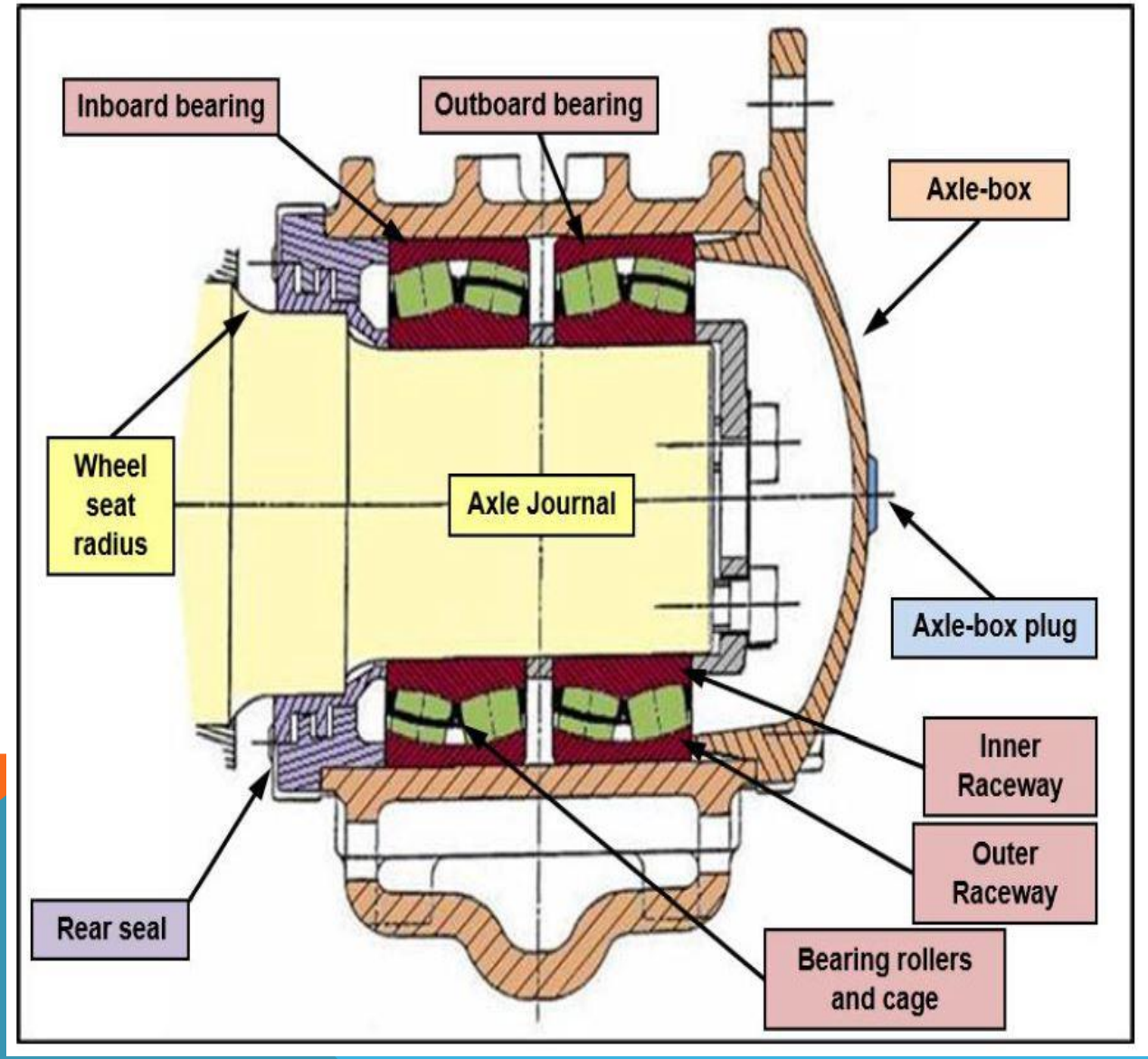
- No Storage of Corrosive Chemicals in same area
- First In First Out
- Use of Forklift/Crane for Lifting the Packing
- Proper Slings
- Wheel-sets fitted with Bearings
  - Lifting of One Wheel-set at a time
  - In Lorry/Wagon – Use of Wedge
  - Storage in Dry Covered Area
  - Rotation of Axle Box periodically
    - If stabled for long time

ICF SPHERICAL ROLLER BEARING

- Spherical outer race
- Cylindrical Inner Race
- Double Row Spherical Rollers
- Bronze Cage



ICF SPHERICAL ROLLER BEARING



AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing
Cylindrical Inner Race - Steel, Forged and Machined
Spherical Rollers – Steel, Forged and Machined
Cage – Steel/Brass, Cast and Machines
Spherical Outer Race – Steel, Forged and Machined
Labyrinth Ring (Collar)
Rear Cover
Ring
Retaining Ring, locking plate and end locking screws
Front Cover

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Standard Periodicity of Attention

IOH – 09 months

POH – 18 Months

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in IOH

- Clean
  - Cleaning of Cover
- Inspection
  - Notice Grease Oozing
  - Examination of Grease after removal of Cover
    - If Grease burnt/discolored
      - Remove Bearing for Overhauling

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in IOH (Contd…)

- Inspection
  - Examination of Grease after removal of Cover
    - If Grease is OK
      - Remove Old Grease
      - Cleaning with Kerosene Spray
      - Radial Clearance Check
      - Re-Lubrication by Grease 1.75 kg

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in POH

- Cleaning of Axle Box
- Removal of Axle Box
  - Mechanical screw Puller
  - Precaution to use Pads
    - To prevent rest of Screw on Axle Centre
- Removal of End Locking Plate

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in POH (Contd…)

- Removal of Bearing by
  - Special Hydraulic Dismounting Extractor
    - Injection of Oil between Journal and Race
- Through Cleaning of Bearing
- Inspection of Roller Ring Cage by
  - Swiveling Outer Race
- Inspection of roller track by Removing few Rollers

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in POH (Contd…)

- Items of Bearing checked in Inspection
  - Pitting on Roller Track and Roller
  - Worn out Cage
  - Cracked Inner Race
  - Damaged Outer Surface of Outer Race
  - Rust Corrosion
  - Excessive or Less Clearance
  - 100% Zyglo Testing for Cracks

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in POH (Contd...)

- Items checked other than Bearing
  - Axle end holes ☐
    - by Go-No Go Thread Plug
  - End locking plates ☐
    - To be replaced
  - End locking bolts ☐
    - by Go-No Go Thread Ring
  - Retaining Ring ☐
    - Flat and free from Defects

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in POH (Contd…)

- Items checked other than Bearing
  - Labyrinth Ring
    - Not to be dismounted unless defective
    - If dismounted the to be replaced
  - Felt ring ☐
    - To be renewed
    - Soaking in Oil 50°C for 30 min
  - Rear and Front Cover ☐
    - Check for Cracks and Height

AXLE BOX BEARING USED IN ICF BOGIE

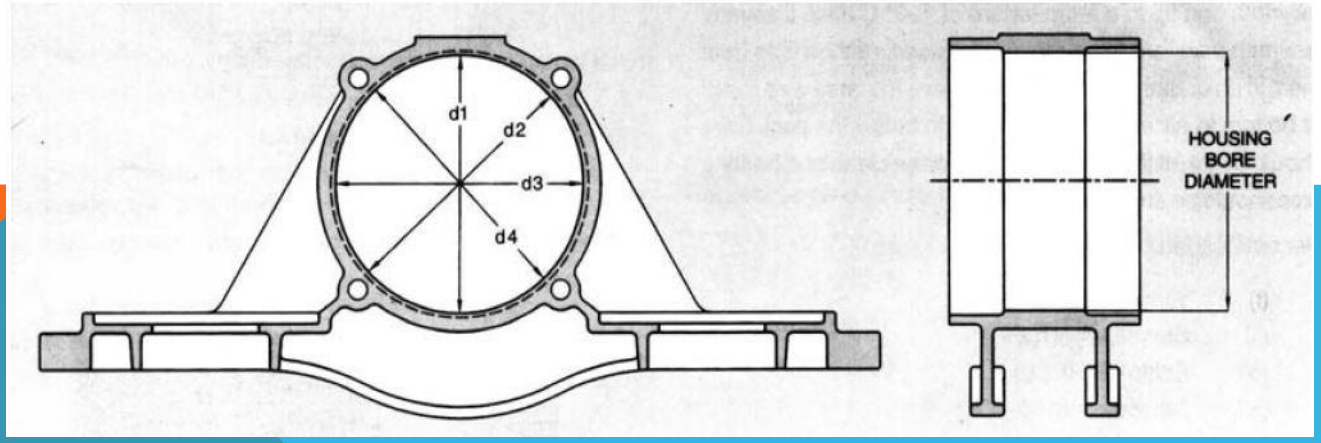
Spherical Roller Bearing

Steps of Attention in POH (Contd…)

Items checked other than Bearing

Axle box housing

Damage Distortion at Spring Seat Bore



$$d = 280^{+0.052}_{+0.030}\ mm$$

AXLE BOX BEARING USED IN ICF BOGIE

Spherical Roller Bearing

Steps of Attention in POH (Contd…)

- Mounting
  - Axle Preparation
    - Cleaning
    - Polishing by Fine Emery 180 grate min
    - Surface waviness
    - Journal Dia
    - Check of Shoulder Dia
      - if Labyrinth Ring to be fit

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd…)

Mounting

Axle Preparation

Waviness (Contd…)

Check with precession straight edge applying blue paste 90^{o} apart

Check dia at unblued area with snap gauge

Check dia at three different locations in bearing seating area

At each location turn snap gauge by 180^{o}

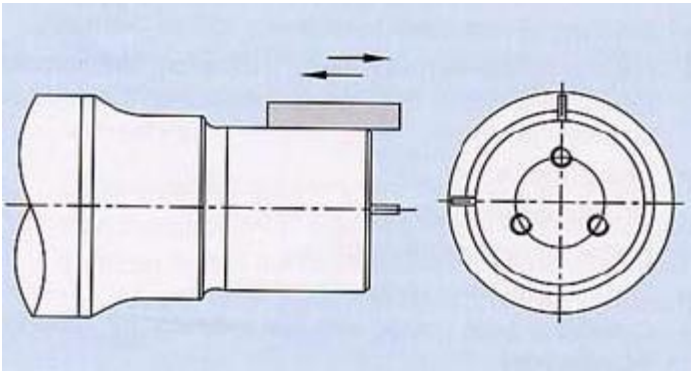
Journal dia is average of max and min

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd…)

Axle Preparation (Contd…)

Waviness



Dia Measurement

Journsl Diameter ØA(Max/Min)	Maximum permissible out of roundness (mm)	Maximum permissible taper (mm)
130.068 /130.043	0.015	0.015

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd...)

Mounting

Measurement of Radial Clearance

Clearance between roller and outer race increases as bearing components wear out

Will be more when free than when mounted

Condition	New	In-Service
Free	0.145 to 0.190 mm	0.270/0.295 mm FAG/NBC
Mounted	0.080-0.160 mm	0.220/0.245 mm FAG/NBC

CHECK RADIAL CLEARANCE

Check between outer race and free (unloaded) rollers

Feeler gauge to be inserted to reach rear row of rollers

Rollers should not roll over the feeler gauge blades

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd...)

- Mounting
  - Labyrinth Ring
    - Heating upto 100°C
    - Place on Shoulder Seat of Axle
    - Pushing by Pusher Jig
    - Light Tapping to ensure proper seating
    - Coating of Grease
  - Rear Cover
  - Renewal of Felt Seal
  - Renewal of O-Ring
  - Ring

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd...)

Mounting

Spherical Roller Bearing

Heating upto 120°C

Overheating avoided

Stamp Face on Outside

Bearing Bore aligned with axle

Light Tapping to ensure proper seating

Pressing of Bearing for Few Minutes

Towards Rear Cover

Check of Clearance after mounting

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd…)

- Mounting
  - Retaining Ring
  - Renewal of Locking Plate
  - Capscrew by Torque Wrench
    - M16 – 12 KgM M20 – 16 KgM
  - Lubrication
    - Grease 1.75 kg per bearing
  - Axle Box
    - Filling of V Groove by Grease
  - Front Cover

Brand Name Of Grease
Servogem RR3
LL3 (Balmerol multigrease)
Bharat RR Grease-3

AXLE BOX BEARING USED IN ICF BOGIE

Steps of Attention in POH (Contd…)

Precaution while Grease Storage

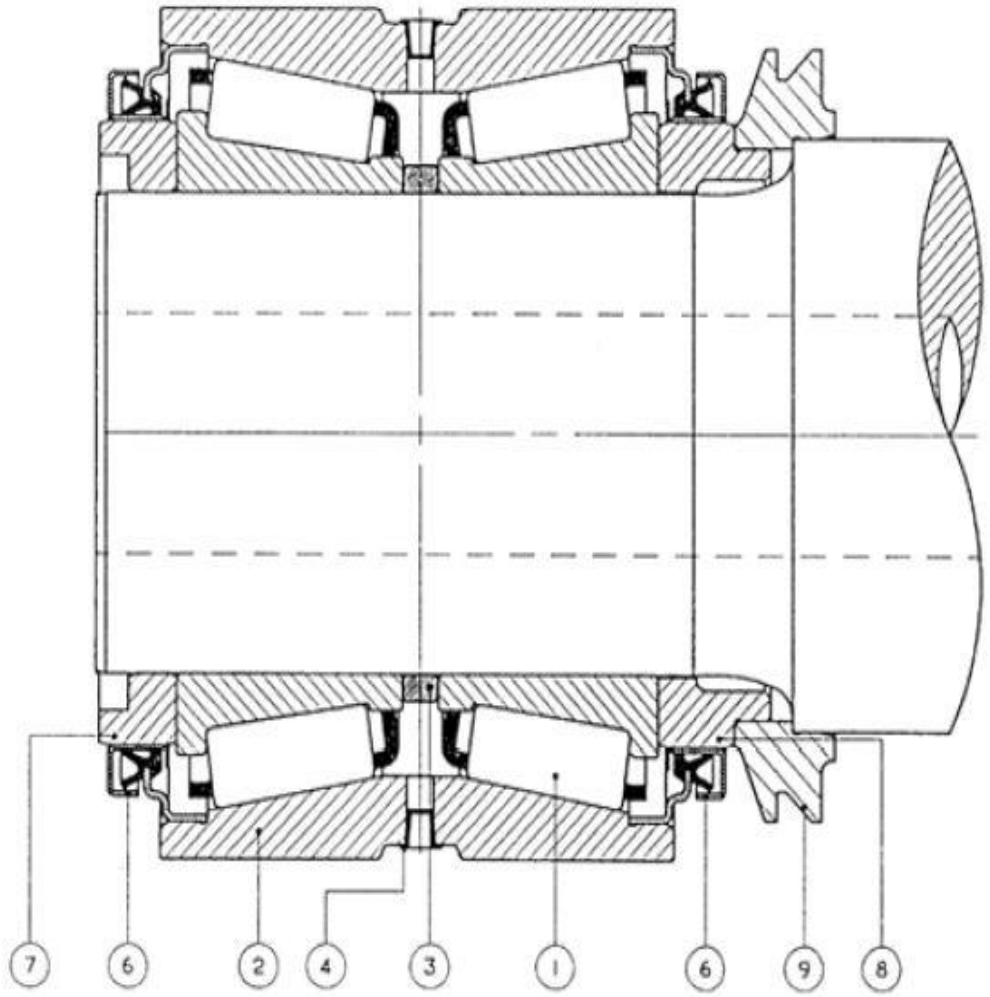
- Drum should always be covered
- Stored in Vertical Position
- Do not mix different brands

AXLE BOX BEARING USED IN ICF BOGIE

Practice in Open Line

- Visual Check for
  - Grease Oozing
  - Any Damage
- Temperature
  - Limit of Temperature of Top Crown 80°C
  - RDSO Letter No. MC/AB Dated 21/24.08.2009
- Abnormal Sound
- Accident Involved Bearing to be marked
  - as Accident involved and
  - not to be used

CONSTRUCTION OF TAPER ROLLER BEARING – FIAT BOGIE



CONSTRUCTION OF TAPER ROLLER BEARING – FIAT BOGIE

- Cone Assembly
- Double Cap
- Cone Spacer
- HDL™ SEAL
- Backing Spacer
- Sealing Ring
- Backing Ring

CBTU IMPORTANT PARAMETERS

Parameter	Value
End Play	0.025 to 0.330 mm (NEW) 0.025 to 0.500 mm (In Service, old)
Max Pressure for Hyd. Extraction	12 to 15 tonnes
Cap Screw Torque Value	18-22 kg-m
Journal Dia	130.043 to 130.068 max 0.02mm taper
Inner Dia of TBU	130.000 to 130.025
Shoulder Dia	160.174 to 160.134 mm measured in two planes in three points (max difference between two points 0.012 mm)
Mounting Pressure	28 to 32 Tonnes

AXLE BOX BEARING USED IN FIAT BOGIE

Practice in Open Line

- Visual Check for
  - Grease Oozing – Slight Oozing allowed
  - Any Damage
- Temperature
  - Limit of Temperature of 80°C
  - Difference of Temp more than 20°C
  - RDSO Letter No. MC/RB/General Dt 06.01.2010
  - Minutes of meeting held 13.04.2011 at RDSO
- Abnormal Sound
- Accident Involved Bearing to be marked
  - as Accident involved and

AXLE BOX BEARING USED IN FIAT BOGIE

Practice in Workshop received for Turning/IOH

- Visual Check for
  - Grease Leaking
  - Roughness in revolving
  - Overheating
  - Any Damage
- Loose or Missing Axle End Bolts
  - If one bolt missing
    - Remove all the bolt
    - Renew Locking Plate
    - Tightening of All Axle End Bolt

AXLE BOX BEARING USED IN FIAT BOGIE

Practice in Workshop received for Turning/IOH

Loose or Missing Axle End Bolts (Contd...)

If more than one bolt missing

Removal of Wheel from Truck

Removal of End Cap

Any evidence of

Bearing not seated

End Play > 0.75 mm

To be dismounted

Check of End Play

AXLE BOX BEARING USED IN FIAT BOGIE

CTBU – Cartridge Taper Bearing Unit

Steps of Attention in POH

- Removal of Tabs of Locking Plate
- Removal of End Capscrew Locking Plate and End Cover
- Removal of CTBU
  - Insertion of Pilot Sleeve
  - By Hydraulic Puller as prescribed by OEM
  - Precaution to be taken
    - CTBU should not fall on Ground

AXLE BOX BEARING USED IN FIAT BOGIE

CTBU

Steps of Attention in POH (Contd…)

- Through Cleaning of Bearing
- To send CTBU to OEM
  - For Refurbishing/Reconditioning

AXLE BOX BEARING USED IN FIAT BOGIE

CTBU

Steps of Attention in POH (Contd...)

- Items checked other than Bearing
  - Axle end holes ☐
    - Cleaning by Air Blowing
    - by Go-No Go Thread Plug
  - End locking plates ☐
    - To be replaced
  - End locking bolts ☐
    - by Go-No Go Thread Ring

AXLE BOX BEARING USED IN FIAT BOGIE

Spherical Roller Bearing

Steps of Attention in POH (Contd…)

- Mounting
  - Axle Preparation
    - Cleaning
    - Surface waviness
    - Journal Dia
    - Check of Journal Collar Dia

AXLE BOX BEARING USED IN FIAT BOGIE

Steps of Attention in POH (Contd…)

Mounting

Pressing of CTBU

application of Sealant of Gap

Backing Ring and Axle

To prevent Water Ingress

Application of Rust Preventive Coating

On exposed surface of Axle

Between Hub and Bearing

Application of Thin Coat of

Anti Slip Oil (SAE 30)

AXLE BOX BEARING USED IN FIAT BOGIE

Steps of Attention in POH (Contd…)

- Mounting
  - Pressing of CTBU
    - Check of Inner Dia of CTBU
    - Check of End Play
      - At Bench
    - Pressure by Hydraulic Pusher 28-32T
    - Check of End Play
      - After Mounting

AXLE BOX BEARING USED IN FIAT BOGIE

Steps of Attention in POH (Contd…)

- Mounting
  - End Cap
  - Renewal of Locking Plate
  - End Capscrew by Torque Wrench 18-22 KgM

Precaution during Fitment into Bogie

- CTBU not able to take Misalignment
- Alignment of Control Arm
  - Bore and Bolt fixing of Control Arm affects performance severally

COMPONENTS OF CTRB - CASNUB

Cone Assembly

Cup

Spacer

Wear Ring

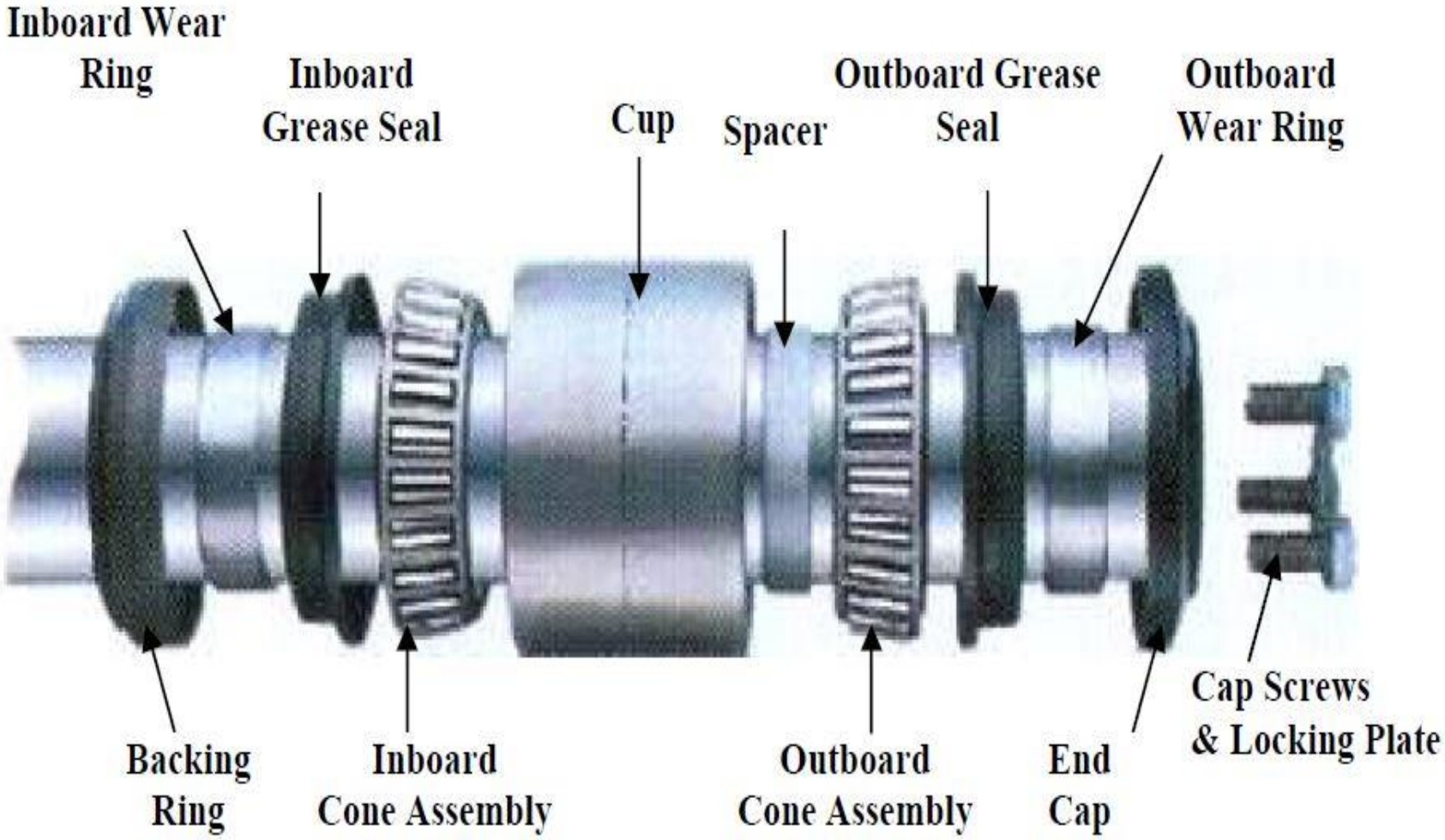
Grease Seal

End Cap

Axle Cap Screws

Backing Ring – Interference Fit

COMPONENTS OF CTRB - CASNUB



AXLE BOX BEARING USED - CASNUB

Practice in Open Line

- Visual Check for
  - Grease Oozing – Slight Oozing allowed
  - Any Damage or Loose Parts
- Temperature
  - Limit of Temperature of 90°C
  - RDSO Letter No. MW.RB.Genl Dt 20/21.11.2012
- Abnormal Sound
- Accident Involved Bearing to be marked
  - as Accident involved and
  - not to be used

AXLE BOX BEARING USED - CASNUB

Practice in Workshop received for ROH

- Visual Check for
  - Grease Leaking
  - Roughness in revolving
  - Overheating
  - Any Damage
- Check of End Play
- Removal of End Cap for Turning
- Fixing of End Cap and tightening of End Capscrew
- Renewal of Locking Plate

AXLE BOX BEARING USED - CASNUB

Cartridge Taper Roller Bearing

Periodicity – Every POH

Steps of Attention in POH

- Removal of Tabs of Locking Plate
- Removal of End Capscrew Locking Plate and End Cover
- Removal of CTBU
- Insertion of Pilot Sleeve
- By Hydraulic Puller as prescribed by OEM

AXLE BOX BEARING USED - CASNUB

CTRB

Steps of Attention in POH (Contd…)

- Through Cleaning of Bearing
- Items to be checked
  - Flaked/Spalling
  - Brinelling
  - Peeling
  - Rust/Corrosion
  - Heat Discoloration
  - Crack on rollers
  - Electric Burn

AXLE BOX BEARING USED - CASNUB

CTRB

Steps of Attention in POH (Contd...)

- Items checked other than Bearing
  - Axle end holes ☐
    - Cleaning by Air Blowing
    - by Go-No Go Thread Plug
  - End locking plates ☐
    - To be replaced
  - End locking bolts ☐
    - by Go-No Go Thread Ring

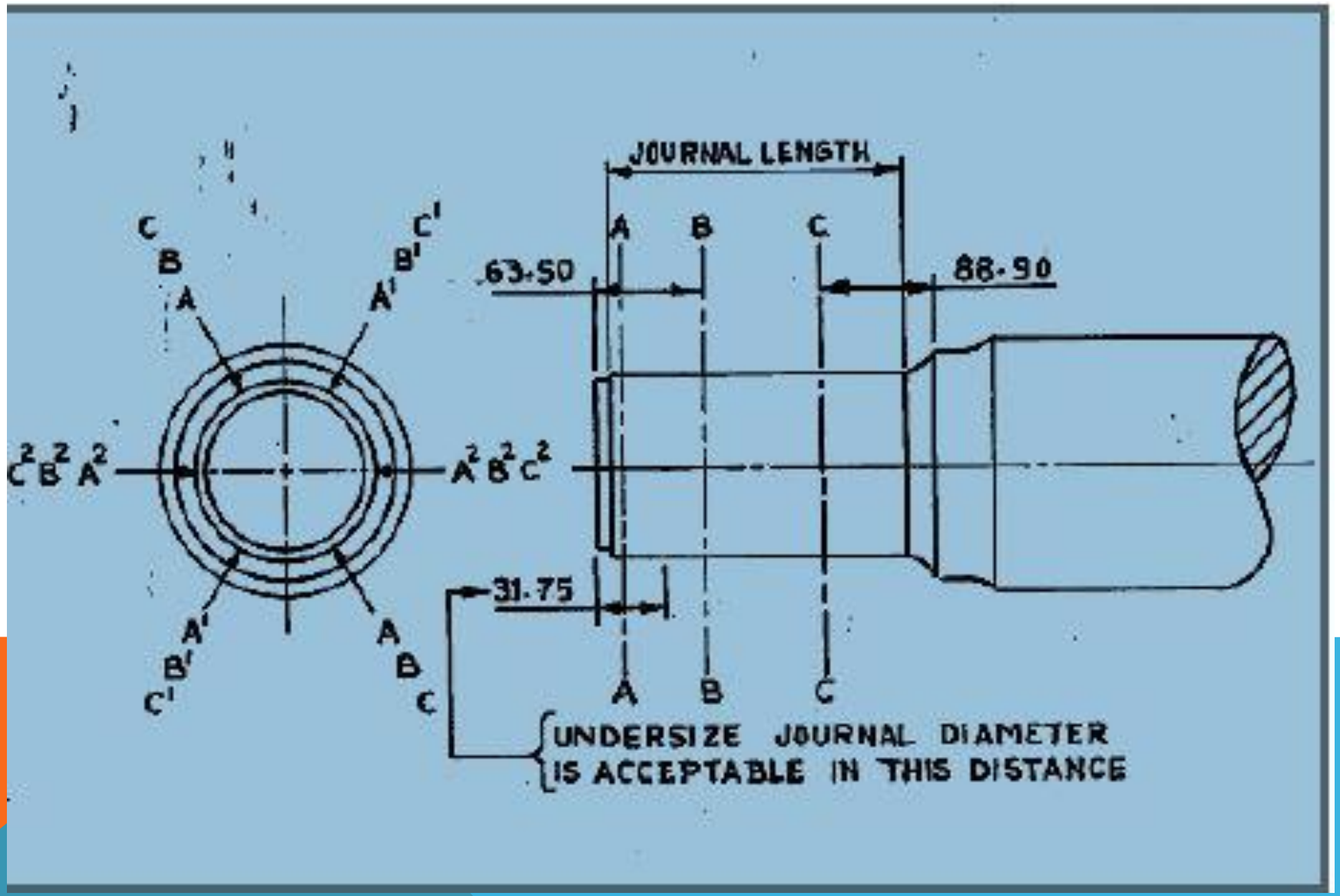
AXLE BOX BEARING USED - CASNUB

Spherical Roller Bearing

Steps of Attention in POH (Contd...)

- Mounting
  - Axle Preparation
    - Cleaning
    - Polish by Emery 80 grit or higher
    - Journal Groove on Axle
      - By Seal Wear Ring or Upset
      - can be polished by Emery
    - Surface waviness
    - Journal Dia
    - Check of Journal Collar Dia

CTRB JOURNAL DIMENSIONS



CTRB JOURNAL VALUES

JOURNAL CLASS (Size)	ACCEPTABLE TOLERANCES FOR JOURNAL DIAMETER		BEARING SEAT LOCATIONS			
	MAXIMUM	MINIMUM	A	B	C	D
E (6"x11")	144.564 mm (5.6915")	144.539 mm (5.6905")	73.0 mm (2.88")	132.2 mm (5.20")	166.7 mm (6.56")	236.5 mm (9.31")

AXLE BOX BEARING USED - CASNUB

Steps of Attention in POH (Contd...)

Mounting

Pressing of CTRB

Application of Rust Preventive Coating

On exposed surface of Axle

Between Hub and Bearing

Application of Thin Coat of

Anti Slip Oil (SAE 40 or 50)

AXLE BOX BEARING USED - CASNUB

Steps of Attention in POH (Contd...)

- Mounting
  - Pressing of CTRB
    - Check of Inner Dia of CTRB
    - Check of End Play
      - At Bench
    - Pressure by Hydraulic Pusher 50T
    - Check of End Play
      - After Mounting (0.03 to 0.38 mm)

AXLE BOX BEARING USED - CASNUB

Steps of Attention in POH (Contd…)

- Mounting
  - End Cap
  - Renewal of Locking Plate
  - End Capscrew by Torque Wrench 40 KgM

Precaution during Fitment into Bogie

- CTRB not able to take Misalignment
- Alignment of Adaptor
  - affects performance severally

CTRB JOURNAL VALUES

JOURNAL CLASS (Size)	ACCEPTABLE TOLERANCES FOR JOURNAL DIAMETER	
	MAXIMUM	MINIMUM
E (6”x11”)	144.564 mm (5.6915”)	144.539 mm (5.6905”)

CTRB MOUNTING PARAMETERS

Final Seating Pressure - 50±5 Tonnes

Cap Screw Torque – 40 kg-m

Lateral Play – 0.03 to 0.38 mm

If a bearing rotates freely by hand but indicates less than 0.03 mm Lateral on Dial indicator, the application is satisfactory for service

Grease – RDSO Spec No. WD-24-MISC-2003

Qty – At each Cone 115 g

Between Roller Assembly 170 g

Total 400 g

MACHINES AND TOOLS

Machines Required

- Axle Box Cleaning Plant
- Automatic Bearing Cleaning Plant
  - 3 Stage Washing
- Induction Heater with Demagnetizer for
  - Heating of Labyrinth Ring and Bearing
- Oil Bath for Heating
- Hydraulic Bearing Extractor for
  - Spherical Roller Bearing
- Hydraulic Bearing Mounting and Dismounting for CTRB

MACHINES AND TOOLS

- Machines Required
  - Hydraulic Bearing Mounting and Dismounting for CTBU
  - Hydraulic
  - Measuring Container
  - Zyglo Testing Machine
  - Engraving Machine

MACHINES AND TOOLS

Tools Required

- Cleaning Oil Vessel
- Snap Gauge
- Feeler Gauge to check Radial Clearance
- Bore Gauge to check Bore
- Torque Wrench for Tightening of Bolts
- Pusher Jig
- Measuring Container
- Thread Ring Gauge
- Thread Plug Gauge