MECHANICAL

PREFACE

Mechanical parts in rolling stock always bear a vital role. Bogie frame, Centre pivot, Side bearer, Brake rigging arrangement, Shock absorber, Wheel, Axle & its guide arrangement, Sole-bar, Cross members, Cattle guard, Trough floor, Schaku coupler, Buffer, Gear case, Primary & secondary suspensions are the vital mechanical components/ parts. Proper maintenance and thorough knowledge of the same is needed to have reliable operation of EMUs/ MEMUs and to improve the riding comfort.

BRIEF DESCRIPTION OF BOGIES

Bogies of Motor coaches (MC), Trailer coaches (TC) are of all welded, light weight construction. The axles, with self-aligning roller bearings mounted inside cast steel axle boxes, are rigidly guided by telescopic dash pot and axle box guide assemblies. Helical springs working in parallel with dash pots are used for primary suspension. Coach body is supported on two side bearers located 1700 mm (EMU TC), 1600 mm (MEMU TC) (Ref. IRCA Part IV, para no. 1.5.2, page 3) & 1200 mm (EMU/MEMU MC) apart on a floating bogie bolster. In HCC bogies side bearer is located 1200 mm apart for both MC & TC. These in turn rest on two pairs of helical springs (air springs in new rakes) supported on a spring plank hung on swing links from bogie frame. In HCC bogies lower spring plank is having fixed type cradle arrangement. The Helical springs at each end of bolster are damped by hydraulic shock absorbers. Side bearers consist of metal slides immersed in oil baths well protected from dust ingress.

No weight is transferred through the bogie pivot, which is located in the center of the bolster. The pivot acts merely as a center of rotation & serves to transmit acceleration & retardation forces.

The floating bolster in TC bogie is secured in the longitudinal direction to bogie frame by means of two anchor links with silent block bushes, located diagonally opposite to each other and transmit draw & braking forces between bogie frame and coach body through the center pivot. The MC bogie bolster is located between bogie transoms & transmits draw and braking forces through rubbing plates fixed at the bolster ends.

Riding comfort

Rigidly guided axles with self aligning spherical roller bearings, having practically no play in longitudinal & lateral direction and helical spring working in parallel with dash pot/ shock absorbers with specified characteristics, all contribute to riding comforts. It is therefore essential to ensure that these features are well maintained in service in order to obtain the desired performance through the life of these bogies.

PRIMARY & SECONDARY SUSPENSION

Primary suspension is interposed between wheel and bogie frame & is primarily responsible for holding the bogie on wheels. Besides, it takes up the vertical oscillation (caused by jumping of wheels, undulation of tracks etc.) through axle guide spring (AGS) & damp the same through hydraulic dash pot arrangement. It consists of:

AGS	– One pair in each wheel
Hydraulic dash pot	– One pair in each wheel
Rubber snubber over axle box	- One pair in each wheel

Secondary suspension is interposed between coach body and bogie and is responsible for holding the body over bogie. Besides it takes up both vertical & horizontal oscillation of the coach through its helical springs/ air springs, hydraulic shock absorbers, equalizing stays & nylon rubbing plate. It consists of:

Swing bolster (bogie bolster)	– One in each bogie
Lower spring plank	– One on either side of the bolster
Bolster hanger	– Four nos. on either side of the bolster (2 outer & 2 inner)
Swing bolsters spring	– One pair on either side of the bolster (each pair consist of 2 outer & 2 inner springs). In case of air suspension bogies, one air spring assembly is provided in either side of the bolster.

Bolster hanger pin – four nos. on either side of the bolster (2 nos. at top & 2 nos. at bottom)
Bolster hanger block - four nos. on either side of the bolster (2 nos. at top & 2 nos. at bottom)
Equalising stay tube – Two pairs in each bolster of MC; Two nos. in each bolster of T/C.
Anchor link – Two nos. in each bolster of TC
Nylon rubbing pad – Four nos. in each bolster (for non-modified MC)
Eight nos. in each bolster (for modified MC)
Shock absorber – One at either side of the bolster.

MOUNTING ARRANGEMENT OF TRACTION MOTOR

EMU traction motor is nose suspended on bogie frame through sandwich block arrangement and the other end is supported over axle through axle cap and suspension bearing arrangement. Transverse movement is limited by the flanges of the axle suspension bearing. The axle suspension bearing high leaded bronze shell type. One half of the bearing is keyed to the axle cap to prevent rotation and to align the oiling window. The oil lubrication is provided by spring loaded wick assembly of the axle lubricator.

The axle caps are not interchangeable on the motor or between motors. Similarly, split axle bearing halves are not interchangeable. Ensure, therefore, that matching axle caps and matching outer half bearing are being mounted.

The pinion which is shrunk on the armature shaft drives the loco axle through a spur gearwheel which is pressed onto the axle. The gear case is of welded steel construction and is in two halves, which are bolted together. The complete gear case is supported on the motor frame and end shield at pinion end. The joints between the gear case halves are baffled and grooved to carry felt sealing rings so as to prevent ingress of dust and any other foreign material and the escape of the gear lubricant. *Do not overfill the gear case which may ingress to the pinion end armature bearing and axle suspension bearing. This may cause premature bearing failures.* To avoid overfilling, drain plug is provided in motor side of the gear case.

Traction motor pinion is coupled with axle mounted bull gear for transmission of torque with a ratio of 20:91. When a new or reconditioned motor is fitted into a bogie, check backlash between the pinion and gear wheel. New gears are manufactured to have a back lash of 0.25 mm, measured at the outer non-relieved end. If the measured back-lash exceeds this limit, check that the gear wheel and pinion are fitted correctly and that the axle cap bolts have been tightened properly.

Recommended lubricant for axle suspension bearing: Servo System 57; Servo System 100 of IOC.
Quantity of lubricant in each cap : 2.4 lts.

Recommended lubricant for gearcase : Blue Coat /Camex Compound - F.
Quantity of Lubricant in Gearcase : 1.7 Kg at min. level
3.4 Kg.at max. level

Torque Spanner Settings: The values specified below are for bolts with lubricated threads:

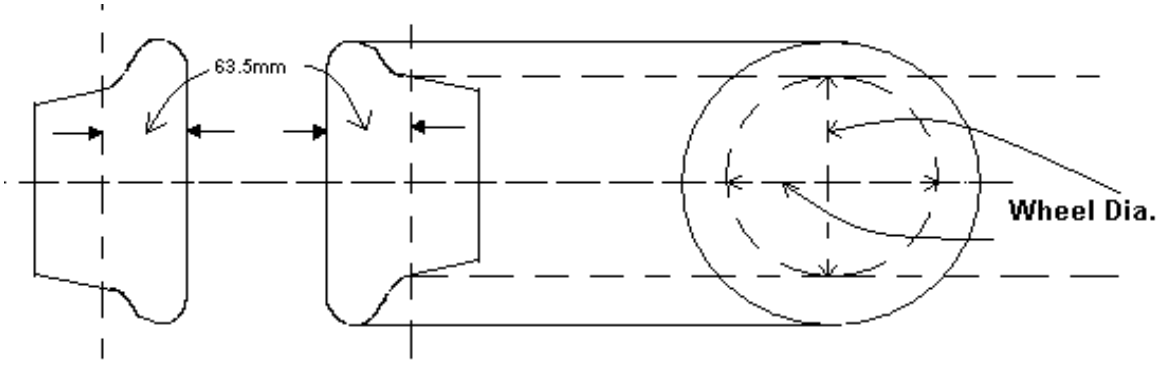
Axle cap bolts, M 24 : 62-64 Kg.m.
Gear case mounting bolts, M 36 : 97-99 Kg.m.
Gear case joints bolts, M 30 : 50-55 Kg.m.

} (Ref. BHEL's Manual MM/AC-M/EMU/003)

EMU WHEELS

EMU/MEMU coaches are provided with composite design of wheels consisting of rolled steel wheel centers with renewable tyres. Presently solid wheels have also been introduced in EMUs & MEMUs. The tyres of trailer coach bogies are fastened to the wheel disc with glut rings whereas the motor coach bogies have, in addition to the glut rings, 4 locking keys to ensure more positive securing. Such arrangement is not required in case of solid wheel.

Measurement of Wheel Diameter on Tread :



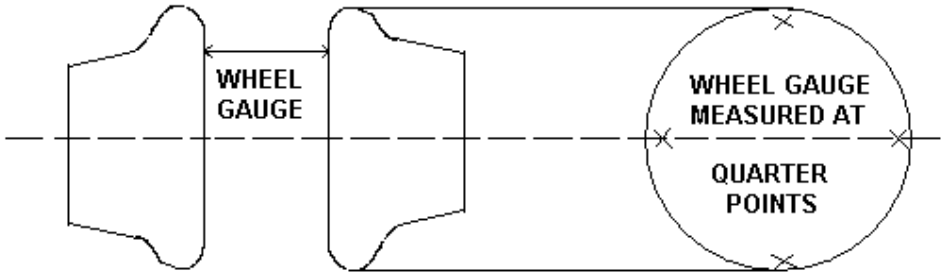
Wheel diameter is measured on the tread at a distance of 63.5mm from the inside face of the wheel. Two measurements 180^0 apart should be taken for each wheel.

Wheel diameter - New: $952^{\pm 3}_{0}$ mm. (ref. RDSO Sketch no. K-4004);
Condemn: 877 mm (M/C), 857 mm (T/C), 865(HCC)

Permissible variation in wheel trade diameter at the time of tyre turning and wheel replacement are as follows:

a) Wheels of the same axle - 0.5 mm.
b) Wheels of the same bogie – 5.0 mm.
c) Wheels between two bogies under the same axle – 13.0 mm.

Wheel gauge:



Wheel gauge is the distance between inside faces of the flange on the right & left side wheels of an axle as shown in adjoining figure. There should be no variation in the values of wheel gauge measured at four points 90^0 apart on a wheel set. However the actual value of the wheel gauge can vary as per following tolerances (Ref.: IRCA Part III Para 2.8.7 & RDSO CMI-K-001).

Standard: 1600mm; Maximum 1602mm; Minimum 1599mm. i.e. 1600^{+2}_{-1} mm.

If the wheel gauge is more than permissible limit, there exists a possibility of a relatively newer wheel hitting the nose of crossing. This happens because the wheel gauge is one of the parameters affecting the clearance at check-rail opposite the nose of crossing.

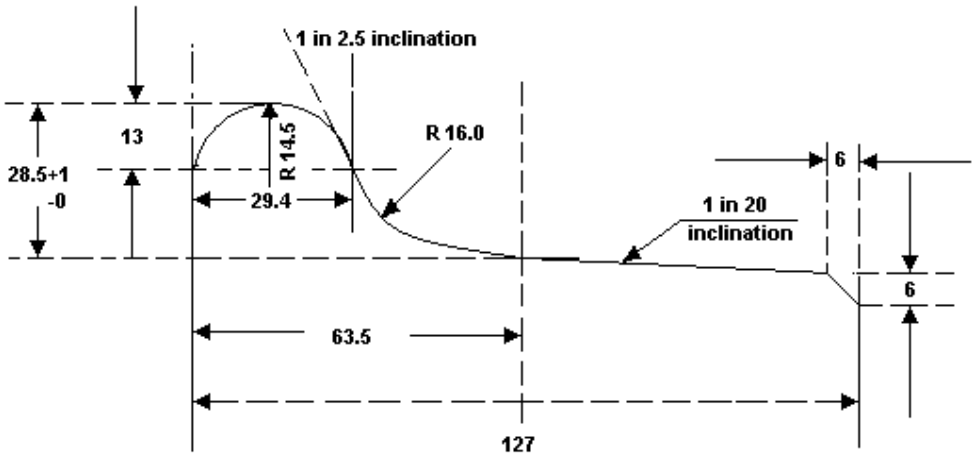
If the wheel gauge is less than minimum value, there is a possibility of wheel hitting at the back of a tongue-rail while passing through the switch & thus damaging the tongue-rail.

The wheels are required to be gauged at 3 or 4 quarters (as per possibility) and recorded duly indicating the following:

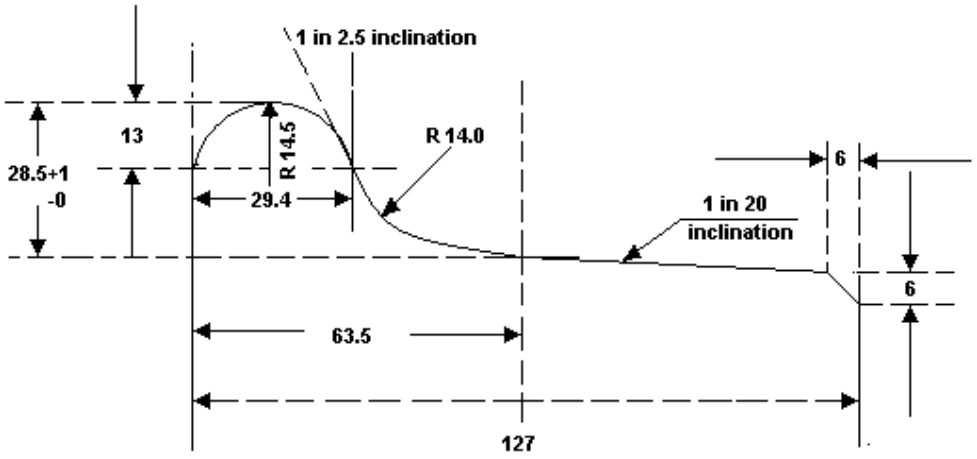
- Tight or slack gauge
- Whether any indication exists about shifting of wheel on the axle.

Note: It must be ensured that the back surface of the wheels are cleaned thoroughly before measuring the wheel gauge in order to avoid erroneous readings.

Tyre Profile:



NEW WHEEL PROFILE
All Dimensions Are in mm.



WORN WHEEL PROFILE (Ref.: RDSO sketch no. 91146 alt. 2)
All Dimensions Are in mm.

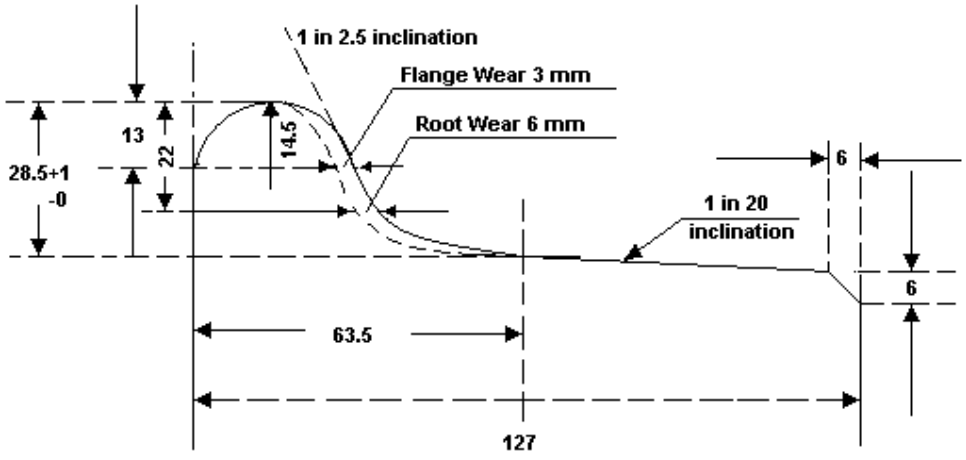
The outer periphery of a wheel which comes in contact with the rail is known as **Tyre Profile.** The important features of the tyre profile are:

- A chamfer of 6 mm at 45^0 on outer edge is provided to avoid sharp edges and also to prevent small burs (chips of metal) projecting beyond the outer surface of wheel due to spreading of small thin layer on outer periphery of the tyre.
- An upward inclination of 1 in 20 toward inside is provided to ensure that the wheels remain in central position of the track and allows the outer wheel to travel on the higher tread diameter & inner wheel on a smaller diameter on curves.

Note: The height of wheel flange is measured from the tread of the tyre and is 28.5mm.

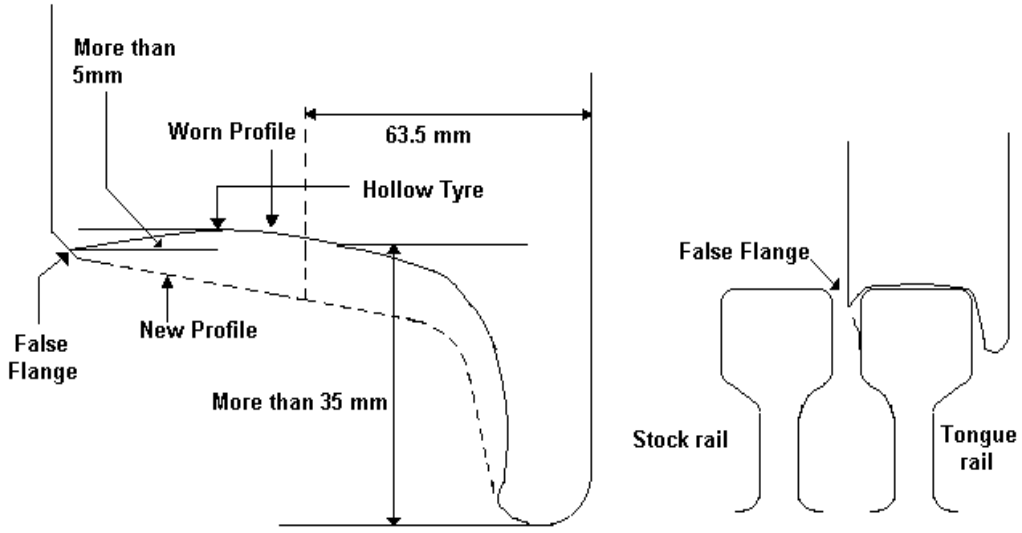
<u>Common defects on Wheels</u> :

	Defects	Parameters for immediate attention (As per ACTM Vol. III, 1994)
a)	Root Wear	6 mm at a distance of 22mm from top of the flange.
b)	Flange Wear	3 mm at a distance of 13mm from top of the flange.



WHEEL PROFILE
All Dimensions Are in mm.

c) Hollow tyre : 5mm depth

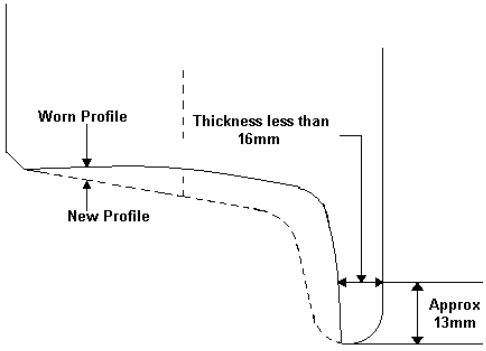


When the projection of outer edge of the wheel tread forms hollowness and it exceeds 5mm, the outer edge of the wheel forms a false flange & the worn tread is called **hollow tyre.**

The hollow tyre has the danger of developing a false flange. There is no effect on angularity or eccentricity but wear on tyres has the effect of increasing the conicity of the wheel tyre. This reduces the critical speed of the rolling stock beyond which excessive hunting & oscillations take place thereby increasing the flange force 'Y' and the chances of derailment.

A false flange may split open the points while traveling in trailing direction while negotiating the crossing. It may tend to get wedged in between the tongue rail & stock rail. The wheel going across the wing rail would then get lifted as instead of traveling on the tread portion, it would be traveling on the false flange. This will make the wheel to suddenly lift up & drop down near the nose of the crossing.

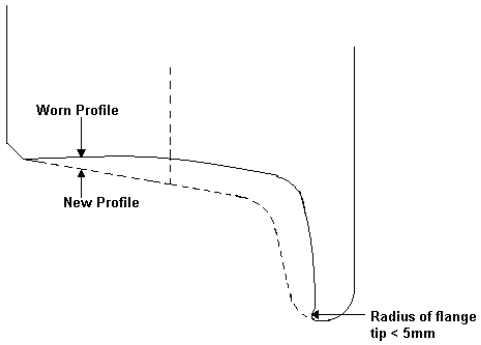
d) Thin flange



When the flange thickness reduces to less than 16mm, the flange is called a thin flange. It should be measured at the distance of 13mm below the flange tip. A thin flange increases lateral play between the wheel set & track and increases:

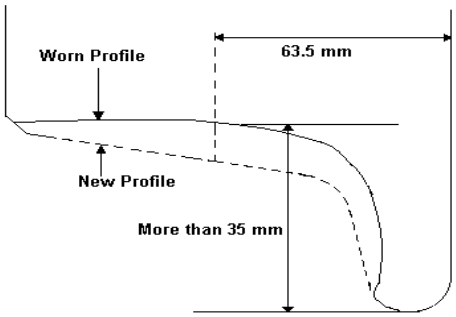
- Lateral oscillations adversely affecting Y/Q.
- Angularity of wheel set on run.

e) Sharp flange



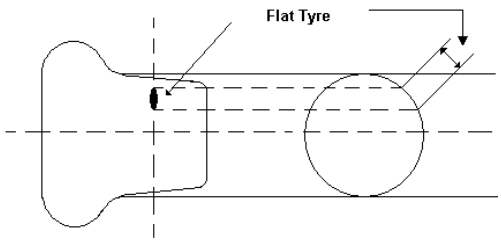
This occurs when the flange wears in such a way that radius at the tip of the flange becomes less than 5mm. The flange forms a fine sharp edge. Due to this, the wheel set can take two roads at slightly gapping point or wheel may ride over the chipped tongue rail.

f) Deep flange



When the depth of the flange, measured from the flange top to a point on the wheel tread (63.5 mm away from the back of wheel) becomes greater than 35mm, it is called a deep flange (35-28.5=6.5mm) as shown in adjoining figure. Under this condition, the wheel flange would tend to ride on the fish-plate & check block and may damage the track components.

g) Flat tyre



Wheels having flats on tyre damage the rails due to impact & cause high contact stresses. This may cause rail fracture leading to derailments. The maximum permissible value of flatness on a broad gauge wheel tyre for coaching stock is **50mm.**

Wheels are to be checked thoroughly with the help of wheel defect gauge (shown in Plate no. 38 & 39 in IRCA Part IV, June 2003) during schedule inspections. If any of the above defect noticed on wheel, the wheel to be taken for tyre turning. During turning wheel profile to be maintained as per RDSO sketch no 91146 alt.2.

Besides this, wheels to be checked regularly for slack tyre, shifting of tyre, glut ring/key loose, disc crack etc. These can be detected by visual checking, sounding of wheels and by DPT testing. Affected wheel is to be withdrawn from service in such cases.

Ultrasonic testing of axle at 9 months interval is a must to detect the flaw in axle if any. If ultrasonic flaw is detected in the axle, the axle to be condemned. After UST testing, axle bearing of the 'Fit to Run' wheels to be checked visually before securing the axle cover.

BRAKE RIGGING

Brake rigging is the mechanism which transmits braking force on wheels by actuation of brake cylinders.

This includes: brake cylinder slack adjuster, inner lever, inner hanger, outer lever, outer hanger, different Pins, brake shoe, tie/pull rod, tie rod pins, brake beams, bulb head cotters, different types of bushes, brake shoe keys, split pins, washers and articulation piece. Proper brake rigging ensures effective utilization of brake power and enhances the life of wheels and brake block.

Brake rigging in EMU is checked during schedule inspection. During brake rigging, lubrication of pin joints are carried out in order to ensure free movement of levers and thus ensures effective transmission of brake force. Further conditions of bushes, pins in pin joints are checked for any wear or grooving or damage. The diametrical clearance between the brake pins and bushes should be limited to 1mm [Ref RDSO Mech. Manual CMI-K001]. Bulb head cotters are particularly checked for any abnormal grooving and changing the same if required. Brake shoe key are checked for any loss of its tension.

HAND BRAKE: Manually operated hand brake is provided in vendor type trailer coaches and can be applied in wheel no. 2/7 and 3/6. The hand brake consists of a hand wheel which will operate the brake blocks on the inner axles of both the bogies. The brake shall operate the brakes through undergear mounted lever arrangements and trunion of the brake cylinders. When the hand wheel is rotated to the applied position, the lever arrangement pulls out brake cylinder piston through trunion against the spring tension and finally brakes are applied. When the wheel is returned to release position, spring of the brake cylinders pulls it back to its original position and brakes are released.

This brake is utilized to prevent rolling of train during stabling on track.

BRAKE CYLINDER

In EMU/MEMU, brake cylinder with JSL 8" type slack adjuster is provided to perform following functions:

1) Brake cylinder produces requisite brake force as compressed air is supplied. The brake force is proportional to the air pressure and the piston diameter.
2) The built in, single action slack adjuster quickly and automatically restores the original brake shoes clearance as soon as the admissible slack length exceeds due to excessive wear of the brake block.
   This ensures constant piston stroke and low air consumption. Automatic slack adjuster guarantees a constant brake application time, a constant brake shoe clearance and a constant air consumption.
3) Slack adjuster tube needs manual resetting when it comes out beyond a specified length (indicated by a red band on tube) due to wear of brake block. This work is carried out along with the changing of brake block when the rake touches the shed.

BRAKE BLOCK

"K" type composite brake block is the latest improvement over cast iron brake block and has following advantages:

1) It has a higher and more stable coefficient of friction (μ) than the conventional C.I. block resulting in lower application forces and permitting the use of smaller cylinders.
2) The metallic dust produced during C.I. block application were detrimental to the under-gear mounted electrical equipments. Further C.I. block were a fire hazard

due to the 'sparking' that occurred during use. The composite brake block being non metallic remains relatively cool during frequent applications. Since it maintains uniform contact with the wheel, composite blocks eliminate heat concentration.

3) The composite weighs 2.5 Kgs (approx.) as compared to the C.I. block which weighs between 10 to14 Kgs. Hence former is more convenient in handling.

Important parameters of composite brake block:

(Based on the QAP of the suppliers)

Density	: Variation should be within ± 0.10 unit.	As per RDSO Spec. no. C-9508 (Rev.3) & RDSO Sketch no. 80029. Alt.4.
Average μ value	: 0.25±15%	
Hardness	: To be within ± 10 units.	
Condemning size	: 10 mm	
Ash Contents (in %)	: Variation should be within ± 3.	
Acetone extract	: Should be less than 3%.	

BRAKE POWER OF EMU/MEMU STOCK

As per RDSO's letter no. MC/EMU/AVB, dated : 23.08.04 the revised brake power of EMU/MEMU stock should be as follows:

1. When the rake leaves Car shed it should have 95% effective brake cylinders.
2. When rake leaves night stabling points, at least 90% effective cylinders must be available for running without any speed restrictions.
3. If during the day's service the no. of effective brake cylinders goes below 90% but is above 85% the service may be continued at a restricted speed of 75 kmph.
4. If the no. of effective cylinders goes down below 85% the motorman should operate at the restricted speed of 70 kmph or which he feels is safe & the rake should be withdrawn from service, after completion of the trip.

MECHANICAL ITEMS TO BE CHECKED DURING SAFE TO RUN CHECKS

1. Brake Rigging of motor and trailer coaches:
   a) Condition of brake blocks.
   b) Condition of brake cylinder and slack adjuster for their proper functioning.
   c) Condition of brake beams.
   d) Condition of brake beam safety strap.
   e) Condition of brake head assembly.
   f) Condition of brake head hanger and its securing pins and cotters.
   g) Condition of brake pull rods.
   h) Condition of securing pins, bulb cotters and split pins.

2. Sounding of Wheel Tyres :
   a) For detection of slack tyre and crack, if any.
   b) Skid or flat tyres.

3. Primary Suspension :
   a) Check axle guide spring for breakage.
   b) Feel axle boxes for any abnormal heat.
   c) Check proper securing of axle box covers.

4. Secondary Suspension :
    a) Check condition of bolster and springs for any breakages.
    b) Check the condition of air spring bellows, leveling valve and intactness of all other accessories.
    c) Check BSS bracket and lower spring plank for any crack.
    d) Check the bolster hangers for any crack or loose.
    e) Check the bolster hanger's pins for any crack.
    f) Check the bolster hanger's blocks for any crack or loose.
    g) Check the condition of anchor links in trailer coaches and equalizing stays.
5. Check the cattle guard and its securing arrangements.
6. Check the condition of traction motor gear cases mounting and joint bolts.
7. Check visually for any other abnormality.

ATTENTION TO BOGIE COMPONENTS

Bogie Frame:

Bogie frame should be checked thoroughly after cleaning, for any cracks, particularly at places where bolster suspension brackets and the dashpot guide flanges are welded. Threads on dashpot guides should be checked for damages. Normally, squareness and alignment of dashpot does not require checking. If biased wheel flange wear or wear in the rear cover of the roller bearing axle box have been observed, the squareness and alignment of the guides should be checked thoroughly with the help of a gauge.

Alignment of axle box guides should be measured with reference to the bolster spring suspension bracket (BSS). Therefore, it is necessary to ensure that BSS are in proper alignment between themselves and the centers should form a rectangle within permissible tolerances.

Axle Box Housing :

Double row self aligning spherical roller bearing are housed in accurately machined cast steel axle boxes. The axle boxes are also provided with light alloy front and back covers secured by four bolts. Axle boxes and covers should be thoroughly cleaned and checked for cracks particularly holes of the covers which have shown proneness to failures. The bolts should be examined for worn threads, straightness, etc. before reuse and should be well tightened and locked by spring washers and split pins to ensured that the covers and the axle box housing form a water tight assembly and protect bearing from dust and moisture.

Axle Box Spring :

Axle box springs are of helical type manufactured from centreless chrome vanadium, silico manganese steel. These springs are also shot-peened to obtain higher fatigue life. It is necessary to check these springs for cracks and measure their free height to ensure that they meet the design requirements.

All springs should be grouped in three categories with recommended colour code and used on bogies as per instructions detailed in RDSO technical pamphlet No. C-8419(Rev.I)

Lower Spring Seat:

Lower spring seat on the axle box wing in which guide bush of dashpot moves up and down does not normally wear in service. In the absence of inadequate quantity of oil in the dashpot, the inside surface is likely to wear. If the surface is worn more than 0.4 mm. in diameter or if the surface is scored or otherwise damaged, the lower spring seat should be reclaimed.

Dashpots and Axle Guide Assemblies:

Axle box guides are accurately machined hollow forgings welded to the bogie frame to ensure that the wheel sets are rigidly guided in parallel. These guides are fitted with acetal/bronze bushes at the lower end for close guidance of the wheel sets both in lateral and longitudinal directions. The lower spring seat is filled with oil and the assemblies are sealed with rubber ring to make it oil tight. In the trailer coach bogies, holes on the bogie side frame above each guide are provided to top up the damping fluid when required.

Level of Oil in Dashpot :

In the motor coach bogies, the level of oil in the dashpot from the guide cap should be 97 mm. when motor coach is empty. The level of oil can be checked by unscrewing the filling cap and using dip-stick. For trailer coach bogies approx. 3 pints (l.7 ltrs.) of oil are required per dashpot. The level of the oil in the dashpot can be ascertained in service by unscrewing the bolt provided on the bogie frame for topping oil and using a flexible wire dip-stick inserted through the vent hole on the bogie frame. The level of the oil when the vehicle is empty should be 77 mm. from the guide cap inner surface and should be topped up if the level is less than this. It is necessary to ensure that the bolt on leather washer is tightened well to avoid ingress of dust through the hole which will lead to scoring of dashpot bronze bush. Oil spilling over the dashpot while replenishing should be wiped clean so that the subsequent leakage of oil, if any, may be detected easily.

BOLSTER SPRING:

Bolster springs are of helical type manufactured from centreless ground chrome vanadium, silico manganese steel. These springs are also shot peened to obtain higher fatigue life. It is necessary to check these springs for cracks and measure their free height to ensure that they meet the design requirements.

All springs should be grouped in three categories with recommended colour code and used on bogies as per instructions detailed in RDSO technical pamphlet No. C-8419 (Rev. I).

LOWER SPRING BEAMS:

All lower spring beams should be carefully checked for crack etc especially at bolster hanger pin housing before use.

HYDRAULIC SHOCK ABSORBERS:

The hydraulic shock absorbers are fitted to work in parallel with bolster springs. Shock absorbers, which are found either leaking or physically damaged, should be

replaced. As the resistance of these shock absorbers is likely to deteriorate in service, it is necessary to attend them as per instructions given in manufacturers' maintenance manual.

RUBBING PLATE IN MOTOR COACH BOGIE:

Nylon rubbing plate has been fitted to the bolster which serves as a cushion between the bolster and bogie frame. Initial clearance of 1mm. on each side has been provided between the nylon rubbing plate and steel rubbing plate. During service, this clearance should not exceed 3 mm on each side. Any higher clearance may cause excessive longitudinal oscillations and may strain stay tubes (connecting the bolster to the spring plank) and cause their breakage.

EQUALISING STAYS:

Equalizing stays (MC) connecting the spring plank and bolster, pin jointed at both ends, have been provided to prevent lateral thrust on bolster springs. Any restricted movement at these joints is likely to prevent free movement of bolster. The free movement of pins can be ensured by greasing the assembly. The pins should be provided with washers and split pins to ensure that they do not fall in service.

AIR SPRING IN SECONDARY SUSPENSION:

Over the years, the number of passenger traveling in suburban area of metropolitan cities have increased manifold. The loading of EMU coaches has increased from designed value of 18t to 34t (in trailer coach), popularly known as super dense crush load (SDCL). The bogie clearances basically meant for absorbing dynamic movement of the coach just vanish, resulting into severe hitting between various bogie components leading to premature failure of bogie components and poor riding behavior of the coach.

To overcome the problem, pneumatic suspension (air spring) at secondary stage has been introduced with optimized values of stiffness and damping characteristics. Presently two types of Air spring have been used in EMUs/ MEMUs i.e. Contitech (Continental) make, Type: 747 N 3100 P 03 and Firestone make, Type: P4-2410-12. Make wise general technical data are given below:

Contitech make, Type: 747 N 3100 P 03	Firestone make, Type: P4-2410-12
Static vertical loads on Air spring Tare---------- (2.1 bar)- 51 KN Full load---------- (5.7bar)- 142 KN Air spring volume----------26 ltr Additional volume----------20 ltr. Design height of Air spring----$255^{\pm 5}_{0}$ mm Min. height of at full load----- 215 mm	Static vertical loads on Air spring Tare---------- (2.06 bar)- 50 KN Full load---------- (5.95bar)- 145 KN Air spring volume----------24 ltr Additional volume----------20 ltr. Design height of Air spring----$255^{\pm 5}_{0}$ mm Min. height at full load---------215mm

Working principal: Air suspension is a suspension where properties of air are used for cushioning effect (springiness). Enclosed pressurized air in a predefined chamber called air spring made up of rubber bellow and emergency rubber spring provide various suspension characteristics including damping. Air springs are height controlled load leveling suspension devices. With the changing of loads, air spring

reacts initially by changing the distance between air spring support and vehicle body. The height monitoring valve (called leveling valve) in turn actuated, either getting the compressed air pressure to the air spring or releasing air pressure from it to the atmosphere. This process continues until original height is restored.

Advantage of Air spring:

- Capable to sustain SDCL of sub-urban traffic.
- Constant floor height of coach.
- Excellent ride comfort.
- Safe running.
- Virtually constant natural frequency from tare to full load.
- Low design height.
- Integral input signal for load dependent braking & acceleration.
- Isolation of structure borne noise.
- Improved reliability, reduced maintenance.
- Great durability.
- Possibility of voluntarily choosing air spring characteristics.

Air spring accessories:

Bogie frame & suspension- i) In place of standard bolster suspension hanger arrangement, a fixed lower spring beam (as cradle) to accommodate the Air springs have been provided on bogie frame.
ii) Two no. lateral hydraulic damper and lateral bump stop has been provided at secondary stage.
iii) Primary springs have made stiffer.

Bogie bolster - i) Air inlet arrangement to Air spring has been provided.
ii) 20 ltr. Additional reservoir parallel to each Air spring provided.
iii) Leveling valve & installation lever provided.
iv) Vertical (300 kg.) & lateral (200 kg.) damper provided.
v) Duplex check valve provided.

Under frame - i) Pipe line is drawn from MR pipe for Air spring.
ii) One isolating cock, one non-return valve, one 150 lts air reservoir, one air filter & two separate isolating cocks to isolate each bogie have been provided.

CENTRE PIVOT (Motor Coach):

The body bolster of the under frame is provided with a bush of inner diameter 90mm in the top and 150mm diameter hole at the bottom and the center pivot pin, when fitted to the body bolster, perfectly fits into these holes. Any wear due to bogie rotation is taken up by the upper and the lower bushes between the center pivot pin and bogie bolster. While fitting the center pivot to bogie bolster, it should be ensured that:

1) The clearance between the center pivot pin and guide bush in the body bolster is H7-e8.
2) Centre pivot pin plate has a machined surface so, as to bear squarely on the body bolster.

After fitting the center pivot pin to the body bolster, there should be no clearance between the center pivot pin plate and body bolster. The bolts for securing the pivot plate to the body bolster do not transmit any tractive or braking forces. These are meant only for securing the center pivot while the forces from center pivot to the body bolster are transmitted through the mating surfaces between the pivot pin and body bolster. It is therefore, extremely essential to ensure that the designed clearances between the pivot pin and body bolster guide bush are maintained. The lower and upper bushes should be replaced when the total diametrical wear exceeds 1mm. Before lowering the center pivot the bogie bolster, the pivot bearing of the bolster should be filled with 3 liters of oil.

CENTRE PIVOT (Trailer Coach) :

The center pivot arrangement of trailer coach is not designed to transmit any vertical load but only transmits tractive and braking forces. Rubber sealing used on center pivot for trailer coaches should be carefully examined to ensure that it is not torn or perished to avoid foreign matter coming in contact with silent block bush. The type of fit between the silent block and sleeve is H7-u6 and the tolerance on pivot pin is C9. This requirement should be met.

Centre pivot of the trailer bogie is secured to under frame by means of four bolts with nut and spring washers, the nuts being tack welded to the body bolster. It should be ensured that all bolts are correctly tightened with spring washers.

The silent block sleeve is secured to bogies by means of two studs with nuts and springs. In case the silent block bush requires removal it should be removed carefully by means of a tubular dolly registering on the outer ring to avoid damage to the rubber bush. Under no circumstances, force should be used either on the rubber or in the inner bush for removing the silent block bush.

SIDE BEARERS:

Side bearers consist of a hard wearing ground steel plate immersed in an oil bath with a floating bronze wearing piece, which has a self aligning spherical top surface on which the body rests and transmits the vertical load. The oil well is provided with a cover to prevent ingress of dust.

The hard ground plate and the spherical bronze wearing piece are likely to wear in service. The hard ground plate should be renewed when the wear exceeds 1.5mm or ridges are observed on the plate. The bronze wearing piece should be renewed when the wear on the mating surface reaches 3mm or damages occur to the oil grooves. Sharp edges which are known to develop at the periphery of the wearing pieces are likely to impair lubrication and should be rounded off before re-using.

The oil well is welded on to bolster. Spot checks have indicated that oil leaks out of the well due to porous welding and the vehicles continue to be in service without oil. Absence of oil apart from causing excessive wear, leads to undue constraint for bogie rotation on curves and produces screeching noise. It is necessary that porous welds are gouged and re-welded, and the oil well is filled with requisite quantity of oil. For filling up of oil in side bearer without lifting the coach, oil filling nipples have been provided on the oil well. Any of the following oils can be used for the side bearers and quantity required per side bearer is 2.5 litres.

IOC- SERVOLINE-68 (Presently Servoline-100 is being used).
HPC- YANTROL-68
BPC- BHARAT UNIVOL-68

It is important to ensure dust seal cover on the side bearer sits effectively all over without any gap on the oil well and sleeve slides freely on the guide to prevent dust and moisture coming in contact with the oil. The bronze bearing piece shall be provided with 1mm relief over the periphery and the sharp edges of the oil grooves shall be rounded off.

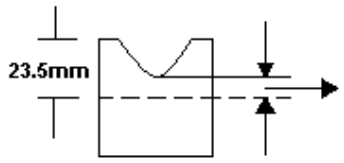
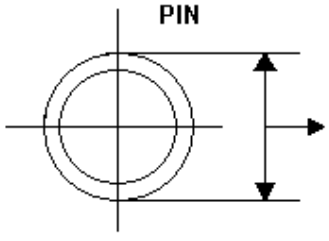
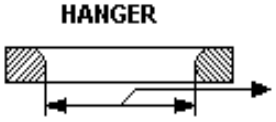
ANCHOR LINKS (Trailer Bogies):

No coach should be permitted to run with broken anchor links as this is the only medium to transfer the draw and braking forces from the body to the bogie and vice versa. Anchor link should be carefully examined for cracks at the weld joints. The rubber in the silent block should also be carefully examined for deterioration. Appearance of fretting on the edges of rubber is an indication of deterioration of rubber. Whenever a silent bloc is to be replaced, it must be from those that have been duly tested. To avoid pre-loading of the anchor link while assembling on the bogie, ensure that the assembly can be done without forcing the link into position. This can be done conveniently after lowering the body on the bogie. Care should be taken not to damage silent bloc while removing from the anchor link.

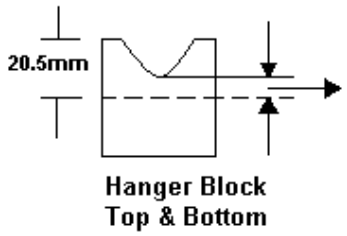
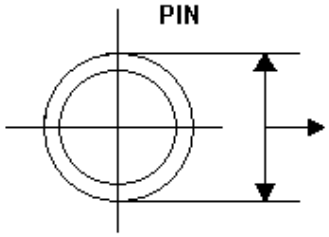
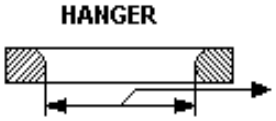
HANGER AND HANGER BLOCKS:

Hanger and hanger blocks should be thoroughly cleaned and examined for cracks/wear and other damages. The extent of permissible wear on these components are indicated below (Ref. RDSO Manual no. CMI-K001, Apr'2000):

Motor coach:

Components	Size(New)	Size(Condemning)	Wear in mm	Shop issue size
 Hanger Block Top & Bottom	9.5 mm	8 mm	1.5 mm	8.5 mm
	45 mm	43.5 mm	1.5 mm	44 mm
	246 mm	249 mm	3 mm	247.5 mm

Trailer Coach:

Components	Size(New)	Size(Condemning)	Wear in mm	Shop issue size
 Hanger Block Top & Bottom	8 mm	6.5 mm	1.5 mm	7 mm
	45 mm	43.5 mm	1.5 mm	44 mm
	354 mm	357 mm	3 mm	7.5 mm

The wear on the hanger can not be made good by welding as it is made of Class1 case carburized steel. The wear on hanger block can however be built up by welding with matching electrodes after pre-heating to 250^0 C as it is done for items made of class III steel. The hanger block should be normalized and machined to the specified dimensions.

SEMI PERMANENT SCHAKU COUPLER

Semi permanent type of coupler has been designed to provide permanent connection between intermediate coaches. The only change from automatic coupler demands replacement of automatic coupler head with intermediate tube. The coupling is done manually and the two couplers after being aligned are secured by means of an adjustable cup sleeve joint. It consists of following parts:

1) Intermediate tube: The intermediate tube is the connecting member between the draw and buff gear and the adjustable cup sleeve.

2) Draw and Buff Gear: The rubber spring of the draw and buff gear has an energy absorption capacity of about 800 Kg-m and it is therefore capable of protecting the vehicle under frame to a large extent against impact stresses. The cup sleeve joints connect the draw and buff gear with the coupler head. The connection to the bearing bracket with support arranged on the vehicle is effected by the bearing bolt which, while fitting the coupler is put through the bore of the articulated bearing in the fork eye and secured. The occurring compressive forces are transmitted via the yoke into the front plate and further transmitted to

the rubber spring. At the end of the pressure stroke of 56 mm, the rear plate of the yoke supports itself upon the fork eye. The tractive forces are transmitted through the cup-sleeve joints, the yoke, the rear plate, the rubber spring and the two hexagonal head screws to the fork eye. The articulation bearing arranged in the fork eye permits the lateral and vertical displacement as well as twisting around the longitudinal axis of the coupler. Lubrication of the articulation bearing is effected by the aid of a grease nipple in the bearing bolt. When fitting the coupler into the vehicle, care must be taken to ensure that the collar of the articulated bearing in the fork eye is located at the top side.

3) Bearing Bracket with Support: It has the function of transmitting the traction and impact forces from the coupler to the vehicle under frame structure, and to keep the coupler in its horizontal position between the vehicles. There is a leaf spring in the carrier which supports the coupler. The thrust piece is guided in two slots in the carrier. After loosening the hexagonal nut, it is possible to adjust the precise coupler height by the aid of the hexagonal head bolt. After effecting this adjustment, the hexagonal nut must be again firmly tightened. Under the draw and buff gear device there is the fastening for the leaf spring. A slide plate protects the bearing surface of the leaf spring from excessive air. The carrier is screwed on the bearing bolt and secured by the cylindrical dowel pin. The bearing bolt passes through the articulation bearing in the fork eye of the draw and buff gear and is housed in the bearing bracket, which is fixed with the vehicle under frame. The bushes and other bearing spots are greased by the aid of a grease nipple through suitable boreholes in the bearing bolt.

4) Adjustable Cup Sleeve: It has the function of transmitting the tractive forces from one semi-permanent coupler to the other and to facilitate rapid coupling and uncoupling. It consists of a pair of cup sleeves which can be radially moved over the spindle via the handle. The aligning device serves as abutment for the spindle and prevents the two coupler from getting twisted. The bolt retains the two cup sleeve halves in the vertical plane. The wing nut secures the spindle against working loose.

5) Centering Device: It retains the coupling in their position at their center line between the vehicles and retracts them into the central position after every side displacement. On the one side it is pivoted by a bolt to a shackle which is welded to front plate of the draw and buff gear. On the other side it is fitted to the vehicle structure. The centering device consists of a spring casing for the two pressure spring, the spring pot and the spring plate. The spring casing is closed by screwing on the cover and a spring ring prevents it from working loose. The shackle welded on the cover takes up a bolt for fixing the centering device to the vehicle. A tension screw guided in the spring pot and the spring plate establishes the connection to the fork head. The bolt serves for fixing the forked head to the draw and buff gear. After loosening the hexagonal nut, the centering device can be altered in its length. After adjusting the coupling in its correct central position the hexagonal nut must be tightened firmly again.

IMPORTANT MECHANICAL CLEARANCES

After assembling bogie and lowering coach body the various bogie clearances should be checked for following dimensions. The clearance between axle box and bogie frame and between bogie and body bolster are very important and these should be within the tolerances. Normally these clearances will not be less than the specified values if

the springs and rubber washers are as per drawings and specification and there is no undue wear in the hanger, hanger block and hanger pins. Therefore in case after assembly the clearances are found to be less, the reason for the same should be investigated and necessary rectification done by renewing the required components. **However, adjustment upto 6 mm may be done by providing packing below the springs.**

Type of Coach	A Crown Clearance	B Bolster to Bogie Frame	C Bogie Frame to Body Bolster	D Rail Level to Centre Line of Coupler	E Bolster Stop	Rail Level to Centre Line of Buffer	Rail Level to Cattle Guard
AC EMU Motor Coach	$38^{\pm}6$	$24^{\pm}5$	95 min.	$1035^{\pm}{}^{0}_{15}$	44	1090 ± 0	$210^{\pm5}_{0}$ 188 (for air spring coaches)
MEMU /DMC	$38^{\pm}6$	$24^{\pm}5$	143 min.	$1035^{\pm}{}^{0}_{15}$	44	1105 ± 0	$210^{\pm5}_{0}$
AC EMU Trailer Coach	$42^{\pm}6$	$40^{\pm}5$	70 min.	$1035^{\pm}{}^{0}_{15}$	49 min.	1090 ± 0	--
MEMU Trailer coach	$33^{\pm}6$	$40^{\pm}5$	151 min.* 130 min.*	$1035^{\pm}{}^{0}_{15}$	55 min.	1105 ± 0	--

* 151 (min.) for the coaches mfd. from 1993 to 1995 and 130 (min.) for the coaches mfd. 1996 onwards.
Ref.: RDSO Maintenance Manual no. CMI-K001, Drg. No. MEMU/DMC_2-9-0-201, EMU-2-6-046

Other important mechanical clearances in tare condition:

S/no.	Description	EMU	MEMU	Reference
1	Height of bogie frame from rail level: M/Coach T/ Coach	 $688^{\pm}5$ $680^{\pm}5$	 $688^{\pm}5$ $680^{\pm}5$	Drg. EMU/M2-9-0-529, DC/EMU-0-0-002, MEMU/DMC-9-0-012 MEMU/TC-0-0-001
2	Distance between two axle guide centre in same bogie: M/Coach T/ Coach	 $630^{\pm}0$ $570^{\pm}1$	 $630^{\pm}0$ $570^{\pm}1$	Figure 8 & 9 of RDSO manual no. CMI-K001, Apr'2000
3	Centre line distance between two sides (parallel to rail level) of bogie frame: M/Coach T/ Coach	 $2210^{\pm}0$ $2159^{\pm}1$	 $2210^{\pm}0$ $2159^{\pm}1$	Figure 8 & 9 of RDSO manual no. CMI-K001, Apr'2000

S/no	Description	EMU	MEMU	Reference
4	Diagonal distance of axle guide: M/Coach T/ Coach	 $3643^{+}_{-}1$ $3612^{+}_{-}1$	 $3643^{+}_{-}1$ $3612^{+}_{-}1$	Figure 8 & 9 of RDSO manual no. CMI-K001, Apr'2000
5	Distance between two bogie centre for both M/coach & T/coach	14630	14783	Drg..i)EMU/M-9-0-006 (M/C) ii)EMU-2/D-9-0-503 (T/C) iii)MEMU/DMC_2-9-0-201 iv)MEMU/TC_2-9-0-201.
6	Distance between two wheel centre (wheel base) of same bogie for both M/coach & T/coach	$2896^{+}_{-}1$	$2896^{+}_{-}1$	Figure 8 & 9 of RDSO manual no. CMI-K001, Apr'2000 & Drg. i)MEMU/DMC_2-9-0-201 ii) MEMU/ TC_2-9-0-201.
7	Centre to centre distance between transom and adjacent axle guide: M/Coach T/ Coach	 $733^{+}_{-}1$ $493^{+}_{-}1$	 $733^{+}_{-}1$ $493^{+}_{-}1$	Figure 8 & 9 of RDSO manual no. CMI-K001, Apr'2000
8	Centre to centre distance between two BSS bracket in each side: M/Coach T/ Coach	 $800^{+}_{-}1$ $1340^{+}_{-}1$	 $800^{+}_{-}1$ $1340^{+}_{-}1$	Figure 8 & 9 of RDSO manual no. CMI-K001, Apr'2000
9	Clearance of suspension brg. with axle	Lateral- 0.75 mm. (new) at each end. 4.0 mm.(wear limit)each end. Diametrical- 0.33mm.(min) 1.5mm.(max)		BHEL maintenance manual no. MM/AC-M/EMU/003
10	Sandwich Unit: i) Free height of rubber sandwich unit. ii) Top and bottom spring (38.1 X 2). iii) Two extreme top and bottom spring plates (2 X 9.5mm).	New 157/158 76.2 19.0	Condemning 153.3 These plates normally do not wear. 18.0	
	iv) Overall free assembled height of sandwich unit.	252.2/253.2	247.7	
11	Traction motor nose dimension between two wearing plate	241.3/242.06	243.5	
12	Dimension between bogie transom noses.	240.506/239.710	243.0	

All dimensions are in mm.

Vital Mechanical clearances and spring height of Air Spring coaches with HCC bogie in Tare condition:

S/no	Description	M/C	T/C	Reference
1	Crown Clearance	31±2	43±3	ICF Drg. Nos. i)ACEMU/M/ASR-9-0-003. ii) AC/DCEMU/C_2-9-0-203. iii) EMU-2-6-046
2	Bolster to Bogie Frame	40±5	40±5	
3	Bogie Frame to Body Bolster	100±3	100±3	
4	Rail Level to Centre Line of Coupler	$1035^{\pm 0}_{5}$	$1035^{\pm 0}_{5}$	
6	Rail Level to Centre Line of Buffer	1090±0	1090±0	
7	Rail Level to Cattle Guard	188	--	ICF drg. No.EMU-2-6-046
8	Height of bogie frame from rail level	688±5	688±5	ICF Drg. Nos. i)ACEMU/M/ASR-9-0-003. ii) AC/DCEMU/C_2-9-0-203.
9	Height of air spring	$255^{\pm 5}_{0}$	$255^{\pm 5}_{0}$	
10	Tare height of axle guide spring	$213^{\pm 2}_{1}$	228±1	
11	Clearance of lower spring plank from rail level.	164±5/ 144±5 (with 60/80 mm LS beam)	144±5 (with 80 mm LS beam)	

Helical Coil Springs used in EMUs/MEMUs of South Eastern Railway

S/no.	Drg. No.	Stock	Type	Remarks
1.	DC/EMU-0-1-002	EMU/TC MEMU/TC	Primary	Free Ht. 304± 2 mm.
2.	DC/EMU-0-5-005/2	EMU/TC	Secondary (outer)	Free Ht. 281± 2 mm. (in set)
3.	DC/EMU-0-5-005/1	EMU/TC	Secondary (inner)	
4.	DC/EMU/M_2-0-1-203	AC/EMU/M/ASR AC/DC EMU/C_2 AC/DC EMU/D_2	Primary	Free Ht. 250 ± 2 mm.
5.	EMU/M-0-5-049/1	EMU/M	Secondary (outer)	Free Ht. 305± 2 mm (in set)
6.	EMU/M-0-5-049/2	EMU/M	Secondary (inner)	
7.	EMU/M-0-1-024	EMU/M	Primary	Free Ht. 284 ± 2 mm
8.	EMU/M-0-5-050/1	EMU/M	Secondary (Outer)	Free Ht. 375 ± 2 mm (in set)
9.	EMU/M-0-5-050/2	EMU/M	Secondary (inner)	
10.	MEMU/TC-0-5-006/1	MEMU/TC	Secondary (outer)	Free Ht. 410 ± 2 mm
11.	MEMU/TC-0-5-006/2	MEMU/TC	Secondary (inner))	Free Ht. 295 ± 2 mm
12.	MEMU/DMC-0-1-001	MEMU/DMC	Primary	Free Ht. 293 ± 2 mm
13.	MEMU/DMC-0-1-002	MEMU/DMC	Primary	(Supersedes Drg. No. MEMU/DMC-0-1-001)
14.	MEMU/DMC-0-5-002/1	MEMU/DMC	Secondary (outer)	Free Ht. 402 ± 2 mm (in set) (Supersedes Drg. No. MEMU/DMC-0-5-001 with free Ht. 399 ± 2 mm.
15.	MEMU/DMC-0-5-002/2	MEMU/DMC	Secondary (inner)	

Following Helical coil spring is being used in MEMU coaches which have not been included in RDSO's list of drawings

S/no.	Drg. No.	Stock	Type	Remarks
1.	MEMU/TC-0-1-002	MEMU/TC	Primary	Free Ht. 290 ± 2 mm