



**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

(FOR OFFICIAL USE ONLY)

**MAINTENANCE HANDBOOK
ON
FLEXICOIL BOGIES MARK - I
CAMTECH/2002/BOGIE/1.0**

MAY, 2002

**Centre
for
Advanced
Maintenance
TECHnology**



Maharajpur, GWALIOR - 474 020

**MAINTENANCE HANDBOOK
ON
FLEXICOIL BOGIE MARK - I**

FOREWORD

The proper maintenance of Flexicoil MK-1 Bogie is necessary for trouble free operation of WAP1 and WAP4 Electric Locomotives and to avoid failure enroute. CAMTECH has prepared this handbook to cover all aspects of maintenance and to ensure reliability.

The service limits prescribed in this handbook are to ensure good ride quality and reliability. These service limits have adequate safety margin. It should be clearly understood that practices and service wear limits mentioned in the book have been suggested keeping in view the desirable riding quality and reliability. Wear limits based on riding quality/ comfort are far more restrictive than wear limits based on safety criteria. Any major deviation from the former, though not recommended, need not to be considered unsafe for running of locomotives on line.

I compliment CAMTECH for bringing out this handbook, which will be of immense help to the supervisory and artisan staff of electric loco sheds and workshops.

RDSO, LUCKNOW
28th June, 2002

P. BHATTACHARYA
EXECUTIVE DIRECTOR/ MP

A WORD FROM EXECUTIVE DIRECTOR

The proper maintenance of Flexicoil Bogie Mark-I is necessary for trouble free operation of all WAP1 and WAP4 class of AC electric locomotives and to avoid failure enroute. CAMTECH has prepared this handbook to cover all essential aspects of maintenance of Flexicoil Bogie Mark-I.

The handbook describes various maintenance schedules along with their periodicity and detailed procedure to be adopted during repair and overhauling. A very useful compilation of list of common defects and their remedies is included in the handbook. The staff in Electric Loco Shed will benefit from this handbook, which in turn will be reflected in improved reliability and availability of Electric Locomotives and thus economy in operation.

CAMTECH, GWALIOR
23rd July, 2002

M.L.GUPTA
EXECUTIVE DIRECTOR

PREFACE

The Flexicoil bogie mark-1 is used in all WAP1 and WAP4 class of AC electric locomotives. It is vital equipment and its proper upkeep and maintenance is necessary to ensure reliability and availability of AC electric locomotive. This handbook on "Maintenance of Flexicoil bogie mark-1 " has been prepared by CAMTECH with the objective of making our maintenance personnel aware of correct maintenance and overhaul techniques to be adopted in field.

It is clarified that this handbook does not supersede any existing provisions laid down in the "Maintenance manual of electric locomotive" and "AC traction manual" or instructions issued by Railway Board/ RDSO. It is also clarified that this is not a statutory document.

I am sincerely thankful to all officers and staff of Electric Loco Directorate and Motive Power Directorate of RDSO/ LKO for their valuable comments. I am also thankful to all field personnel who helped us in preparing this handbook.

Technological upgradation and learning is a continuous process. Hence feel free to write to us for any addition/ modification in this handbook or if you have any ideas. We shall highly appreciate your contribution in this direction.

***CAMTECH, GWALIOR
16th May, 2002***

***RANDHAWA SUHAG
DIRECTOR(ELECTRICAL)***

CONTENTS

	A WORD FROM EXECUTIVE DIRECTOR	v
	FOREWORD	vii
	PREFACE	ix
	CONTENTS	xi
	<i>CORRECTION SLIP</i>	<i>xvii</i>
Chapter 1.	INTRODUCTION	1
	1.1 Brief Description	1
	1.1.1 Bogie Frame and Bolster	1
	1.1.2 Suspension	6
	1.1.3 Bolster Spring Friction Device	7
	1.1.4 Wheel Set and Axle Box	10
	1.1.5 Brake System	13
Chapter 2.	MAINTENANCE	18
	2.1 Trip Inspection	18
	2.1.1 Bogie and Bolster	18
	2.1.2 Brake Gear	18
	2.1.3 Traction Motor Axle Suspension	
	Bearing	19
	2.1.4 Traction Motor Gear Case	19
	2.1.5 Axle Box	20
	2.1.6 Suspension Spring	20
	2.1.7 Return Current Shunt	20
	2.1.8 Speed recorder/ Speed	
	indicator/ Drive connections	20
	2.2 Periodic Schedules	21
	2.3 AOH Schedule	26
	2.3.1 Removal of Bogies	26
	2.3.2 Dis-assembly of Bogie	27
	2.3.3 Re-assembly of Bogie	35
	2.3.4 Re-application of Bogies to	
	Locomotive	38
	2.3.5 Clearance Check Sheet of	
	Flexicoil Bogie Mark - I	39
	2.3.6 Wheel Set Changing	40

2.4	IOH Schedule	42
2.4.1	Bogie Frame and Bolster	42
2.4.2	Brake Rigging	44
2.4.3	Suspension Spring	44
2.4.4	Gear Case	45
2.5	On line Maintenance	47
Chapter 3	GUIDE LINES FOR WELDING	49
3.1	Welding of Manganese Steel Liners And Wear Plates	49
3.1.1	Welding Electrode	49
3.1.2	Welding of Existing Axle Boxes and Bogie Frame	49
3.1.3	Welding Procedure	52
3.1.4	Electrode Care	54
3.1.5	Inspection and Rectification of Defects	55
3.2	Repair of cracked Bogie Frame by Welding (Both Cast and Fabricated)	56
3.2.1	Evaluation of Cracks and other Defects	56
3.2.2	Preparation for Welding	57
3.2.3	Jigging and Preheating	60
3.2.4	Electrode	60
3.2.5	Welding Set, Current & Polarity	61
3.2.6	Welding Technique and Precaution	61
3.2.7	Finishing	62
3.2.8	Stress Relieving	63
3.2.9	Inspection	63
3.2.10	Control of Distortion	63
3.2.11	Weld Repair of Cracks Extended over an Area	64
3.3	Welding of Centre Pivot Pin to the Under Frame	65
3.3.1	Parent Metal Particulars	65
3.3.2	Edge Preparation	66

	3.3.3	Welding	66
	3.3.4	Inspection	67
	3.3.5	Repair of Cracks	68
Chapter 4		COMMON PROBLEMS, CAUSES AND REMEDIES	70
	4.1	Suggestions to avoid Failures	71
	4.2	Do's	74
	4.3	Don'ts	77
		<i>References</i>	80

ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/2002/E/BOGIE/1.0/C.S. # XX date-----

Where “XX” is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No.	Date of issue	Page no. and Item no. modified	Remarks

CHAPTER 1

INTRODUCTION

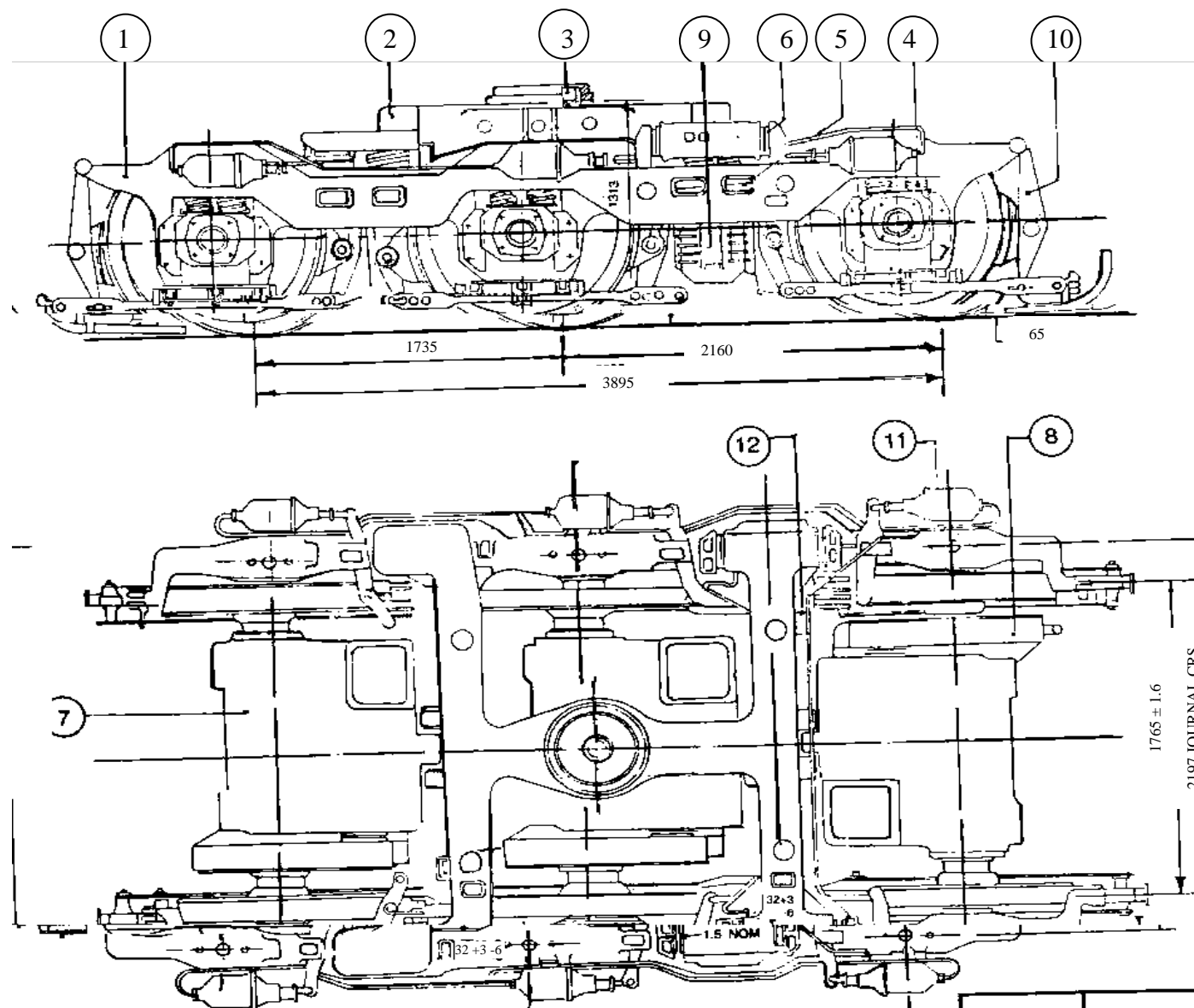
The Flexicoil Mark-I bogie is provided in all WAP1 and WAP4 class of electric locomotives. This is a very vital safety equipment of the locomotive. It is necessary to maintain the bogie in good condition to ensure reliability and safety. Important clearances are also required to be maintained as per prescribed limit to have good riding quality. Therefore this handbook has been prepared to provide ready reference to maintenance staff of AC electric loco sheds. There are two Flexicoil bogies, so named after flexing action of springs, fitted in a locomotive. Each bogie has three traction motors, wheel set along with axle boxes and brake rigging. Therefore it is very essential to have both bogies in healthy working condition.

1.1 BRIEF DESCRIPTION

The Flexicoil mark-1 bogie comprises of the following main components:

1.1.1 Bogie Frame and Bolster

The bogie frame and bolster of “FLEXICOIL” Mark – I bogie are of steel casting box type construction. The general arrangement of bogie is shown in Figure 1.1.

**DETAILS****ITEM DESCRIPTION**

1. Bogie Frame
2. Bolster
3. Centre pivot
4. Primary Suspension
5. Secondary Suspension
6. Friction Damper
7. Traction Motor
8. Gear Case
9. Nose Suspension
10. Brake Rigging
11. Brake Cylinder
12. Lifting Link

Figure 1.1**GENERAL ARRANGEMENT OF B.G. FLEXI-COIL BOGIE MK-I**

The locomotive body weight is transferred to bolster through a centre pivot. The steel – cast “H” type bolster is supported on the steel – cast bogie frame at four corners, by pair of helical springs placed in spring pockets of main longitudinal member of the bogie frame.

The bolster is located with respect to bogie frame by upright pedestals, which are integral part of the bogie frame. This arrangement serves to transmit force from bolster to the bogie frame and vice-versa. Lateral stops are provided on the bolster as well as on the bogie frame to limit the side movement by flexing action of the springs. The bogie frame is in turn supported on the axles by another set of springs resting on the top of axle boxes. The load of the locomotive superstructure rests on the centre pivot bowl of the bogies. Bogie pivot arrangement and clearance is shown in Figure 1.2. The bowl is fitted with vertical and horizontal liners made of phenolic material, which provides rotational freedom between body and bogie in operation. Two lifting links as shown in Figure 1.3 are located diagonally opposite which provide easier accessibility as well as reduce number of mechanism to engage or disengage the bogie when installing or removing.

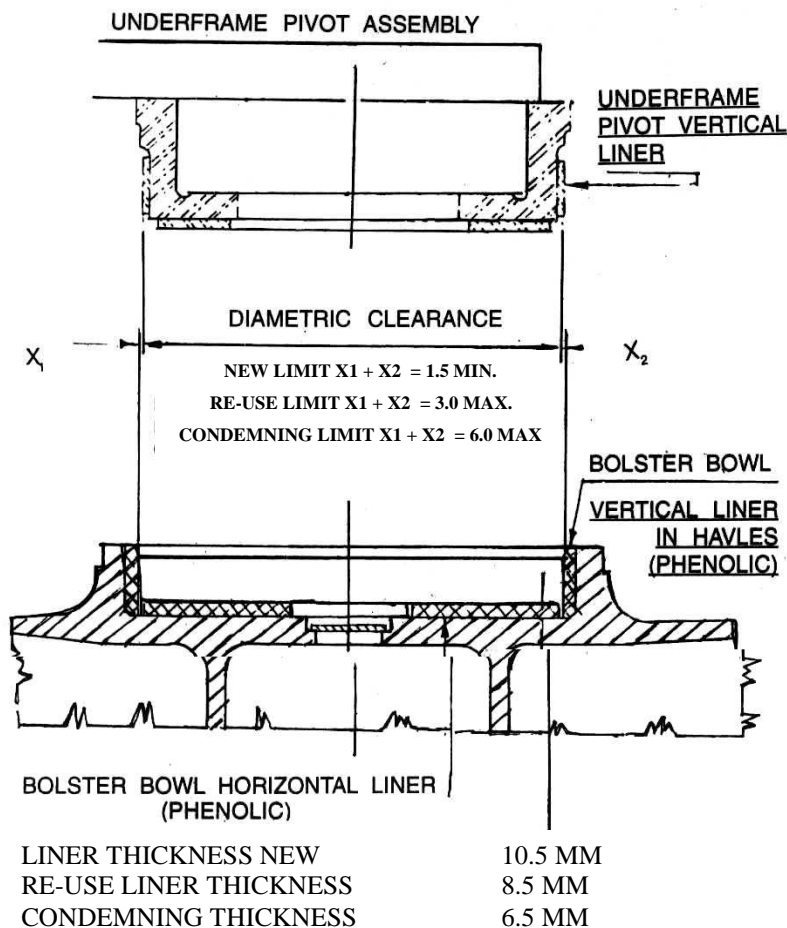


FIGURE 1.2
BOGIE PIVOT ARRANGEMENT AND CLEARANCES

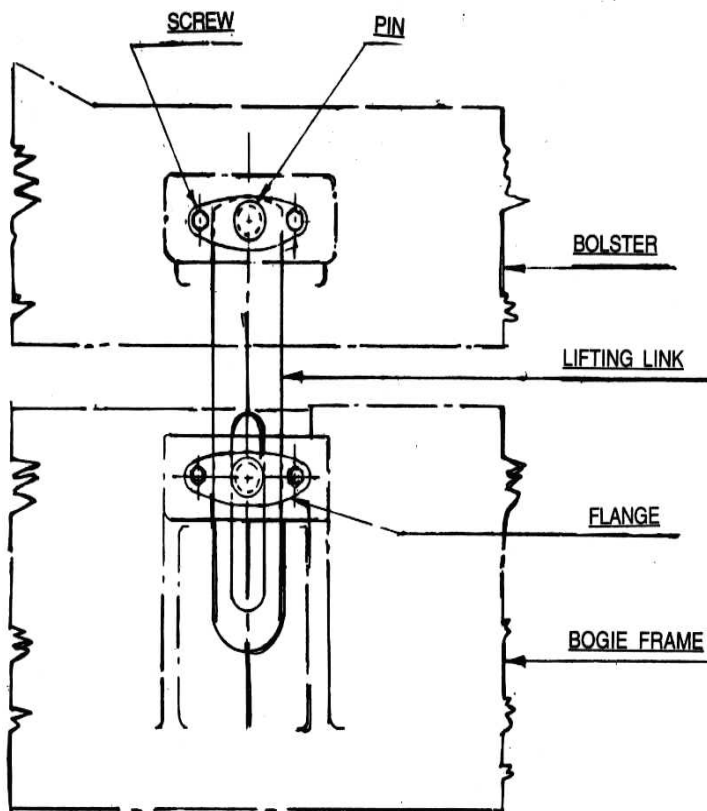
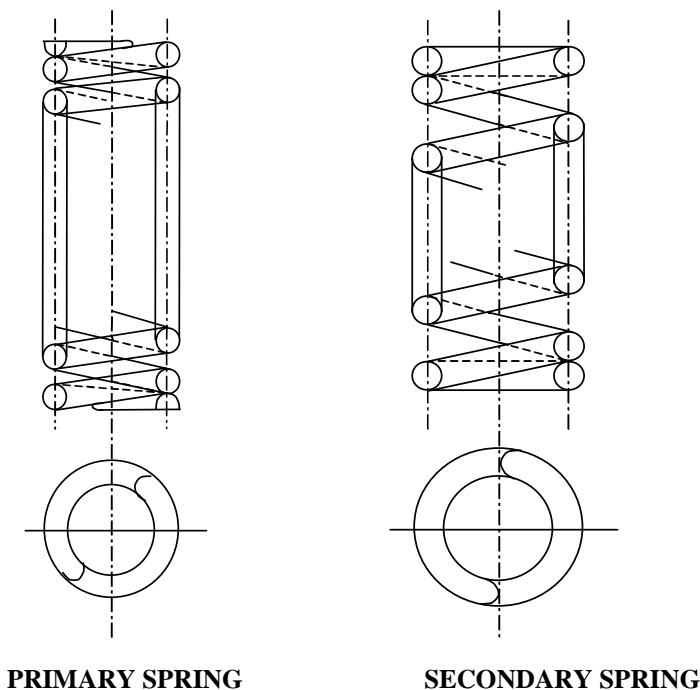


FIGURE 1.3
LIFTING LINK

1.1.2 Suspension

This flexicoil bogie Mark-I has two stages of suspension in which helical springs have been used at primary and secondary stages. Primary, between axle box and bogie frame and secondary, between bogie frame and bolster. A view of primary and secondary suspension spring is shown in Figure 1.4. The loco flexibility on the primary and secondary stage is 0.75 mm/t and 1.13 mm/t respectively. The total static deflection is 150 mm, comprising 66.0 mm in primary and 84.0 mm in secondary. The transverse flexibility between the body and the bogie has been achieved by the flexing action of the helical spring at the secondary stage. The support of the bolster springs has been placed on wider arm to give better stability in rolling. Shims of different thickness already provided on the bogie frame and bolster below the spring seats of primary and secondary suspension are to be retained and ensured during assembly since they are matched to get equal working heights of springs after calibrations.

Spring Data	PRIMARY	SECONDARY
	Dimension in mm	Dimension in mm
Outside Diameter	178 ± 1.5	210 ± 1.5
Bar Diameter	33 ± 0.05	38 ± 0.05
Free Height	385 ± 6	478 ± 7
Solid Height	267.3	345.8
Static Height	319 ⁺³ ₋₄	394 ⁺⁴ ₋₅
Static Load	3.697 t	4.11t
Solid Load	6.667 t	6.902 t
Direction Of Winding	R.H.	R.H.
No. Of Coil - Total	8.5	9.5
No. Of Coils - Active	7	8

**FIGURE 1.4****A VIEW OF PRIMARY AND SECONDARY
SUSPENSION SPRINGS****1.1.3 Bolster Spring Friction Device**

Each bogie frame has two spring loaded snubbing pistons in the pedestals. These are made of phenolic material. This arrangement provides high friction between bolster and bogie frame for damping in both vertical and lateral mode of oscillations. The bolster

spring friction device is used in the bolster assembly. It consists of a phenolic piston, steel washer and a spring contained within a cylindrical housing in the bolster. The dimension of snubbing piston is shown in Figure 1.5 (a). A suitable fixture and a jack may be used to apply or remove the friction piston as shown in Figure 1.5 (b). After the piston is installed a safety stop should be welded in position. A suitable wedge should be inserted in between safety stop and piston guide before removing and re-assembling of bolster into the pedestal bogie frame.

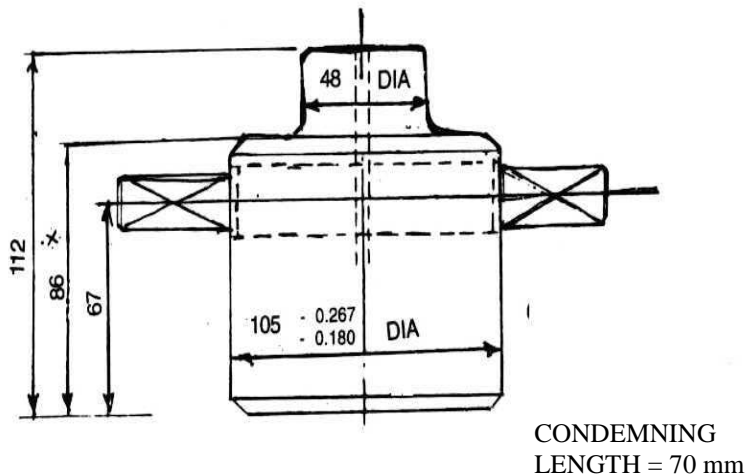


FIGURE 1.5(a)

SNUBBING PISTON DETAILS

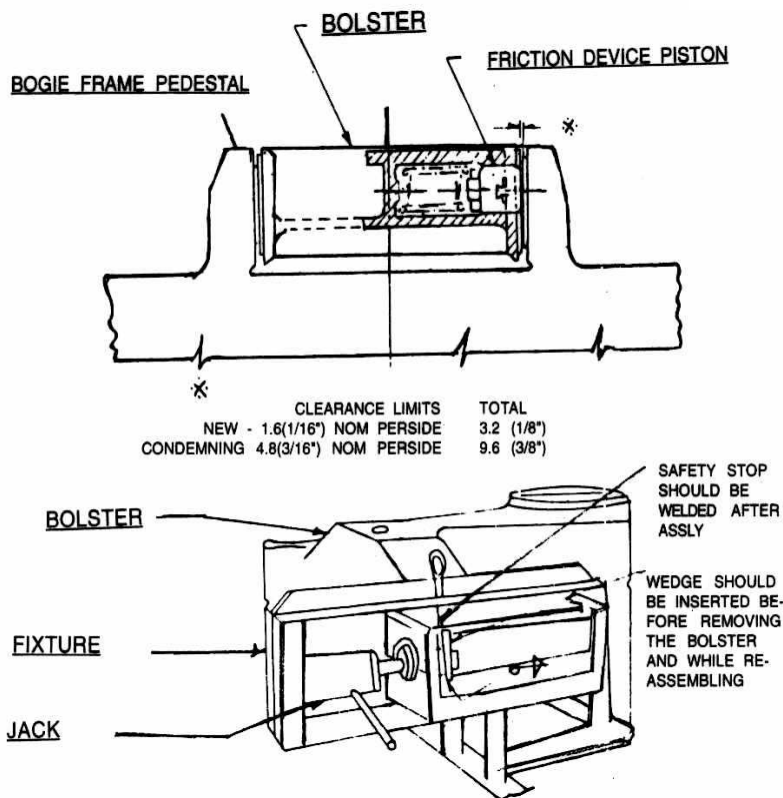


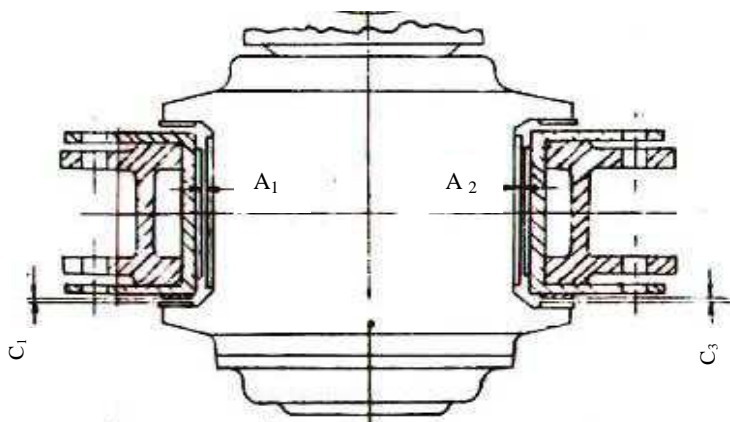
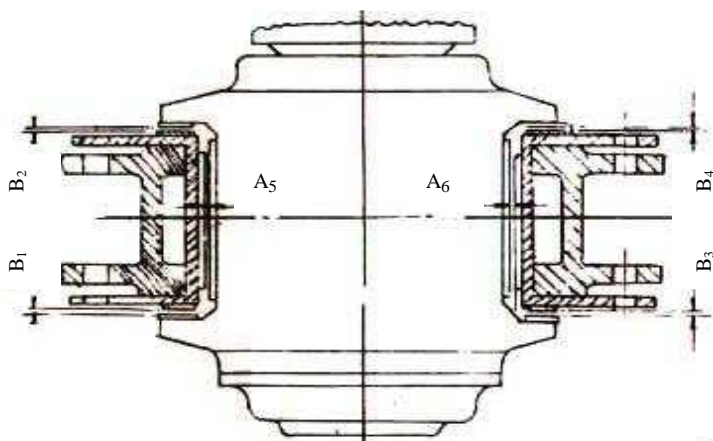
FIGURE 1.5 (b)

FIXTURE FOR APPLYING PISTON TO BOLSTER

1.1.4 Wheel Set and Axle Box

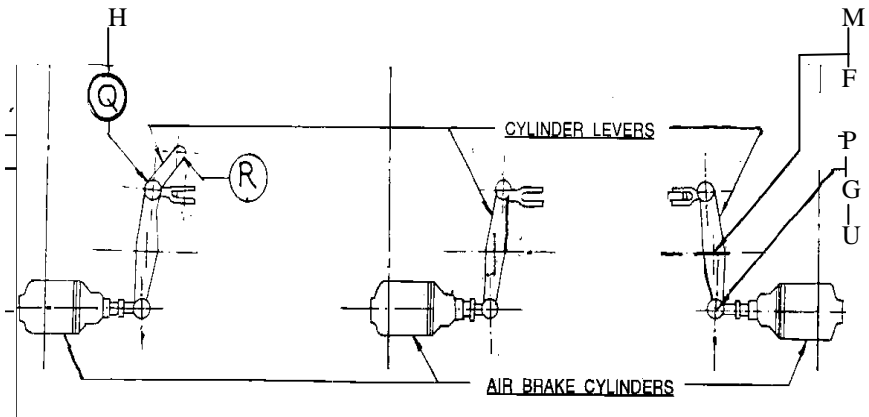
Each bogie has three wheel sets along with six axle boxes mounted in pedestal cast integral with the bogie frame. One adaptor is screwed to each pedestal keeping liner face inside the pedestal. Negotiation over curves and turnouts is obtained through the lateral play between axle box and pedestals. In conventional design of axle boxes, the axial thrust arising from flange-rail reaction is exchanged between the axle and the housing in a rigid manner. To reduce the effect of the impact a resilient device has been incorporated in the path of the axle thrust. In end axle boxes, the thrust is made to pass through a conical rubber thrust pad held between inner and outer thrust collars. Middle axle boxes are with FLOATING bearing so as to permit safe negotiability over sharpest curves and turnouts. Clearances for WAP1 loco are given below.

Lateral clearances			
All dimensions are in mm	Original		Service limit
	Min.	Max.	Max.
End axle number 1,3,4 & 6 (total per axle) Dimensions $C_1 + C_2, C_3 + C_4$	1.80	3.60	9.50
Centre axle number 2 & 5 (Total per axle) Dimensions $B_1 + B_2, B_3 + B_4$ $B_5 + B_6, B_7 + B_8$	1.80	3.56	6.0
Longitudinal Clearance			
All axles (total per axle) Dimensions $A_1 + A_2, A_3 + A_4$ $A_5 + A_6, A_7 + A_8$	0.35	1.95	3.50

**END AXLE BOX****MIDDLE AXLE BOX****FIGURE 1.6****CLEARANCES BETWEEN AXLE BOX AND PEDESTAL LINERS**

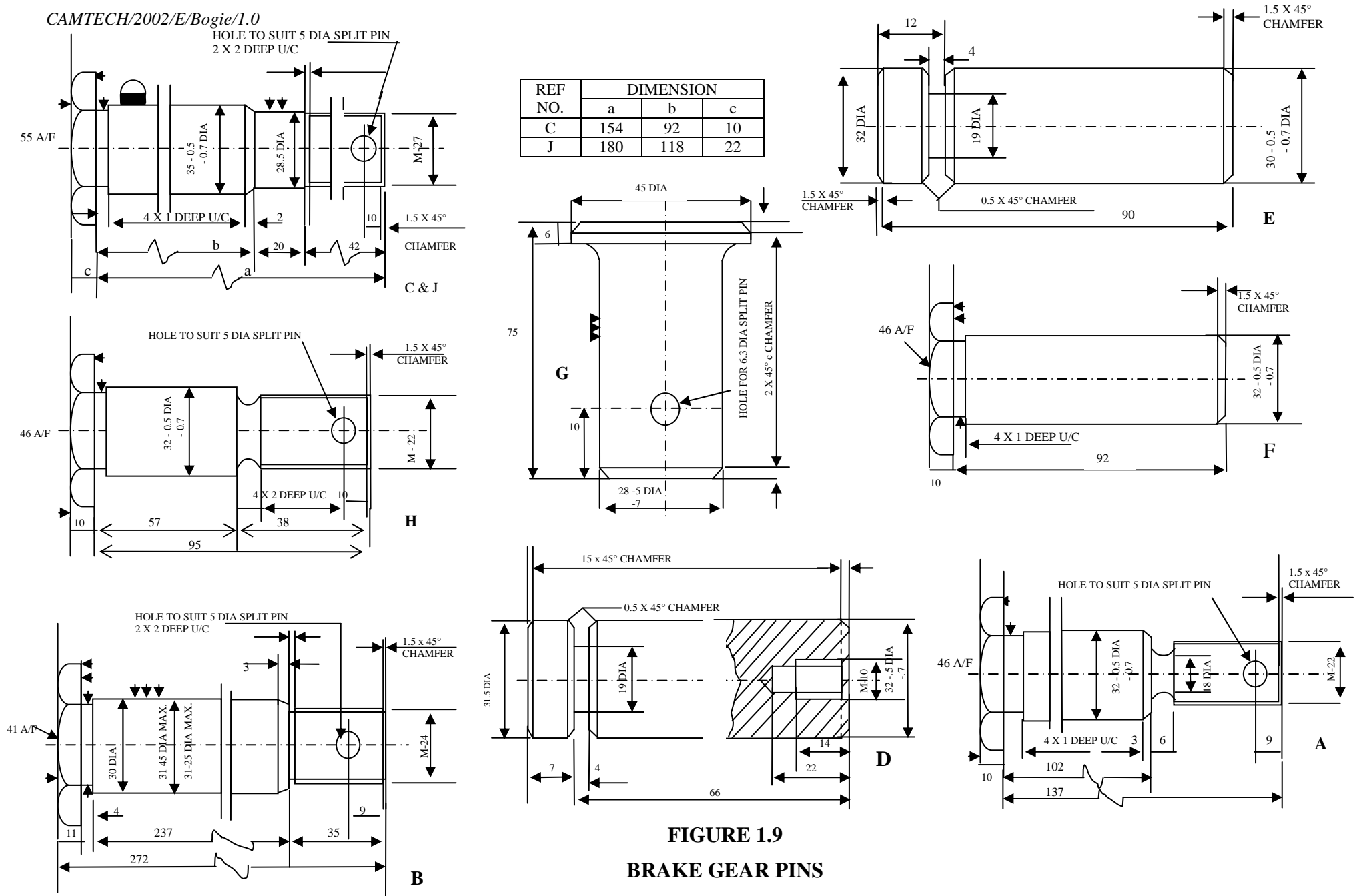
1.1.5 Brake System

Pneumatic brake system is applied in this bogie. Six (203 dia x 203 stroke) brake cylinders per bogie are used to operate clasp type brake rigging. Each cylinder piston is connected to the brake lever to actuate the brakes on one wheel only. In service, the brake shoes adjustment can be done by actuating adjusting rod at the bottom. Brake blocks and shoes are of conventional type. Details of brake rigging are shown in Figures 1.8 (a), 1.8 (b), 1.9 & 1.10.



H-Q	PIN FOR CLEVIS 32 DIA
R	BUSH 28 ID x 38 OD x 22 LONG
P-G-U	BUSH 28 ID x 38 OD x 25 LONG
F	PIN FOR AIR BRAKE CYLINDER LEVER
M	BUSH 32 ID X 41 OD X 32 LONG
(All dimensions are in mm)	

FIGURE 1.8 (a)
BRAKE CYLINDER AND BRAKE LEVER ASSEMBLY



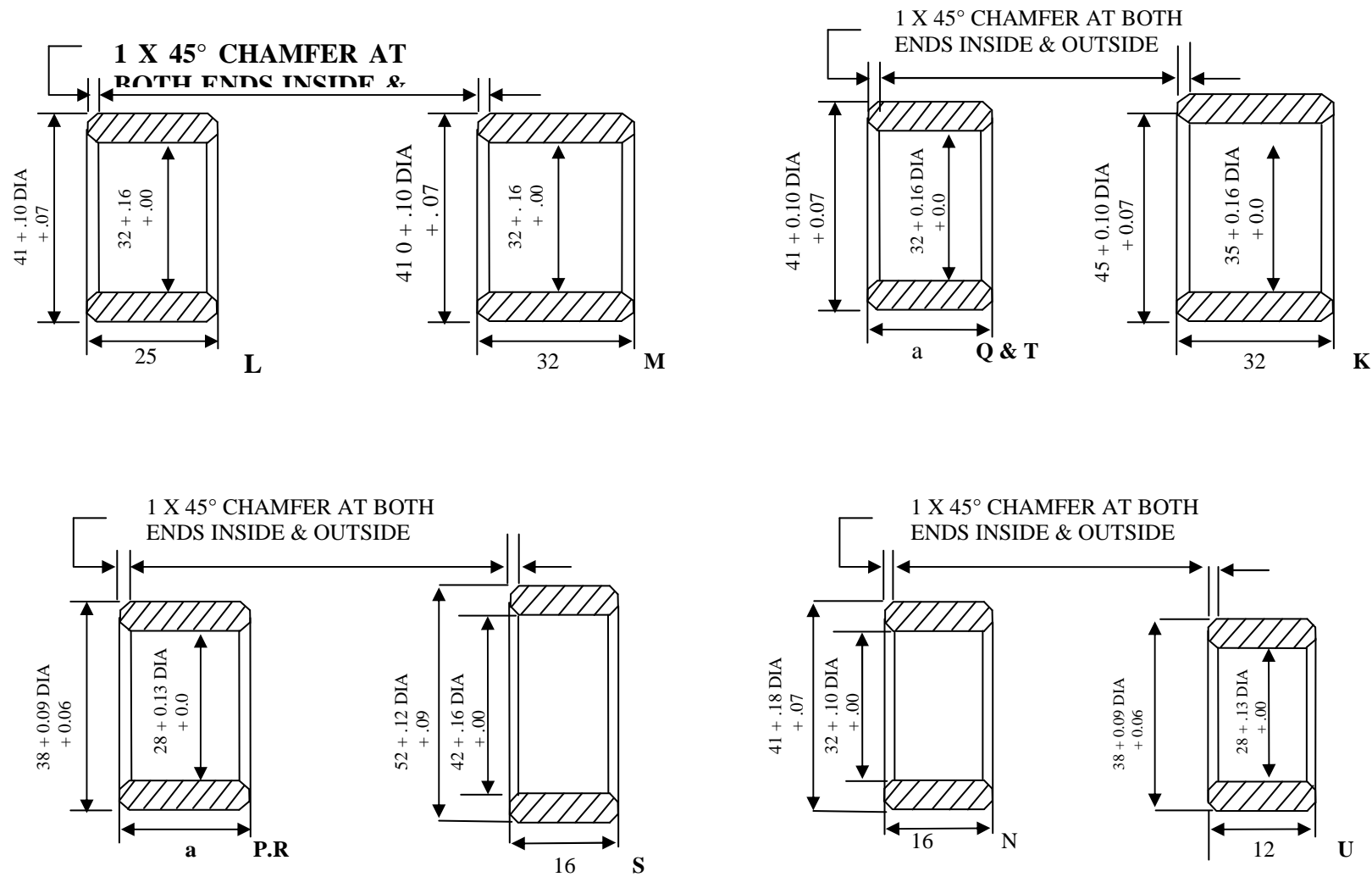


FIGURE 1.10

BRAKE GEAR BUSHES

DETAILS OF FIGURE 1.8 AND FIGURE 1.9

Ref	Description	No./ Loco
A	Pin for brake hanger lever	8
B	Pin for slack adjuster	12
C	Pin	12
D	Pin for brake head hanger	24
E	Pin for brake head lever	4
F	Pin for air brake cylinder lever	12
G	Pin for push rod	12
H	Pin for clevis	24
J	Pin for brake head hanger	12

Note : Condemning diameter = Nominal diameter - 2mm

DETAILS OF FIGURE 1.10

Ref.	Description	No./ Loco
K	Bush 35 ID x 45 OD x 32 Long	24
L	Bush 32 ID x 41 OD x 25 Long	32
M	Bush 32 ID x 41 OD x 32 Long	32
N	Bush 32 ID x 41 OD x 16 Long	24
P	Bush 28 ID x 38 OD x 25 Long	12
Q	Bush 32 ID x 41 OD x 22 Long	32
R	Bush 28 ID x 38 OD x 22 Long	2
S	Bush 42 ID x 52 OD x 10 Long	72
T	Bush 32 ID x 41 OD x 20 Long	48
U	Bush 28 ID x 38 OD x 12 Long	24

Note : Condemning diameter = Nominal diameter + 2mm

CHAPTER 2

MAINTENANCE

Various maintenance schedules are to be carried out at regular intervals to keep equipment in healthy condition always. Maintenance schedules for Flexicoil Bogie Mark-I of electric locomotives are given below:

2.1 Trip Inspection

As and when locomotives comes to the trip shed, following inspection to be done:

2.1.1 Bogie and Bolster

- Visually examine, both bogies and bolsters for cracks etc.

2.1.2 Brake Gear

- Check brake rigging for loose nuts, pins etc. Brake shoe release should not be less than 6 mm.
- Check for loosening of adaptors.
- Ensure that the safety straps of bottom brake adjusting pull rods are in position and the screws holding them are intact.

- Apply the air brake of the locomotive and check that all the brake cylinder pistons are operating freely. Brake cylinder pressure should not exceed 3.5 kg/cm^2 .
- Check the wear on brake shoes and replace if necessary.
- Observe for any leaks in the bogie hose pipe connections.

2.1.3 Traction Motor Axle Suspension Bearing

- Check the oil level in the lower sump of axle cap with clean dipstick.
- Observe for any leaks of oil, burning smell or overheating.
- Proper tightness/sealing of axle cap bolts.

2.1.4 Traction Motor Gear Case

- Check amount of lubricant in gear case with dipstick and top up if necessary up to the maximum mark on dipstick and close the spring loaded cap.
- Visually examine for cracks and rectify.
- Check intactness of gear case bolts.
- Check for any damage to felt seal and oil leakage.

2.1.5 Axle Box

- Visually examine axle box for any damage or cracks from any striking object or for any unusual condition.
- Check for missing or improper locking of cover's studs.
- Observe overheating sign on outside position of each box. Running temperature should not be more than 28° C above ambient temperature.
- Attend booked repair, if any.

2.1.6 Suspension Spring

- Visually examine all the suspension springs, and spring seat for any crack and damage.

2.1.7 Return Current Shunts

- Examine the shunt connection between traction motor and under frame, tighten if required.

2.1.8 Speed recorder/ Speed indicator/ Drive connections

- Examine the flexible drive connections of speed indicator for any rubbing marks and damage.

2.2 PERIODIC SCHEDULES

The activities to be carried out during various periodic schedules are as under:

Indication: "*" work to be done, "-" Work not to be done

SN	WORK TO BE CARRIED OUT	I A	I B	I C	AO H	IO H
1	Bogie and Bolster <ul style="list-style-type: none"> Cleaning of bogie frame Thorough cleaning of bogie frame in washing tank Cleaning and painting Examine for defective and missing parts and cracks <ul style="list-style-type: none"> a) Bolster - I and II b) Bogie frame I and II Check bolster liner. Provide if deficient. Overhaul Bogie frame and bolster Check bogie squareness 	-	-	*	*	*
		-	-	-	-	*
		-	-	-	*	*
		*	*	*	*	*
		*	*	*	*	*
		*	*	*	*	*
		-	-	-	*	*
		-	-	-	-	*
2.	Bogie Pivot <ul style="list-style-type: none"> Check centre pivot housing for cracks. Check proper sizes and clearances 	-	-	*	*	*
		-	-	-	*	*
3.	TM Nose Suspension <ul style="list-style-type: none"> Check condition of nose suspension bolts etc. Provide overhauled nose pad Check for wear on bogie lug wear plate Ensure intactness of pins of nose suspension Check clearance between nose pad and TM lug. 	*	*	*	*	*
		-	-	-	*	*
		*	*	*	*	*
		*	*	*	*	*
		-	-	-	*	*

SN	WORK TO BE CARRIED OUT	I A	I B	I C	AO H	IO H
6.	Hand Brake <ul style="list-style-type: none"> • Clean the hand brake parts and check for tightness of bolts. • Check and ensure its working. • Lubricate and adjust as necessary. 	*	*	*	*	*
7.	Outer Hangers <ul style="list-style-type: none"> • Overhaul • Check condition of outer hanger • Uncouple the hanger pins. Check for groove, worn out and refitted properly. • Check hanger bush before fitting. Repair the pin hole if found oval. • Provide safety bracket. 	- * - - -	- * - - -	- * * * *	* * * * *	* * * * *
8.	Suspension Spring <ul style="list-style-type: none"> • Check all primary and secondary springs for breakage if any. • Clean with brush don't scrape. • Dimensional check and pairing by colour coding and record 	* - -	* - -	* - -	* * *	* * *
9.	Safety plates <ul style="list-style-type: none"> • Check tightness of all safety plate bolts. Attend if found loose. 	*	*	*	*	*
10.	Buffer Height <ul style="list-style-type: none"> • Check and record buffer height of the locomotive at both ends. Adjust if Required. 	*	*	*	*	*

SN	WORK TO BE CARRIED OUT	I A	I B	I C	AO H	IO H
11.	Axle Boxes <ul style="list-style-type: none"> • Check grease condition. • Check the fixation screw of bearing end plate. • Remove old grease. Replace with fresh. • Check lateral and longitudinal clearances between axle boxes and pedestal horn liner. • Check the condition of liners for welding and replace, if necessary. • Check and ensure proper fixation of front covers. • Check proper tightness of stay plate. • Overhaul axle boxes. 	-	-	*	*	*
		-	-	*	*	*
		-	-	*	*	*
		*	*	*	*	*
		*	*	*	*	*
		*	*	*	*	*
		-	-	-	-	*
12.	Wheel and Axle <ul style="list-style-type: none"> • Check wheel for crack, other defects and overheating signs • Measure and record flange wear, root wear, tread wear, wheel diameter. Re-profile, if necessary. • Ultrasonic testing of axle to be done. 	*	*	*	*	*
		-	-	*	*	*
		-	-	*	*	*

2.3 AOH SCHEDULE

Whenever a locomotive has been taken in AOH/ IOH, first of all make out a list of deficiencies and defects as per log book and history book. Check all clearances of bogie and record them before lifting the locomotive and starting the overhaul activities.

2.3.1 Removal of Bogies

1. Place the locomotive on repair line. Record the bogie frame number.
2. Disconnect the following before any attempt is made for lifting the locomotive for running out the bogies.
 - a. Release safety interlock which is attached to the under side of the superstructure under frame and locks into the recesses of the bogie bolster.
 - b. Air brake pipe connections.
 - c. Hand brake chain connected to brake lever.
 - d. Speedometer connections etc.
 - e. Return current shunts between bogie and body for electric locos.
 - f. Sand pipe connections.
 - g. Traction motor leads and connecting screws of bellows.

The bogie may then be removed by the following procedure:

1. Lift the superstructure at lifting points with crane and lower on the stand placed at proper location or lift with high lifting jacks to a sufficient amount to

disengage pivot from the bolster bowl and to permit the complete bogie to pass under the draft gear while being removed longitudinally along the track.

2. Before lifting superstructure following precautions to be observed:
 - a. Make sure that all physical connections between the superstructure and the bogie are disconnected.
 - b. When lifting or jacking a locomotive, to remove one or both the bogies, all four corners should be raised equally to prevent strain on under frame.
 - c. Superstructure should not be lifted excessively more at one end than the other until the pivot do not disengage from the bolster bowl.

2.3.2 Dis-assembly of Bogie

The following general procedure may be followed for disassembly of bogie:

2.3.2.1 Bolster Removal

Before attempting to remove the bolster disconnect the following.

1. Disconnect the two lifting links, which normally hold the bolster to the main frame.
2. The piston of the bolster friction device should also be secured by inserting a suitable wedge to prevent any possibility of the piston being forced out when the bolster is raised clear of the piston. There are two friction devices in one bolster.

3. Lift the bolster from the bogie assembly by a crane and sling after ensuring complete disconnection of fittings and keep a side for cleaning and inspection.

2.3.2.2 Bolster Spring Removal

Remove all the secondary helical springs with shims, if any, and keep them in sets for cleaning, inspection and testing.

2.3.2.3 Friction Damping Device

After continued use, the wear on the friction piston will reduce its length and loosen the effect of the spring on the piston. The piston can be continued in use until the piston length 70mm is reached. This dimension will allow 16mm wear on the piston. However, when the piston reaches a dimension of 80 mm or 6 mm wear a compensating washer 6mm thick should be added to the standard 10mm washer. The piston cross pin also be worn by movement in its guide slot. When the cross pin is worn to 10mm or half of its diameter, it should be removed and a new pin should be fitted to the piston.

Procedure for Cross Pin Replacement

- a. Drill and tap cross pin dowel.
- b. Apply a number of washers under the head of the bolt and use the bolt as a puller to remove the cross pin dowel.
- c. Remove the old cross pin and apply a new pin at its place.

- d. Drill the new cross pin to receive a new dowel.
- e. Insert a new dowel of diameter $6 - 0.025 \text{ mm}$ to secure the pin. $+ 0.00$

2.3.2.4 Traction Motor Removal

1. Remove all traction motor nose suspension assemblies as given below:
 - a. Lift motor sufficiently to compress suspension approximately 12mm.
 - b. Remove cotters and tighten nuts of suspension bolts.
 - c. Lower motors so that noses lugs are free of spring suspension.
 - d. Remove pin keepers and drop vertical pins.
 - e. Slide suspension assembly out, sidewise.
2. Drain out gear case.
3. Remove gear case.
4. Drain oil from the axle cap at bottom in case of traction motor TAO- 659.
5. Unbolt axle cap and remove.
6. Lift motor clears of the axle and place it on the floor.

2.3.2.5 Suspension Bearing

For details refer Maintenance Handbook for Suspension Bearing TAO-659 (CAMTECH/98/E/SB/7.0 August, 1998).

2.3.2.6 Dis-assembly of Brake Rigging

1. Remove all the bottom slack adjusters to free brake shoes.
2. Remove all the brake blocks and brake shoes.
3. Disconnect all brake levers, brake hangers etc.
4. Keep all components together for cleaning and inspection.
5. Clean brake rigging equipment to remove clogged oil, dirt, grease etc.
6. Replace worn out components i.e. connection strap, brake hangers, levers, brake shoes, pins, bushes, washers etc.

2.3.2.7 Bogie Frame Removal

1. Remove the pedestal tie bar assembly.
2. Lift the bogie frame by a crane and sling and place it in inverted position at proper location for cleaning and inspection.
3. Remove horn adapters by suitably compressing the primary springs.
4. Remove the spring seat.
5. Remove springs with shims, if any, and keep them in sets for cleaning and inspection.
6. The remaining parts of the bogie may be removed as desired for inspection etc.

2.3.2.8 Brake Cylinder

1. Dismantle brake cylinder assembly.
2. Clean all parts and grease etc.
3. Replace defective piston bucket, pins etc..

2.3.2.9 Hand Brake

1. Clean the hand brake parts and check for any loose or missing parts. Replace if necessary.
2. Lubricate and adjust as necessary.

2.3.2.10 Axle box

1. Disconnect all the attachment to the axle box for cleaning and inspection, i.e., speedometer drive etc.
2. Disassemble the axle box housing and roller bearing for cleaning and inspection.
3. If required, replace racers and thrower or bearings in a set.
4. Assemble the axle box by fitting rear end cover, bearing and outer distance piece.
5. Charge bearing and cavities with specified grease.
6. Lift the complete axle box and fit on axle gently. During the operation, care should be taken to avoid any possible damage of inner races resulting from scoring by the rollers due to unsquare mounting.
7. Fit axle box accessories and affix clamping plate locking the screws in position. Follow on with the assembly of front end cover and seal it.

8. During maintenance schedules remove end cover from one or more boxes per loco after the first 8000 kms. running and examine the grease near the bearing to see condition. If satisfactory, replace any grease lost in end cover during examination and reassemble end cover. Inject 15-30 CC (0.0135 - 0.027 Kg) of specified grease into all boxes. At four/ six monthly periods or 80,000 kms running which ever is earlier, inject 30-50 CC (0.027 -0.045 Kg) specified grease into all boxes. At twelve monthly periods remove axle boxes and clean out for inspection of bearing release as for first assembly.

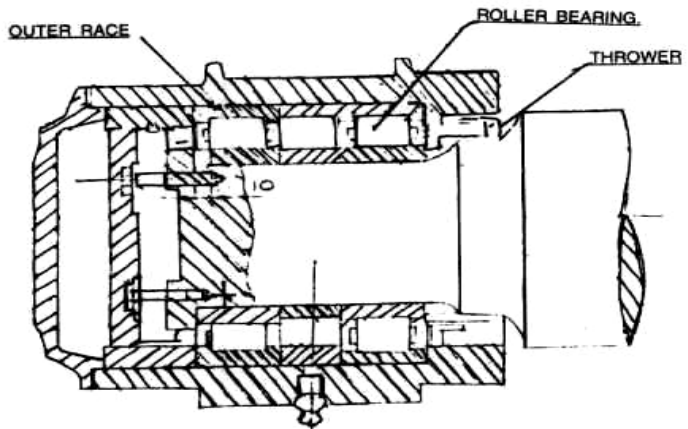


FIGURE 2.1
CENTRE AXLE BOX

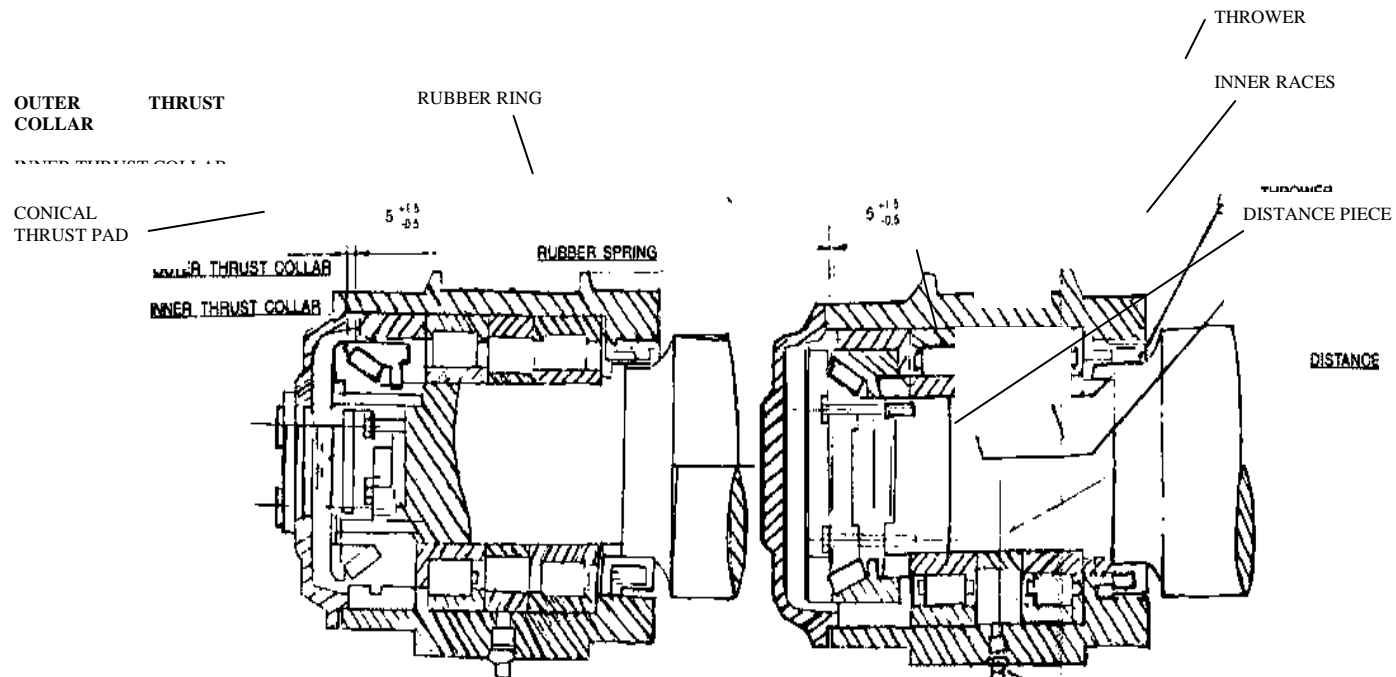


FIGURE 2.2

END AXLE BOXES

2.3.2.11 General instructions for storage and handling

- Always store the bearing and axle boxes with bearings in a clean and dry place in their original wrapping until required for actual installation. Avoid storage in appreciably hot surroundings.
- Do not stack too many bearing on top of each other, otherwise the bearing and its wrapping may lead to corrosion problems. Also never store bearing up right but lay them flat. Utilise old stock first.
- While handling the bearings ensure that absolute cleanliness is maintained. A smooth metal topped bench, which can be wiped will be great advantageous.
- Do not leave the bearings unwrapped and exposed to flying metal chips and other foreign particles.
- Installation of roller bearings axle boxes on wheel sets should be done inside a separate dust proof shed.
- Care should be taken while handling of wheel sets to avoid any damage to the already mounted axle boxes before lowering the bogie frame over the wheel sets for final assembly. The free rotation of axle boxes must be ensured.
- Whenever it is necessary to do any electric welding on the loco/bogie frame the roller bearing should be avoided from electric circuit by connecting the earthing cable close to the spot being welded.

2.3.2.12 Type of Grease

The following type of grease has been approved by R.D.S.O. for motor suspension unit of traction motor HS-15250, armature of both HS-15250 and TAO-659 as well as axle boxes of all type of electric locomotives.

- | | | |
|----|-----------------------|------------|
| 1. | Servogem | RR-3 (IOC) |
| 2. | Balmeral Multi Grease | LL-3(B&L) |

2.3.3 Re-assembly of Bogie

Re-assembly is the reverse process of dis-assembly. After cleaning, inspection, repair and replacement of worn out or broken parts i.e. pins, bushes and liners etc. reassemble the bogie.

1. Set three, wheel set and axle boxes assemblies over a pit as spaces below:

SN	ITEM	Flexicoil bogie Mark-I
1.	Two units with the nose suspension ends facing one another and axles spaced.	2160 mm
2.	Third unit with the nose suspension end facing away from the adjoining unit and axle spaced.	1735 mm

2. For the lack of convenience at least one pit may be nominated for AOH/ IOH and these spacing may be permanently marked on this pit.
3. Keeping the bogie frame in inverted position, assemble primary springs with spring seats in position. Fit horn adaptors with liners fully pressed against the horns. Fit pedestal bolt nuts, spring washer and split pins.
4. Lower bogie-frame as assembled above on wheel sets carefully seating on the axle boxes.
5. Fit pedestal cap along with bolts, nuts spring washers and split pins. Tighten it in position.
6. Assemble complete brake equipment such as levers, hangers, pins etc. with bottom slack adjuster on bogie frame. Slack adjustment can be made by raising the hinged lock and turning the slack adjuster screw head until the brake shoe is at the desired location. When the adjustment has been made, lower the hinged lock over the adjustment screw to prevent the adjustment screw from turning. When greater adjustment is needed, the position of the brake lever on the connecting strap can be adjusted by changing the proper brake lever to an alternative location of the connecting strap.
7. Lower traction motor in between bogie lugs.
8. Assemble nose suspension assemblies.

9. Tighten holder bolts to compress rubber sand-witch block sufficiently to slide in between lugs of motor and frame. Slide the assemblies in position and install vertical pins from the bottom. Apply pin keepers.
10. Fit the gear case and seal all bolts.
11. Connect return current shunts between axle box and bogie frame wherever applicable.
12. Place all the secondary springs in bogie frame secondary-spring pockets with liners/shims, if any.
13. Lower the bolster carefully on the secondary springs after putting the wedge to keep the friction damper piston in the safe position.
14. Connect lifting links between bogie frame and bolster.
15. Check and clean, the bolster bowl. Apply lubricant to the outside diameter of the vertical phenolic liners and fit them in the bowl 90° from the longitudinal centre line of the locomotive. Now place horizontal and vertical phenolic liners. Take care that no foreign material is left on the liners. This may damage and score the liners in service.
16. Fill the bowl with requisite lubricating oil maintaining oil level approximately 10mm above the horizontal liner top surface (Approx. 2 litres per pivot bowl).
17. Check finally and fit other components, which might have left out before placing the bogies under the locomotive superstructure.

2.3.4 Re-application of Bogies to Locomotive

Reapplication of the bogies is the reverse procedure of removal. However when applying a bogie to the locomotive ensure the following:

1. Position both bogies so that bogie bolster bowl and under frame pivot centers are brought in lines.
2. Lower the locomotive superstructure on the bogies carefully. Before the superstructure is completely positioned, see that the bowls and pivots are correctly positioned.
3. Assemble safety interlocks of the superstructure under frame into the recesses of the bogie bolsters.
4. Connect traction motor leads.
5. All the connections are reset and traction motor air ducts are put in proper position.
6. Connect return current shunts between bogie and body.
7. Connect brake piping hose and hand brake chain.
8. Re-adjust brakes
9. Remove all tools, rags or blocking equipment that may be on bogie or chassis.
10. Connect speedometer drive generator, speed recorder etc.
11. Inspect finally for any left over connections, loose fittings or wrong assembly. Get it rectified.

2.3.5 CLEARANCE CHECK SHEET OF FLEXICOIL BOGIE MARK - I

Wheel No.	Longitudinal Clearance	Lateral Clearance		Bolster liner to Bogie liner	Bolster Pad to Bogie Pad (Bottom)		Bolster to Bogie Vertical distance		Bolster to Body Plain distance		Buffer Height		Centre Pivot Clearance	Remark
	0.35 to 3.5	Outer wheel	Middle wheel	New-1.6 to 3.2 Condemn-9.6	Large	Small	Large	Small	Large	Small	Cab- 1	Cab - 2	New- 1.5 Service-3.0 to 6.0	
		1.8 to 9.5	1.8 to 6.0		32 + 2 - 1		31 + 4 - 2		6.0 to 10		1090 to 1035 + 15 - 5			
1	2	3	4	5	6		7		8		9	10	11	12
1.				Cab-1 A/S.	Cab-1 A/S		Cab-1 A/S		Cab-1 A/S		Cab-1 A/S	Cab-2 A/S	Cab - 1	
2.														
3.														
4.				Cab-1 D/S	Cab-1 D/S		Cab-1 D/S		Cab-1 D/S		Cab-1 D/S	Cab-2 D/S		
5.														
6.														
7.				Cab-2 Driver Side	Cab-2 Driver Side		Cab-2 Driver Side		Cab-2 Driver Side		Rail Guard Height 115 + 3.0 - 0.0		Cab - 2	
8.											Cab-1 Driver Side	Cab-2 Driver Side		
9.														
10.				Cab-2 Asstt. Driver side	Cab-2 Asstt. Driver side		Cab-2 Asstt. Driver side		Cab-2 Asstt. Driver side		Cab-1 Asstt. Driver Side	Cab-2 Asstt. Driver Side		
11.														
12.														

All dimensions are in mm. D/S - Driver Side, A/S - Assistant Driver Side

2.3.6 Wheel Set Changing

Whenever wheel set is required reprofiling or changing in service due to wheel defect, seizure of traction motor suspension bearing, hot axle boxes etc., the following details of wheel set to be ensured. The tyre profiles are shown in figure 2.3.

Tread Diameter

Nominal diameter	=	1092 mm
Service limit	=	1016 mm

Difference in tread diameter of wheel on the same axle:

Permissible limit	=	0.5 mm Max.
Service limit	=	2.5 mm Max.

Difference in tread diameter of wheel in the same bogie:

Permissible limit	=	2 mm Max.
Service limit	=	8 mm Max.

Difference in tread diameter of wheel on the same locomotive:

Permissible limit	=	15 mm Max.
Service limit	=	25 mm Max.

Gauge width

Distance between the inside gauge face of the wheels on the same axle:

Permissible variation	=	$1596 \pm 0.5\text{mm}$
Service limit	=	$1596 \begin{matrix} + 1.5 \text{ mm} \\ - 0.5 \end{matrix}$

(Average of four measurements at equal spacing on the periphery of wheel is to be recorded)

2.4 IOH SCHEDULE

In addition to AOH schedule following work to be done during IOH schedule.

2.4.1 Bogie Frame and Bolster

1. Wash the bogie frame and bolster in the washing tank. Clean the bogie frame and bolster to ensure removal of all foreign materials and cleaning agents. Pneumatic pipes are to be blown out first with water and then with air to remove moisture and loose scale.
2. Check for evidence of cracks on bogie frame and bolster and repair the defects.
3. Remove cracked or worn out liners by chipping off. Replace by new liners welded on the Adaptors. Down hand welding should be done.
4. Inspect the pedestal jaws to be sure that the surfaces are smooth and free of any raised area.
5. Inspect the mounting holes and pedestal bolts holes to be sure that these are not elongated and dimensionally perfect.
6. Fit the adaptors lightly on the pedestal jaws pressing against jaws by means of adaptor pressing tool.
7. Measure and ensure all the dimensions of bogie frame as mentioned in Figure 2.4.

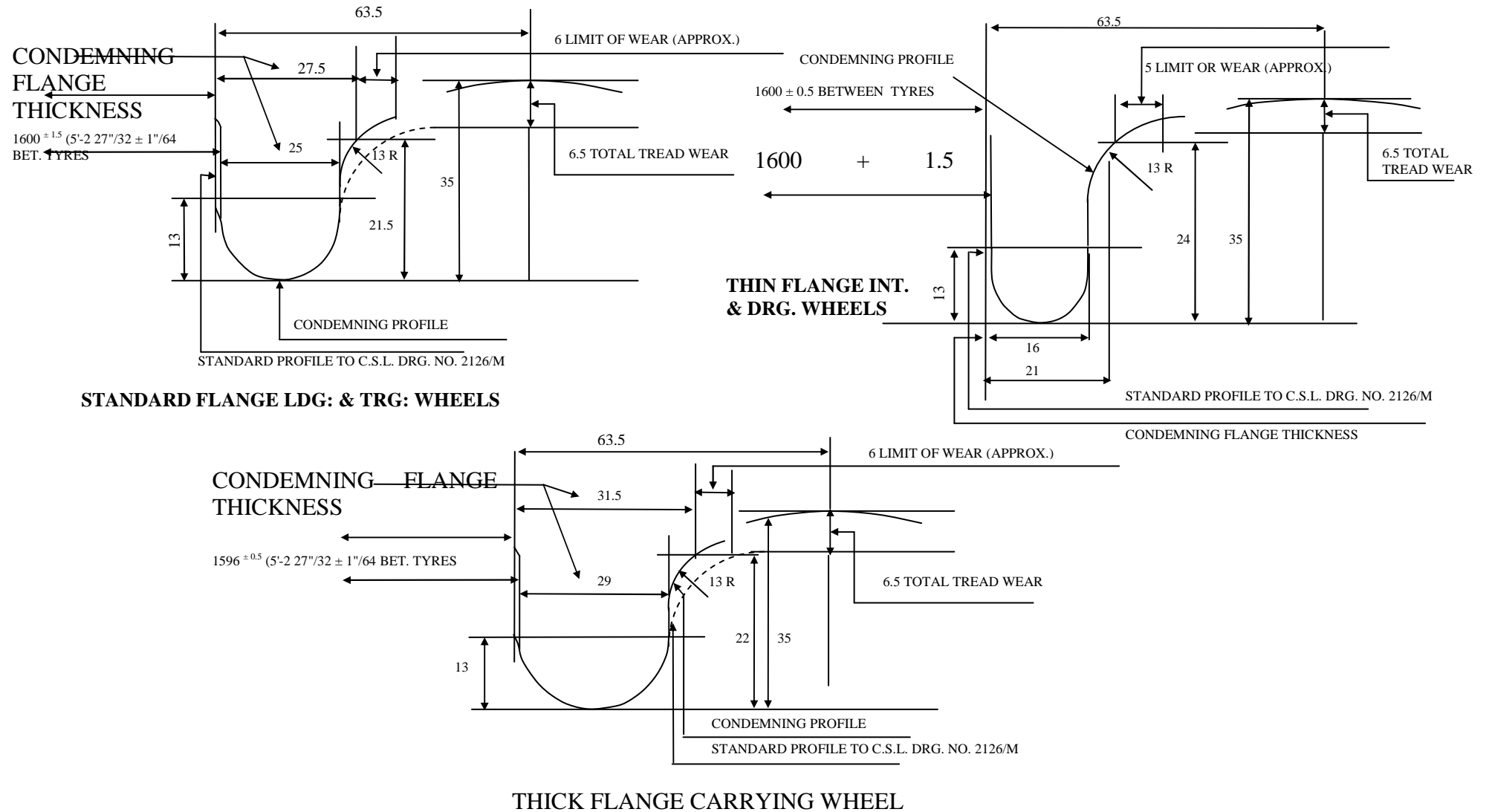


FIGURE 2.3

TYRE PROFILE OF B.G. LOCOS

2.4.2 Brake Rigging

1. Clean and inspect all the brake rigging part and ensure that brake pins, bushes, brake levers, brake head and shoes are useable or not. The wear surface of the brake rigging is equipped with replaceable bushings, pins and bolts. Any of these connecting parts that are worn more than 1.5 mm should be replaced.
2. Cylinder levers, brake levers rods and connecting straps that are bent should be re-used only if they are restored to their original shape. Connecting straps worn more than 1.5mm should be replaced.
3. Bolts and nuts are not subjected to wear can be re-used if they are not damaged but cotter pins should always be replaced.
4. Replace brake heads when face radius becomes worn to the extent that new shoe keys will no longer hold the shoe tightly.

2.4.3 Suspension Spring

1. Clean the springs with wire brush (do not scrape). Visually examine the springs for any cracks or breakage. Cracked spring should not be continued in service under any circumstances.
2. Check and match the "working" height of the springs and record.
3. Check and match "Free" height of the spring and record.

4. Apply protective coating of anti-corrosive paint (black enamel based on epoxy resin) and colour code springs for identification.

2.4.4 Gear Case

The gear case houses gear and pinion and protects from dirt or damage and carries the gear lubricant. Remove the gear case and clean as follows:

1. Drain out the lubricant from the gear case.
2. Dismantle gear case and remove all lubricant and dirt from inside the gear case.
3. Observe precaution given below:
 - i. Do not burn gear case compound because warping will result and when installed it may not properly fit and leakage may occur.
 - ii. Boil, rinse the gear case to remove all cleaner.
 - iii. Thoroughly dry the gear case and repaint it using buff primer or recommended varnish.
 - iv. Felt seals should always be replaced with new seals whenever the gear case is removed or dismantled. Failure to this may result in loss of lubricant and damaged the gears.

4. Assemble the gear case to the truck assembly making sure that the bolts etc. are properly applied and secured.
5. Fill gear case with approximately 6 litre of recommended lubricant and check oil level after an initial trip and add some more if required.
6. Instructions given by the traction motor manufacturers may also be followed for maintenance of the gear case.

2.5 ON LINE MAINTENANCE

The first indication of a bearing failure is the accompanying rise in temperature. Hence the most important check that can be carried out when the bearing is in operation is to check the bearing temperature at various halting stations. If the temperature felt is higher than that of the other axle boxes, the loco may be withdrawn for further investigation.

On line maintenance also calls for observation/ inspection of other aspects like:

- Damaged axle box
- Damaged front/rear cover.
- Loosening of any of the fasteners/ hardware.

During on line maintenance, the operating temperature of freshly greased bearings should be monitored. It should be noted that freshly greased bearings run warmer than those bearings, which have already been in operation. This is because of the extra grease in the axle box. A few trips will stabilise the temperature.

In case of a loco which is withdrawn from service due to defective axle box/ traction motor, an investigation to inspect the bearing without dismounting may be carried out as suggested below:

- Thoroughly clean all the exterior surfaces of the axle box with petrol/kerosene.
- Remove the front cover of axle box housing.

- Examine the grease for the following:
 - Consistency
 - Colour
 - Contamination with water
 - Any foreign particles.
- Take off the axle box housing carefully.
- Examine the bearing and the rear cover for defect.
- Remove the grease from the bearing, wash the bearing and components with kerosene first and finally with petrol.
- Care must be taken so that no hair from the brush sticks to any surface of the bearing. Use of cotton waste is undesirable.
- During cleaning, the bearing should be continuously rotated so that grease from every corner is taken out. It is better to use an ultrasonic bearing cleaning machine to clean the bearings.
- All surfaces, especially those in rolling contact, should be checked by swiveling the bearing.
- Bearing may be rejected due to the defects given below:
 - Pitted/flaked rollers, raceways.
 - Inner ring/outer ring cracked.
 - Cage damaged.
 - Rust/corrosion damaged.

CHAPTER 3

GUIDELINES FOR WELDING

3.1 WELDING OF MANGANESE STEEL LINERS AND WEAR PLATES

3.1.1 Welding Electrodes

1. For welding of manganese steel liners 3.15 mm or 4 mm diameter metal arc welding electrode approved under M1 class of IRS M 28-76 (18% Cr, 8% Ni, 5% Mn) having stainless steel core wire shall only be used.
2. The electrodes shall be preheated in an electric oven at a temperature of 250° C for two hours soaking period or as recommended by the manufacturer.

3.1.2 Preparation for Welding of Existing Axle Boxes and Bogie Frames

- The axle boxes, which have been in service, shall be degreased with a solvent to remove all dirt, oil and grease.
- The worn - out liners/wear plates shall be removed from axle boxes and bogie pedestals by pneumatic chipping/grinding. Oxy - acetylene flame shall never be used for cutting the welds.

- After removal of liners/ wear plates, the weld metal shall be removed completely. The surface shall be ground smooth on the axle box and bogie frame pedestals, confined to the areas where old liners/ wear plate edges had been welded so that new liner is adjusted properly at the same location.
- The mating surfaces of the axle box castings, bogie frame pedestals and the liners/ wear plates shall be prepared by grinding to ensure 70 - 80 % surface contact. To eliminate the possibility of formation of cracks on the liners/ wear plates during grinding operation, intermittent cooling shall be done.
- After grinding, the location to be welded shall be tested by dye penetrant test, both on bogie frame pedestals and axle boxes, to ensure freedom from cracks.
- It is essential to maintain the specified lateral and longitudinal clearances between axle box and pedestal liners. Proper thickness of liners shall, therefore, be selected based on the dimensions measured over the axle boxes and between bogie pedestals after preparation of surfaces. The thickness of liners is specified as 6 ± 0.25 mm.
- No welding of liners on axle box should be done with bearings in position.
- Keep the axle box submerged in water except the area where welds are to be applied.

- It shall be ensured prior to welding of liners that all surface cracks especially on liners have been removed, as any left - over crack on the surface may extend due to contraction of the weld deposit during cooling and cause premature failure of liner during service.
- Mill scale, dust, grease etc. shall be cleaned thoroughly prior to welding by wire brushing or any other suitable method.
- Even the traces of oil and grease shall be cleaned carefully from the axle boxes, bogie pedestals and liners/wear plates prior to welding. The high sulphur in the oil and grease is detrimental to welding, as it will result in weld metal cracking.
- Prior to start of welding liners/ wear plates to axle boxes/ bogie pedestals, the parts shall be clamped securely in place to hold them flat against the axle box housing/ bogie pedestals. Clearance if any, between the liners/ wear plates and the axle box housing/ bogie pedestals shall not exceed 0.15 mm.

3.1.3 Welding Procedure

1. First of all, the liner plate shall be tacked as shown in figure 3.1 at the adjoining surface using lower diameter electrode (3.15 or 4 mm) to prevent distortion of the plate.

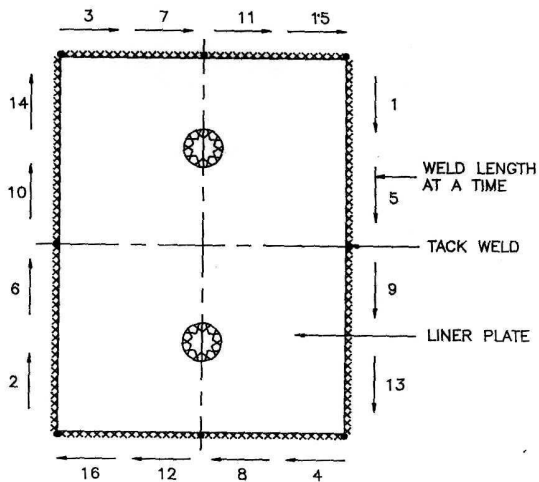


FIGURE 3.1
TACK WELD OF LINER AND WELDING SEQUENCE

2. The current shall be direct or alternative as recommended by the electrode manufacturer.
3. The welding shall be done in horizontal or flat position (i.e. in down hand position).
4. Whenever it is necessary to weld in the vertical position, the welding shall be done in the vertical up position.

5. Continuous welding of the liner plate at any place shall not be more than 50 to 75 mm in length to avoid the heat input concentration at a point.
6. Sequence of welding shall be such that all sides of liner plate are welded alternatively completing small weld length each time. This will maintain interpass temperature between 200 - 250°C. In this way full length of any side of the liner shall be completed to give total continuous welding on each side. When the welding is completed, all the periphery of the liner should get welded.
7. Two axle boxes or opposite pedestal faces of the bogie shall be undertaken for welding of liner plates at a time. Welding can be done in both the liners alternatively. In this way the time gap between the two welding in the same liner for maintaining the interpass temperature can be utilized more effectively.
8. In the welding of manganese liners/ wear plates, care must be taken to prevent cracking resulting from unfavorable weld metal dilution as well as heat built up.
9. Welding shall be carried out with lowest possible current using thinner gauge electrodes. Short stringer beads shall be followed. In no occasion, more than 35mm long bead shall be used. Weaving shall be avoided.
10. Speed of welding should maintain such that sufficient weld thickness is achieved to avoid cracks due to fast cooling at thin layer.

11. Air-cooling is desirable for keeping the heat-affected zone cool.
12. A slight convex fillet weld profile is desirable.
13. The arc shall be struck slightly forward in the weld path and then the arc moved to the welding area. By this method, the arc strike shall be re-welded when reached. Pausing at the end of the weld bead before withdrawing the electrode shall eliminate weld crater/ cracking. All craters shall have the same throat thickness as the weld bead.
14. At no time the arc shall be struck on the surface of the manganese liners/ wear plates. This will cause base metal failure when highly stressed.
15. Light penning using half pond round ball hammer shall be done on each weld deposit bead when hot, except the first run, to reduce welding stresses.
16. In multi layer welds, slag shall be removed before the next pass is deposited.
17. The holes of the liner shall also be welded.
18. Any sharp corners should be grounded to avoid stress concentration.
19. Weld defects, if any, e.g. undercuts, cracks, porosities etc. shall be removed and re-welded.

3.1.4 Electrode Care

1. All covered electrodes shall be stored in a clean and dry storage area free from moisture as laid down in IS: 814 - 74.

2. At areas of high humidity, the welder shall take out an amount of electrodes from the drying oven in accordance with rate of usage for a period of about an hour. Similarly the welder shall protect the electrode from exposure to rain and other possible moisture pick-up. The detrimental effect is primarily in causing the porosity and/or cracking in the weld metal.

3.1.5 Inspection and Rectification of Defects

1. All the welded areas shall be visually examined with magnifying glass after cleaning the slags etc. for the presence of weld cracks.
2. The cracks, if any, shall be confirmed by dye - penetrant test.
3. After identification of defects, the defective area shall be removed fully by grinding up to the sound crack free metal followed by dye - penetration test to ensure freedom from residual cracks. The area shall then be re-welded in accordance with the procedure given above.

3.2 REPAIR OF CRACKED BOGIE FRAME BY WELDING (BOTH CAST & FABRICATED)

3.2.1 Evaluation of Cracks and other Defects

1. The extent of crack shall be located by visual inspection with a magnifying glass (10%) followed by dye penetrant or magnetic particle test.
2. After marking out the full extent of the crack, arrestor holes of suitable size (min. dia10.0 mm) shall be drilled at least 25.0 mm away from the extremities of the crack.
3. The entire crack shall be eliminated by opening out the affected section right up to the bottom of the crack.
4. The removal of the defective area shall be resorted by flame gouging/ arc air gouging/ pneumatic chipping followed by grinding with a portable pencil grinder.
5. The section thus opened out shall extend up to the arrestor holes. The open out section shall further be checked by DPT and MPT.
6. To The areas containing other defects like shrinkage, cavities and inclusions etc. if any, shall also be located and marked and these defects shall be completely removed by flame gouging/arc air gouging/chipping before welding.

3.2.2 Preparation for Welding

1. Where the crack or other defect does not extend through the complete section, V grooves with about 20° inclined angle and 10 mm root radius at both sides shall be made as shown in Figure 3.2.

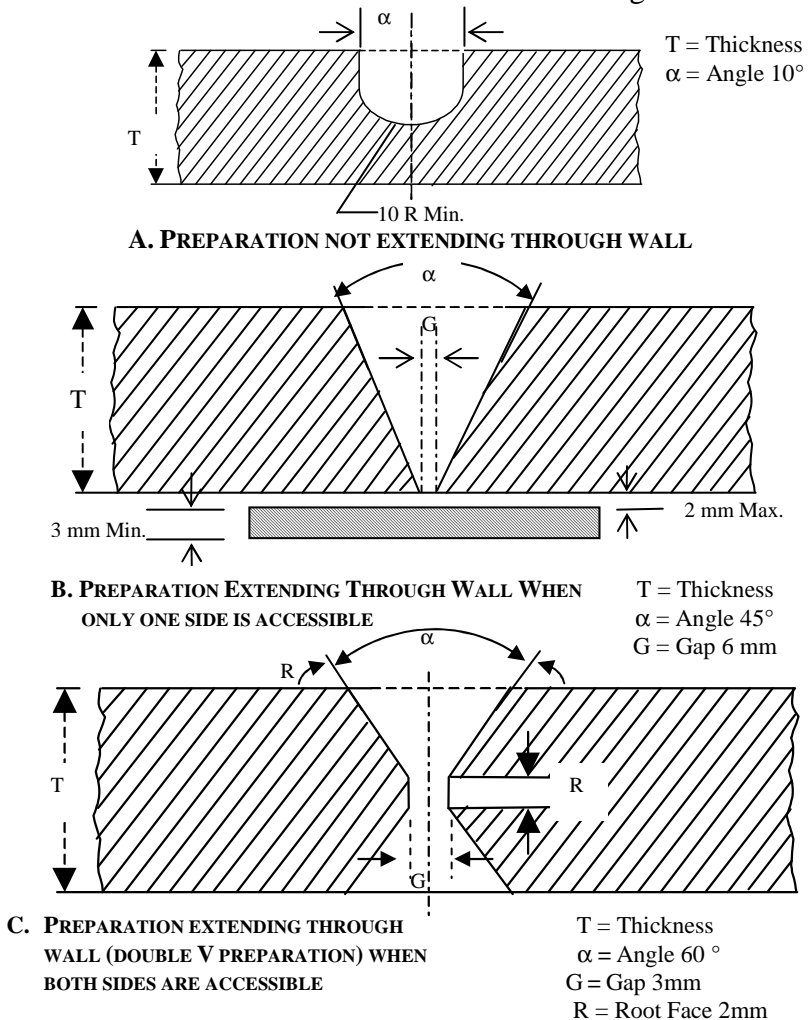
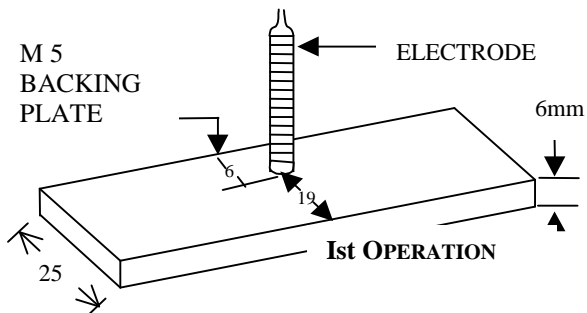


FIGURE 3.2 RECOMMENDED CONTOURS FOR WELD CAVITY PREPARATION
Maintenance Handbook on Flexicoil Bogie Mark - I May, 2002

2. Where the crack extends through and through V shaped grooves with included angle of 50° - 60° with front gap of about 8mm shall be prepared.
3. The flame gouged faces and the adjacent bogie surface shall be ground before grinding by pencil grinder to remove adherent scales, oil, grease, dirt etc. before welding.
4. If the crack extends through and through a mild steel backing plate of 6.0 mm thickness and 25.0 mm width shall be secured by tack welding at the root in close contact with the inner surface along the seam to be welded. Length of each tack weld shall be about 150 mm. Backing plate should not be welded all round the perimeter in order to avoid risk of cracking of the bogie frame.
5. If there is no access from back side to fix the backing plate, an electrode shall be welded on the surface of the back plate and then it shall be inserted vertically through the root gap of the V groove from top and then the electrode shall be pulled upwards and the backing plate is to be held in position by tack welding with the affected bogie frame as shown in Figure 3.3.



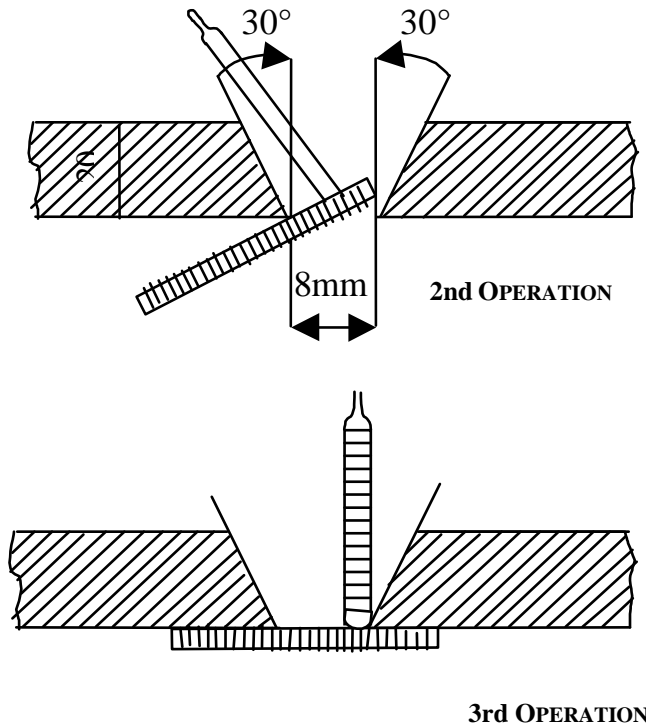


FIGURE 3.3 PROCEDURE FOR FITTING OF BACKING STRIP

- 6 The fitting of the back plate would facilities achieving complete root penetration of weld metal while is to be carried out from one side only.
- 7 The backing strip material should be same as that of bogie frame. The electrode for tack welding should be the same as that recommended for welding of bogie frame.

3.2.3 Jigging and Preheating

When the repair welding is heavy following precautions shall be taken to maintain the critical dimensions of the bogie before start of the welding:

1. Suitable arrangement for preserving the lateral and longitudinal alignment of the bogie shall be made.
2. The pedestal caps shall also be fitted in all horns before commencing any welding.
3. In case of cast steel bogie before welding the area to be retained shall be preheated by oxy-acetylene gas flame at a temperature of 250° to 300° C to minimise the rate of cooling and thereby preventing the cracks during cooling of weld metal.

3.2.4 Electrode

- 1 Basic coated low hydrogen type of electrode approved by RDSO against the IRS class C2 and D1 (special) having IS code E55BGIN126 (IS:1395-1982) shall be used. Electrodes of 3.15 mm size for root run and 4.0 or 5.0 mm size for subsequent runs are preferable.
- 2 Low hydrogen electrode shall be preheated at a temperature of 350°C for at least one hour or at 250°C for 2 hours or as per the recommendation of the electrode manufacturer immediately before use in an electrode drying oven.

3.2.5 Welding Set, Current & Polarity

- 1 DC welding set either a rectifier or a generator is preferred. However AC transformer set can also be used provided it has the facility of max. OCV of 70 volts. With DC rectifier electrode should be positive to minimise heat input.
- 2 Current range shall be as recommended by the electrode manufacturer.

3.2.6 Welding Technique and Precautions

- 1 Welding shall be carried out frequently in down hand position. However in case of necessity welding can also be carried out in horizontal or vertical up position.
- 2 A manipulator may be rigged up so as to arrange welding in down hand position.
- 3 Slag shall be cleaned thoroughly in between runs by pointed chipping chisel and wire brush.
- 4 Welding operation once started, shall be continued till completion maintaining an inter pass temperature of 250-300°C.
- 5 In case any defect such as blow holes, porosities or undercut is formed, the same shall be gouged and rectified by patch welding.

- 6 Welding reinforcement shall be restricted to 3.0 mm and each head shall be deposited in such a way that it covers half of the width of preceding run.
- 7 During use of low hydrogen electrode it shall ensure to maintain shortest possible arc and minimum weaving of the electrode.
- 8 The root run shall be checked carefully against to formation of cracks by visual inspection with the help of a magnifying glass. Before commencing the welding from other side the root run shall be chipped off properly.
- 9 The crater end must be filled up by retracing back the electrode to about 12 mm followed by withdrawn from weld pool.
- 10 When, a new electrode is to be started it shall be struck a little forward of the crater end of the previous run, then traveled back over the crater and then forward again.
- 11 Only a qualified welder shall be engaged in such repair welding.

3.2.7 **Finishing**

The weld reinforcement shall preferably be chipped off and ground finish with the base metal avoiding formation of grinding cracks.

3.2.8 Stress Relieving

The welded area shall be stress relieved by heating to about 600-650°C with the help of Oxy acetylene torch followed by slow cooling under cover of asbestos sheet if the bogie is not subjected to any other heat treatment after repair welding.

3.2.9 Inspection

The weld / repaired area shall be examined visually followed by dye penetrant test or magnaflux test to ensure freedom from surface cracks. If possible, the rectified area shall also be subjected to radiographic examine for internal defect if any.

Three fold inspection system i.e. inspection before welding, during welding and after welding must be introduced to achieve wound welding. If any defect or crack is detected during these tests, the particular area shall be marked and the defect shall be removed by gouging and repair procedure shall be repeated and re-checked by magnetic particle test/ dye penetrant test.

3.2.10 Control of Distortion

- 1 Proper jig and fixture shall be used to avoid distortions during welding.
- 2 The welding procedure and proper sequence shall be followed to minimise distortions.
- 3 Tacking shall be completed as per para 3.2.2 clause 4.

3.2.11 Weld Repair of Cracks Extended over an Area

In case there is a cluster of cracks covering an area of cracks having branches on either side the following procedure shall be adopted to weld repair.

- 1 The whole area covering the crack shall be removed by Oxy-cutting.
- 2 The edges shall be bevelled and ground smoothly with the help of a hand grinder to remove oxidised metals, burrs etc.
- 3 A plate of matching thickness to IS: 2062 Grade 'C' shall be cut to the size and bevelled in such a way that after fixing the plate on the removed portion, the joint formed is a V joint.
- 4 The plate shall be fixed on the effected area and tack welded to keep it in position. Baking plate may be used if welding from both sides is not possible.
- 5 Welding shall be done all around the plate, using electrode as mentioned in para 3.2.4.
- 6 An extra run of the weld shall be given so that thickness of the welded area is slightly more than the parent metal.
- 7 After cooling, the weld shall be flush ground.
- 8 MPT or DPT test shall be carried out to ensure freedom from crack or other defects.

- 9 If possible USFD test of the weld may be carried out to find the presence of any internal defect.
- 10 In case, there is a defect, the defected area shall be removed by gouging and rewelded until a sound weld is obtained confirmed by NDT test.

3.3 WELDING OF CENTRE PIVOT PIN TO THE UNDER FRAME

The detailed welding procedure is given as under:

3.3.1 Parent Metal Particulars

- i. WAG-7 Loco (Drawing No. SK.VL - 128)
 Centre pivot pin - Solid forging Gr. Class III steel to IS : 1875 - 92.
 Dimension - Diameter at the location of welding 340 mm.
 Base plate - Steel to IS : 2062 Gr. ' C '.
- ii WAP4 Loco (Drawing No. 03/3/31/7 Alt.8)
 Centre Pivot pin - Hollow cylindrical steel casting Gr.II C.I.C to IRS: M2 with Corr. No.3 of April 1992.
 Inside Diameter - 377mm,
 Outside Diameter - 460 mm
 Thickness - 41.5 mm
 Base plate - Steel to IS:2062 Gr. ' C '.

3.3.2 Edge Preparation

In case of WAG7 loco, bevelling of the outer edge of the pin shall be done preferably by matching. If bevelling is done by frame cutting, the frame cut surface shall be descaled by grinding. Bevel angle shall be 60° minimum to ensure proper penetration. In case of WAP4 loco pin, bevelling shall be done outside and inside.

3.3.3 Welding

Welding shall be done by manual metal arc welding process.

- 1 **Electrodes:** Any brand of electrode approved under class 'C2 & D1' (with codification EB 5424 H2X) of IRS : M28 shall be used. These are low hydrogen type electrodes. Hence the electrode must be pre-heated to 250°C for 1 hour or as per manufacturer recommendation immediately before use.
 Electrode size: Overhead welding - Root run 3.15 mm & subsequent run - 4mm diameter.
- 2 **Pre-heating of the job:** WAG-7 loco - The weld area shall be preheated to 150° - 200°C by local heating with the help of Oxy-acetylene flame.
 WAP4 loco - No pre-heating is required.
- 3 **Jig & Fixture:** The assembly should be properly clamped with help of suitable jigs & fixture before start of welding. Pin should be suitably supported at the bottom until the welding operation is completed.

- 4 **Welding Techniques:** To avoid distortion the entire circumstances shall be divided into four equal segments as shown in Figure 3.4. Before starting welding, pivot should be tack welded to avoid misalignment and distortion. Special care must be taken at the start and termination point of each weld segment to avoid formation of weld defects at these points. The welding run should preferably overlap at these points to a certain extent. After completing one run covering the entire circumference the process shall be repeated for subsequent runs till the required fillet size as per drawing is achieved. The profile of the fillet should preferably be concave.

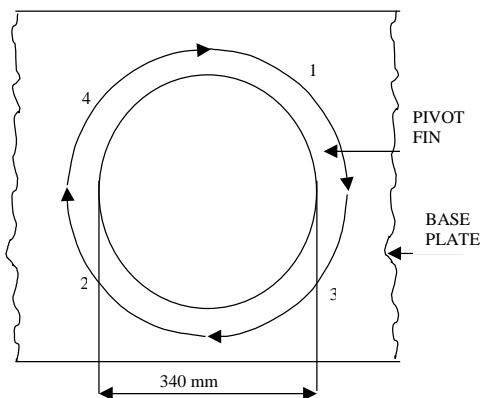
3.3.4 **Inspection**

- 1 After welding, the same shall be inspected visually for any weld defect and the weld size shall be checked with a suitable gauge.
- 2 The weld profile shall be tested by magnaflux/ dye penetrant method for surface cracks.
- 3 If any defect/ crack is present the same shall be gouged out and repaired by welding.

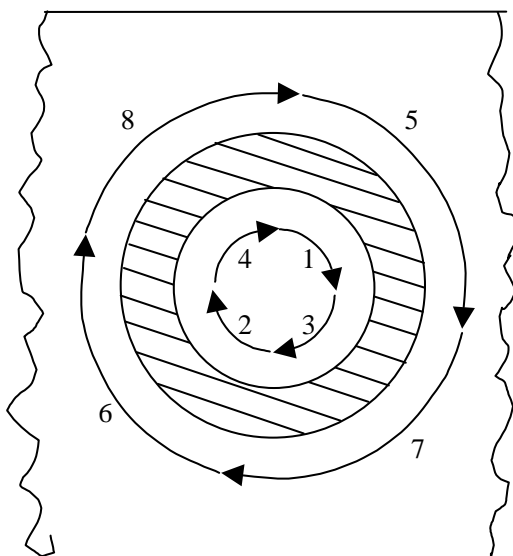
3.3.5 Repair of Cracks

In case of repair of cracks in the weld area in case of earlier welded pin the following procedure shall be followed.

- 1 The cracked area shall be cleaned properly and extent of crack shall be inspected visually as well as by DPT.
- 2 A crack arrestor hole (dia 10mm) shall be drilled 25mm ahead of the tip of the crack.
- 3 The entire crack shall be eliminated by gouging out the metal by pneumatic chipping or by Oxy-acetylene flame.
- 4 The material shall be removed from the cracked area to form a 'V' groove upto the arrestor hole. The surface opened out shall be descaled and smoothened by a pencil grinder.
- 5 Removal of crack shall be ensured by DPT test again.
- 6 After necessary cleaning, welding shall be carried out as per clause.3.3.3 followed by inspection as per clause 3.3.4 .



**SKETCH SHOWING WELDING SEQUENCE FOR WELDING
PIVOT PIN WITH BASE PLATE**



**SKETCH SHOWING WELDING SEQUENCE FOR WELDING PIVOT PIN WITH
BASE PLATE WAP-4 LOCO**

FIGURE 3.4 SEQUENCE FOR WELDING OF PIVOT PIN

CHAPTER 4

COMMON PROBLEMS, CAUSES AND REMEDIES

Following are the most common problems related with flexi-coil mark I bogies

- Crack/ breakage on bogie bolster.
- Crack on centre pivot.
- Breakage of primary suspension spring.
- Crack/ breakage of Adaptor fitted on bogie horn.
- Droppage of magnese liner from Adaptor.
- Excessive wear of pins and bushes provided in brake hanger.
- Breakage/ wear of connection straps.
- Brake binding.
- Crack/ breakage on gear case.
- Breakage of axle cap bolt.
- Failure of axle box.
- Wheel skidding, journal scoring etc.
- Loosening/ falling of foot step/axle box cover.

4.1 SUGGESTIONS TO AVOID FAILURES

The following suggestions are recommended to overcome above problems:

1. The inspection of suspension springs (both primary as well as secondary) should be improved and should be strictly done as per drawings and specifications for every lot of procurement and during changing. The working height and colour matching of suspension spring is shown in figure 4.1. The details for testing of WAP1/ WAP4 springs are given below:

STANDARD (IN MM)	PRIMARY SPRING	SECONDARY SPRING
FREE HEIGHT	385 ± 6	478 ± 7
WORKING HEIGHT	319 ± 2.5	394 ± 3.5
SOLID HEIGHT	266	345

2. The material of all types of pins and bushes being used in the flexi-coil mark - I bogies should be changed to magnese steel as per specifications IRS-R65. Alternatively pins and bushes made from material to IS: 1875 class I and case carbonising may be used.
3. The bogie horns should be given thorough attention for wear and tear during major schedules.
4. Connection straps should be procured strictly as per their drawings and should be used correctly.

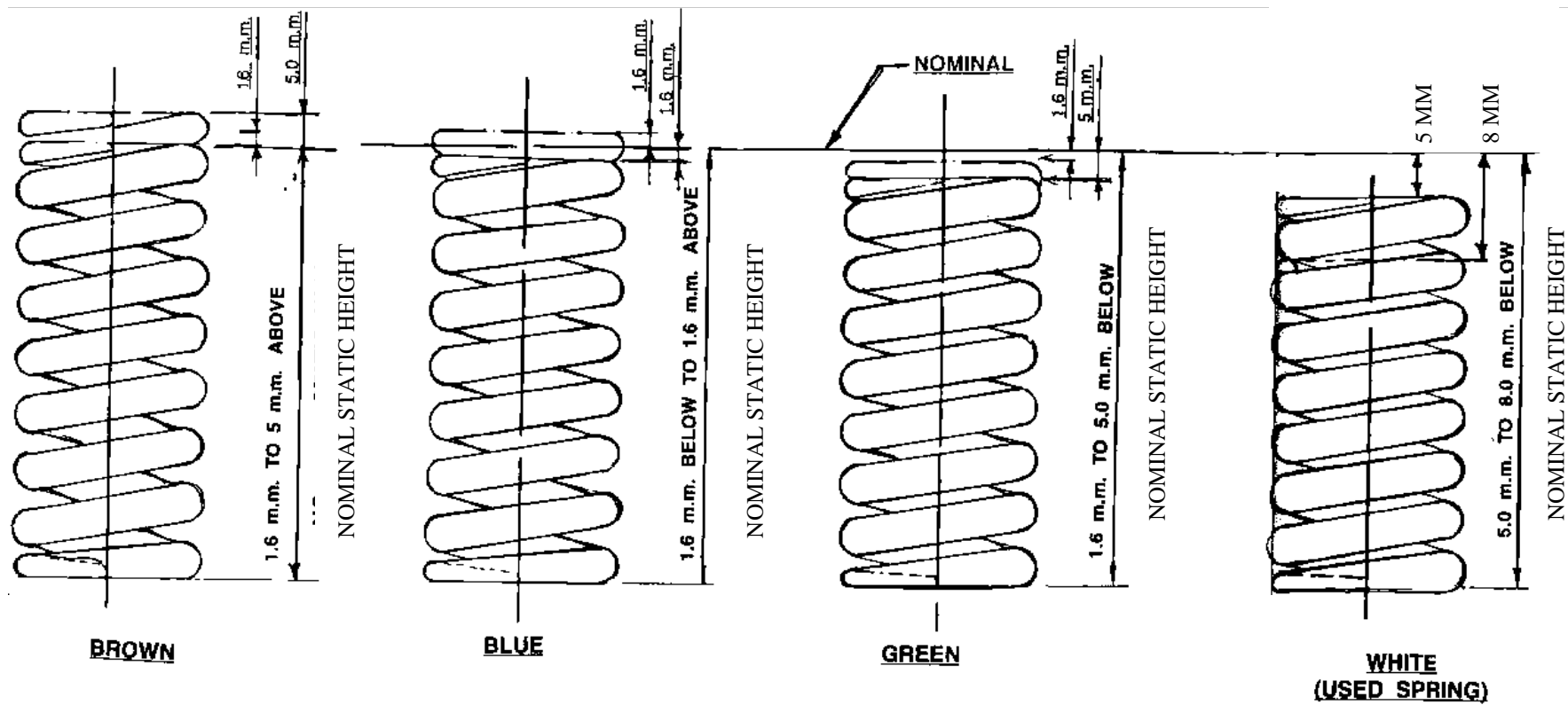


FIGURE 4.1
COLOUR MATCHING OF SUSPENSION SPRING
(FOR MAINTENANCE ONLY)

5. Provide modified guide assembly to restrict lateral movement of outer connection straps (RDSO's MI No ELRS/MS/02283, Rev '0' - 2000).
6. The magnese liners should be continuously welded on the adaptors using a jig as shown in Figure. 4.2 and proper welding electrodes.

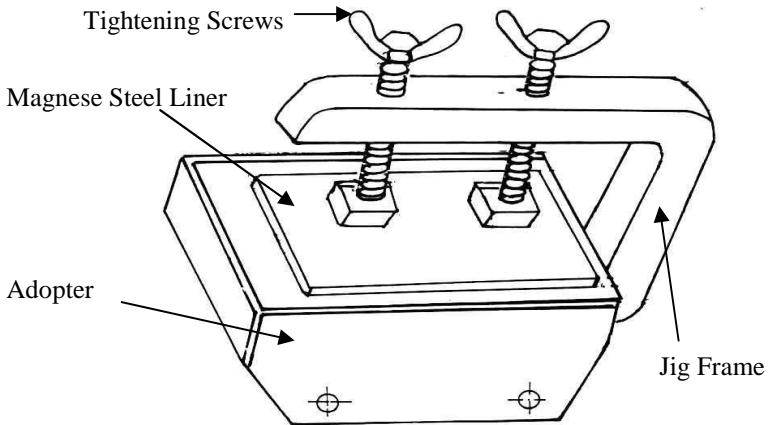


FIGURE 4.2

JIG FOR PERFECT WELDING OF LINERS ON ADOPTER

7. The thickness of the collar of the ferrule used at brake head hanger should be increased so as to prevent it from moving inside and infringing the movement of brake head due to wear in service.
8. The footstep should be shifted from axle box to loco body below the driver's cab similar to arrangement in WAM4 locomotives.

4.2 DO's

1. Keep clean parts and tools in a dry tray.
2. Use lint free cloth to clean the axle box components.
3. Protect bearing to avoid entering ingress.
4. Use ball pein hammer to check the condition of wheels.
5. Clean wheel surface before taking wheel measurements and put the tools in aligned condition.
6. Keep fire extinguisher near to welding or cutting work.
7. Ensure cleanliness of pit. It should not be slippery.
8. Check all brake gear assembly for any left over work.
9. Use crow bar to split the split pin.
10. Maintain the record of cannibalization of wheel set, bogie frame, suspension bearing etc.
11. Keep all gauges, tools and instruments in easily accessible and earmarked places.

12. Be vigilant and careful in work place.
13. Tighten nuts and bolts fully by applying proper torque.
14. Test the property/ quality of released as well as new grease.
15. Follow recommended maintenance practices only.
16. Conduct ultrasonic test of axles during schedules.
17. Carry RDPT/ Megna flux test for crack detection.
18. Use lubricant in axle box and brake rigging approved by RDSO only.
19. Keep bearings racers and thrower wrapped in oil proof paper when not in use.
20. Clean axle box housing and axle racer journal before fitment.
21. Assemble components of axle box as per sequence and tight the cone bolt at a torque of 7.0 M-kg.
22. Check the gap between outer cone and inner cone after tightening the bolts. It should be $5 + 1.5 \text{ mm}$
- 0.5 mm

23. Check visually bogie frame and bolster for any crack.
24. Ensure working of hand brake.
25. Check the brake gear assembly for any missing part.
26. Follow instructions issued by RDSO.
27. Plan to assemble spare bogie and wheel set ready for AOH loco or replacing in the running loco.
28. Write details of wheel i.e. wheel diameter, wheel wears etc. on spare wheel sets.
29. Plan to ready material or spares required for repairing of running locos as well as AOH/IOH locos.
30. Handover charge of work and material to the next shift.
31. Access the arising and act accordingly.
32. Follow instructions properly for welding of cracks arises on bogie frame i.e. grooving, welding, cooling and stress relieving etc.
33. Ensure replacement of *"must change items"* during AOH/IOH.

34. Attend all the defects (indicated by owner or not) of wheel set thoroughly during re-discing or re-axling.
35. Care to avoid damage of ready wheel set.
36. Ensure proper clearance between axle box and bogie horns before lowering the bogie frame.

4.3 **DON'Ts**

1. Don't intermix the axle box components.
2. Don't use oxy-acetylene flame to take out the loose lip.
3. Don't use oversize spanners.
4. Don't lift heavy item like brake block, suspension bearings etc. with loose hands.
5. Don't apply unsafe method of working.
6. Don't use oversize bolts/screws, nut and washers.
7. Don't use flat spring washers.
8. Don't handle tools, gauges equipment with oily or greasy hand.
9. Don't mix up the grease of same grade but different make.

10. Don't carry the grease in the empty container of different grade of grease, oil, chemicals, solvent or paints.
11. Don't carry out the cleaning and greasing simultaneously.
12. Don't carry out the cleaning with petrol and welding on the same job.
13. Don't compromise with clearances on axle box and bogie frame.
14. Don't clean bearings in chemicals/solvent other than kerosene or petrol.
15. Don't clean or remove the bearing, racer and thrower by gas heating.
16. Don't reuse released/ condemned bearings, racers and throwers.
17. Don't strike or pressures fit the bearings, racer and throwers unduly.
18. Don't wash/ wipe the new bearings, racers and thrower as removed from packing.
19. Don't spin uncleaned bearings.
20. Don't use damaged or permanently set rubber thrust pad.

21. Don't allow loose adaptors.
22. Don't apply any modification without approval of competent authority.
23. Don't interchange axle box and fitting of same wheel, other wheel of the same bogie or another bogie.
24. Don't interchange position of wheel set and bogie frame.

REFERENCES

1. Maintenance manual of CLW for WAP1 and WAP4 locomotives.
2. AC Traction manual.
3. IRIEEN journals.
4. Maintenance Schedules issued from Central Railway Head Quarter, MBCST.
5. Maintenance Schedules of ELS/ Northern Railway, GZB
6. Report on problems of Mark I Flexicoil Bogies for WAP1/ WAP4 electric locomotives No.El/ RM - 201 February, 1997 issued by RDSO.
7. Maintenance Instruction No.MP. MI - 97 (Revision - 01) July, 2000.
8. Suggestions given by RDSO.
9. Suggestions given by various sheds during visit as well as during seminar.
10. Study reports and other literature collected from sheds.
