

MECHANICAL

CONTENTS

Reading Material For Foundation Course (Mechanical Department)

SN.	Subject	Page Nos.
1	Objectives of Mechanical Engineering Department	398
2	Classification of Rolling Stock	399-400
3	Organisation of Mechanical Engineering Department in Railway Board, Zonal Headquarters, Divisions and Workshops	400-402
4.	Production Units	403-404
5.	Train Dynamics	405-406
6.	Traction modes and their Comparisons	407-709
7.	Diesel Locomotive – Design features, Major components, Classification and Codification etc.	409-414
8.	Operation and Maintenance of Diesel Locomotives	414-421
9.	Coaching Stock- Design and Maintenance	422-428
10.	Linen Management	429
11.	Bio Toilet	430-432
12	Wagon Stock- Design and Maintenance	433-438
13	Important Components affecting Safety – Wheel assembly, suspension arrangement, draw and buffing gears.	439-442
14	Brake system on Indian Railways - Vacuum brakes and Air brakes.	443-448
15	140 Ton Diesel break-down cranes	449-450
16.	Workshops	451-454
17.	Running	455-457

Question Bank

Part I	True or False type statements	458-465
Part II	Multiple Choice Questions	466-473
Part III	Fill in the blanks type questions	473-474
Part IV	Subjective questions – short answer type	745-477

1. Objectives of Mechanical Engineering Department.

The main objectives of Mechanical Engineering Department and agencies responsible for their fulfillment are summarized below:-

	Objectives	Agency
	Maintain and supply dependable system and diesel locomotives as per predetermined power plan.	Divisional Organisation & Workshops.
	Maintain coaches, keeping in view safety and amenities aspects	-do-
	Maintain wagons for their safe haulage	-do-
	Production of locomotives, coaches and wagons as required.	Production Units & Private Sector.
	Continuous absorption of latest technology in the fields of maintenance and production.	RDSO & CAMTECH
	Ensuring economic use of fuel	Zonal Headquarters & Divl. Organisation
	Co-coordinating procurement of Machinery and Plant for all the departments.	COFMOW & Zonal Head Quarters
	Periodic overhauling of rolling stock	Workshops
	To maintain Breakdown train in ready to use condition.	Divl. Organisation
	Linen Management	Divl. Organisation

2. Classification of Rolling Stock

The definition of various terms used in rolling stock management are given below :-

Train - Vehicle /Vehicles moving on rail which need line clear to enter a block section.

Rolling Stock - Any vehicle capable of moving on railway track excluding push Trolleys.

Locomotives - Engine or motive power source to haul a train. Indian Railways use Steam. Diesel and Electric locomotives.

Coaches - Passenger carrying vehicle (PCV) & some non-passenger carrying vehicles (OCV) attached to passenger trains like postal van, luggage van etc.

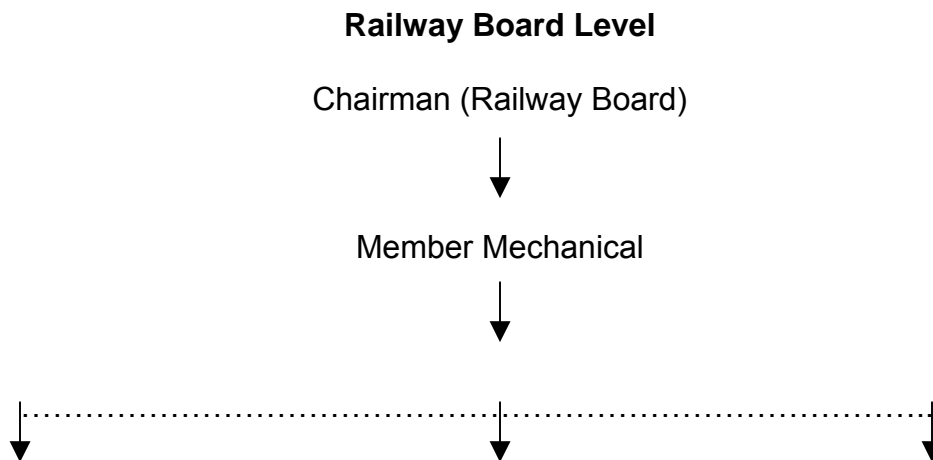
Wagons - Freight rail cars used for transport of freight traffic. Wagon have 4,8 or more wheels. These wagons may be covered, open, flat , tank or well-type.

EMU- (Electrical Multiple Unit)- Self powered set of coaches operated by electricity.

DMU- (Diesel Multiple Unit)- Self powered set of coaches powered by diesel engine.

Rail Cars- Self powered coach generally in single or unit of two.

3. Organisation Of Mechanical Engineering Department



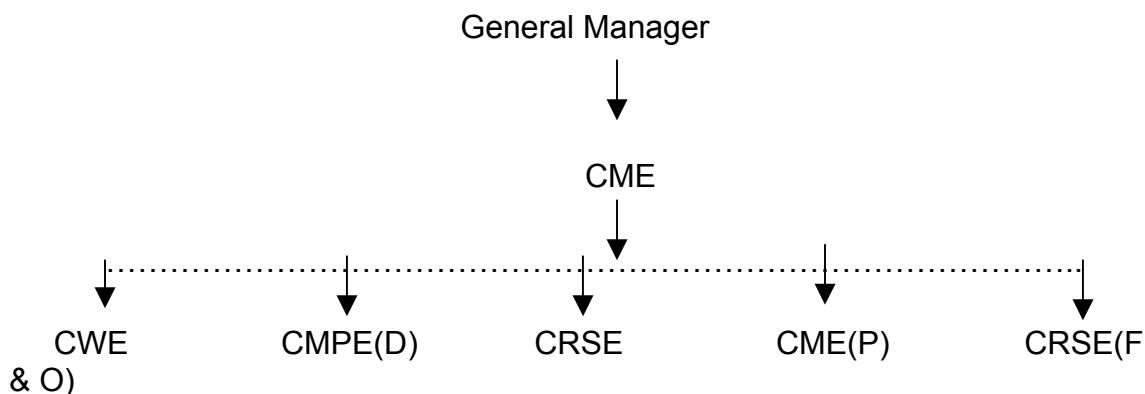
Addl. Member (Mech.Engg.) Addl. Member (Prod units) Addl. Member (Stores)

Addl. Member(Mech. Engg.) is responsible for open line working, inter-railway coordination and coordination with Addl. Member(Traffic) for rolling stock use.

Addl. Member(PU) is responsible for proper functioning of workshops, production units, Mechanical wing of RDSO & COFMOW. He also coordinates with other directorates for Rolling Stock manufacture and repair.

The Addl. Members (General Manager Grade) are assisted by Advisor (HA Grade), Executive Directors (SA grade), Directors (Selection grade), Joint Directors (JA grade), Deputy Directors (Sr Scale) and Asst. Directors (Junior Scale).

Organization at Zonal Headquarters level.



CWE (Chief Workshop Engineer)- is responsible for:

- ❖ Administration of all workshops on the Zonal railway
- ❖ Oversee availability of important items and coordination with Stores Dept.
- ❖ Workshop budget & economy.
- ❖ Maintenance of drawings and specifications of rolling stock items

CRSE (Chief Rolling Stock Engineer) - is responsible for:

- ❖ Proper maintenance of carriage fleet on the open line

- ❖ Coordination with CWE/ Workshops for availability of workshop manufactured items/ sub assemblies.
- ❖ Oversee stock position of vital items and stores coordination
- ❖ Monitor Passenger complaints about amenity fittings.

CME(Plg.) (Chief Mechanical Engineer-Planning)

- ❖ Coordination of M&P sanction and procurement of M&P for all depts.
- ❖ Specification of Machines & Plants and Coordination with COFMOW/COS for procurement
- ❖ Installation, commissioning, prove out warranty of machines and coordinate training of personnel for new machines
- ❖ Planning of Works Program required for Mechanical Department

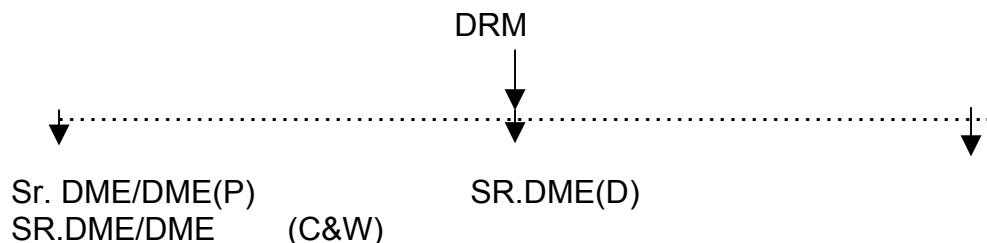
CRSE (F&O) (Chief Rolling Stock Engineering- (Frieght & Operations) is responsible for-

- ❖ Proper utilization of locos on line.
- ❖ Staff training and conversion training from steam to diesel and electric loco operation.
- ❖ Economic use of fuel
- ❖ Proper maintenance of wagon fleet on open line.
- ❖ Coordination with CWE for availability of workshop manufactured items/ sub assemblies.

CMPE (D) (Chief Motive Power Engineer Diesel). is responsible for-

- ❖ Proper maintenance of diesel locomotives.
- ❖ Planning maintenance facilities for diesel locos
- ❖ Liaison with RDSO,DLW, CLW, DMW.
- ❖ Oversee stock of unit exchange spares, particularly imported spares.
- ❖ Monitor outage of diesel locomotives

Organisation at Divisional level



Sr. DME/DME(P) is responsible for maintenance of steam locomotives, maintenance of Break Down trains, Crew management, Running Rooms etc.

Sr.DME/DME(D). is responsible for maintenance of diesel locos, monitor diesel loco ineffective and outage position.

Sr.DME/DME(C&W) is responsible for proper maintenance of carriage & wagon stock, ineffective percentage, passenger complaints, coach and wagon detachments and other unusual occurrences.

Workshop level

Workshop is headed by CWM/DY.CME/WM/AWM depending upon the size of the workshop. Other department Officers in lower grades like Electrical, Stores, Accounts, etc. are placed under his administrative control. Workshop has following departments.

Production Control Organization - Responsible for evaluation, work planning, material arrangement, work study and implementation of incentive scheme.

Inspection - Responsible for quality control in the workshop activities.

Repair - Responsible for rolling stock/sub assembly repairs.

Manufacture - Responsible for manufacture of components/ sub- assemblies mostly on stores work order.

M&P - Responsible for planning, procurement, commissioning and upkeep of machine and plant.

Establishment -Responsible for payment of wages, promotion and placement of staff and other personal matters.

Electrical - Responsible for upkeep of electrical installation, power supply etc.

Stores Depot - Responsible for making of the proper material available , inventory control, scrap disposal etc.

4. Production Units-

Indian Railways have following production units

CLW Chittaranjan Locomotive works - Manufactures Electrical Main Line Locomotives - Capacity- 165 locos/year

Production during 2011-12 – 259 Target 2012-13 - 280

DLW Diesel Locomotive works, Varanasi - Manufactures Diesel Locomotives ~ Capacity- 165 locos/year.
Production during 2011-12 – 246 Target 2012-13 - 250

ICF Integral Coach Factory, Madras - Manufactures coaches of all types - Capacity - 1000 coaches/year.
Production during 2011-12 – 1511 Target 2012-13 - 1525

RWF **Rail Wheel Factory** earlier known as **WAP (Wheel & Axle Plant, Bangalore)** - Manufactures Wheel and axles as well as complete wheel-sets.

Production during 2011-12		Target 2012-13	
Wheels - 201135	Wheel sets	Wheels – 200000	Wheel sets
	70315		73000
Axles	99570	Axles -	95600

RCF Rail Coach Factory , Kapurthala- Manufactures main-line coaches ~ Capacity - 1000 coaches/year.
Production during 2011-12 - 1421 Target 2012-13 - 1600

DMW **Diesel Loco Modernisation Works** earlier known as **DCW(Diesel Component Works, Patiala)** – Re-Manufacturing, Rebuilding of

Diesel Loco sub assemblies; Repower- packing of Diesel Loco. It has now started manufacturing ALCO Diesel loco also.

In addition to the above, a Rail Spring Kharkhana Unit is located at Sithauli, Gwalior. This unit (RSK) manufactures springs for Indian Railways requirements.

New Production Units:

- ❖ Diesel locomotive manufacturing works – Marhowra/ECR – 2050 Cr.
- ❖ Wheel manufacturing plant – Chapra – 870 Cr.
- ❖ Electric Locomotive Manufacturing Factory – Madhavpura – 1450 Cr.
- ❖ Coach Manufacturing Factory – Rai Bareilly 1500 Cr.

5. Trains Dynamics

Train Resistance - The resistance offered by a train to move from stop is called Starting Train Resistance. The resistance offered by it to keep it moving at a specified speed is known as Rolling Train Resistance. In other words force needed to start a train from stationary position is starting resistance and force needed to keep a train moving at certain speed is rolling resistance.

The draw bar pull exerted by locomotive has to be more than the train resistance to keep a reserve force needed for acceleration. Mathematically starting resistance can be expressed by formula. **$R_s = R_{VS} + R_G + R_C + R_A$**

R_s = Total train resistance at start

R_{VS} = Vehicle starting resistance -- Depends on bearing design.

R_G = Grade resistance if any

R_C = Curve resistance if any (On curves, the friction between rail & wheel increases and hence extra force is necessary).

R_A = Acceleration reserve to be divided depending upon acceleration need of the train.

Rolling Resistance : The resistance during movement is called rolling resistance. It depends on speed and car body design but does not depend on bearing design. Mathematically it can be expressed as -

$RR = R_{VR} + R_G + R_C + R_A$

Where RR = Total rolling resistance R_G , R_C , R_A are same as starting resistance.

R_{VR} = Train rolling resistance on level straight track.

$R_{VR} = A + BV + CV^2$

Where A , B & C are constants depending on vehicle design, car body designs. 'A' Depends on mechanical friction in bearing. 'B' Factors include flange friction, swaying and oscillation characteristics of vehicle. 'C' Air resistance depends on body design. Aerodynamic design vehicles have less friction than box type vehicles. The values of A , B , & C are different for different vehicles.

Tractive Effort

The force at rail wheel contact exerted by a locomotive is called Tractive Effort. The tractive efforts at the start get limited by load on driving wheels and limiting frictional co-efficient between rail and wheel. (adhesion) even though the locomotive may be capable of producing much more tractive effort at low speed because of its horse power. On run, however, it depends on speed, loco horse power and wheel diameter.

Adhesion - It depends on rail wheel friction. Adhesive percentage is defined as ratio expressed in percentage of tractive effort at wheel slip and vertical load on driving wheels.

Factors effecting adhesion : - Condition of rail and wheel contact surface e.g. wet, dry, oily, slippery, etc. - Type of track and sleeper density - Rate of increase in torque applied to wheel.

Wheel Slip : If torque applied to wheel exceeds the adhesive torque, wheel slip takes place. This reduces the friction between rail and wheel and further wheel slip takes place. Wheel slip reduce the tractive effort and hence haulage capacity and damages rail and wheel. Wheel slip should ,therefore, be avoided.

Method to improve adhesion : - Clean rails regularly - Use sand while starting - Immediately cut off power if wheels slip.

Equilibrium Speed/Balancing Speed

The train will go on accelerating till tractive efforts of power is more than rolling resistance. Once TE & TR(train resistance) become equal, the speed cannot be further increased. This speed is called equilibrium or balancing speed. The loco cannot continuously work on full power and hence potential TE should be substantially higher than TR for better train operation. This also helps in attaining maximum speed quickly. The balancing speed of a WDM2 loco with a load of 4700 ton on level gradient is 59 km/h. So it is desirable to use 2 WDM2 locos in MU for operating such a train.

Determination Of Train Load

The trailing load that can be attached to a locomotive depends upon.

- ❖ Ability of locomotive to start the load on steepest gradient on the section.
- ❖ Attain maximum permissible speed on most of the route
- ❖ Maintain minimum desired speed on steepest gradient.
- ❖ Acceleration level desired.

6. TRACTION MODE AND THEIR COMPARISONS

Indian Railways use three traction modes-viz. Steam, Diesel & Electric. However most of steam locomotives have been phased out.

Important desired Locomotive characteristics.

Load- speed relationship

Maintenance requirement – frequency of maintenance should be less.

Riding quality - Disturbances to track should be bare minimum.

Reliability- susceptibility to develop defects on run should be low.

Maintenance time as ratio of running time should be less.

Both side operation - Amenability to both front and back operation .

Pollution- impact on environment should be minimum.

Foreign dependence- in regard to technology, availability of spares should be minimum.

Multiple operation -Amenability for multiple operation.

Steam : The steam loco consists of three systems:-

- ❖ Boiler to burn the coal and produce heat energy and to use this energy to heat up- water and produce steam at high temperature and pressure.
- ❖ Engine to use steam at high pressure and temperature to produce mechanical energy and transmit it to the wheels to produce torque to pull the train.
- ❖ Tender to store water and coal.

The steam engine is very simple in design, easy to maintain and highly reliable equipment. This however, has following drawbacks

- ❖ Needs good quality of coal (high calorific value and low ash contents), a scarce commodity in India
- ❖ Low load hauling capacity
- ❖ High pollution
- ❖ Fire hazard
- ❖ Needs frequent stoppages for watering/ filling up coal.

- ❖ Low Utilization (Kms/day)

Diesel Locomotive - This loco also consists of three major systems

- ❖ **Diesel Engine** - to convert chemical energy of diesel oil into mechanical energy
- ❖ **Transmission** - to transmit the energy produced by diesel engine to obtain rotation of the wheels
- ❖ **Control** - to control production of energy/ transmission affection.

Electric Locomotive - This also has three main system.

- ❖ Pantograph to collect electric energy from overhead wire.
- ❖ Transformer/ Rectifiers to step down the voltage and convert into DC.
- ❖ Control Circuit to control power into loco wheels.

Comparison of Steam, Diesel & Electric loco

Criteria	Steam	Diesel	Electric
Load/ Speed	Low Load	High Load (Very high with MU)	High Load (Very high with MU)
	Low Speed	High Speed	High Speed
Need for stoppages for loco requirement.	High - Every 150 Kms	Low - Every 3000 kms	Very Low
Riding Quality	Rough	Smooth	Smooth
Reliability	High	High	High
Multiple	No	Yes	Yes
Maintenance time	High	Low	Low
Forward/Reverse	Only forward.	Both movement	Both
Pollution	High	Low	Negligible
Foreign Dependence	Nil	Regular (for HSD oil)	Minimum

Operational flexibility	High	High	Restricted (OHE needed)
Running cost	High	Low.	Low
Capital cost	Low	High	Higher

7. Diesel Locomotive

Design Features



DIESEL ELECTRIC LOCOMOTIVE - WDM2

A steam locomotive engine is directly coupled to the wheels. This is so because steam engine is capable of producing adequate torque at starting and at very low speeds.

The diesel engine, however, cannot produce high power at start or at very low engine speeds. It is, therefore, necessary that engine is decoupled from wheel while starting and till it attains a minimum working speed. This is achieved by clutch and gear box in automobiles. The clutch gearbox combination is termed as transmission. Transmission is necessary for all IC engines.

In automobile engine, the clutch provides to decouple the engine from wheel, and gearbox helps to increase/ decrease mechanical torque as per requirement of speed/torque. The horse power of automobile engines are low and hence mechanical clutch with mechanical gear box are quite suited for transmission.

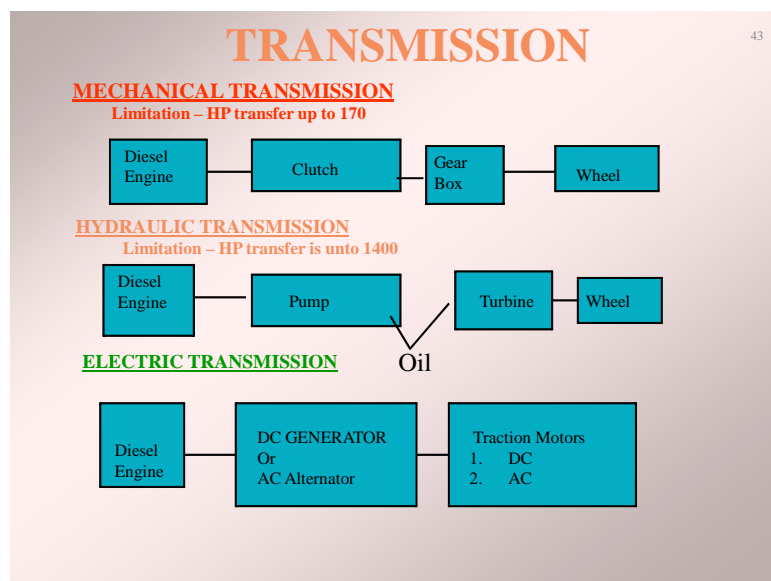
The engine power is very high for rail locomotive engine. Mechanical transmission is, therefore, not suitable as it becomes very bulky and difficult to operate. The transmission of diesel locomotives is therefore either hydraulic or electrical.

In hydraulic transmission, hydraulic coupling with reversing gear box is used.

Hydraulic torque converter acts as clutch and gearbox combined into one with infinite gear ratios. The output torque can be varied from infinitely from zero to more than engine torque. One side of torque converter (impeller end) is connected to engine and continuously rotates while other side (turbine end) is connected to wheel by suitable gear train. The hydraulic transmission attains peak efficiency at a specific speed, and falls steeply on either side of it. By multi-staging the converter, high efficiency can be maintained in the entire working range.

On most of our mainline diesel locos, IR have gone in for electric transmission. In this type of transmission, the engine is permanently coupled to a DC Generator. The output of the generator is fed to traction motors through a control circuit which varies the torque- speed relationship. The traction motors are directly mounted on the axles and drive the axles through gears.

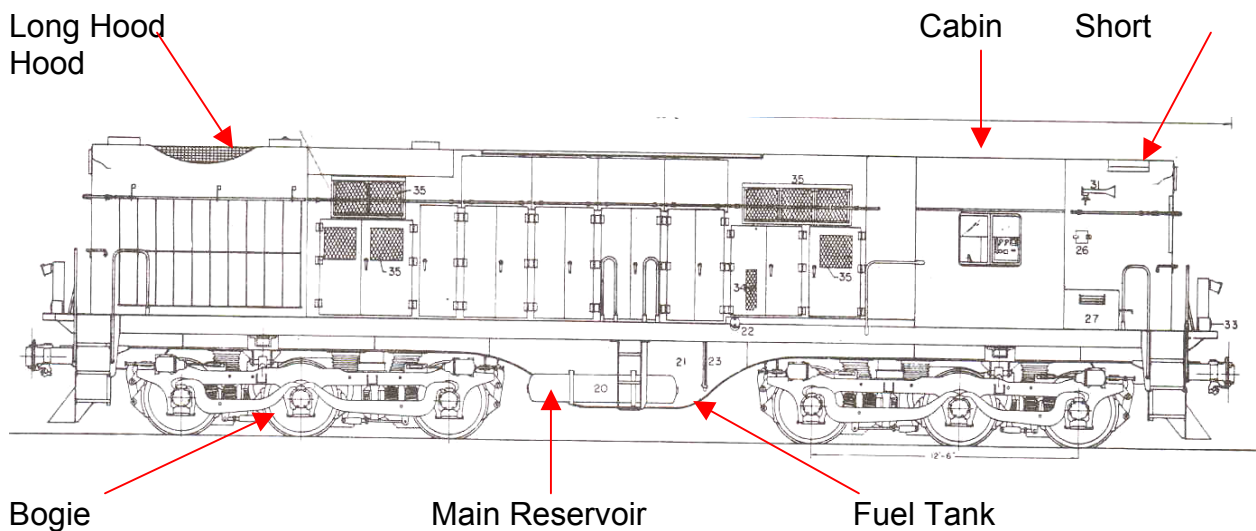
Various types of Transmissions



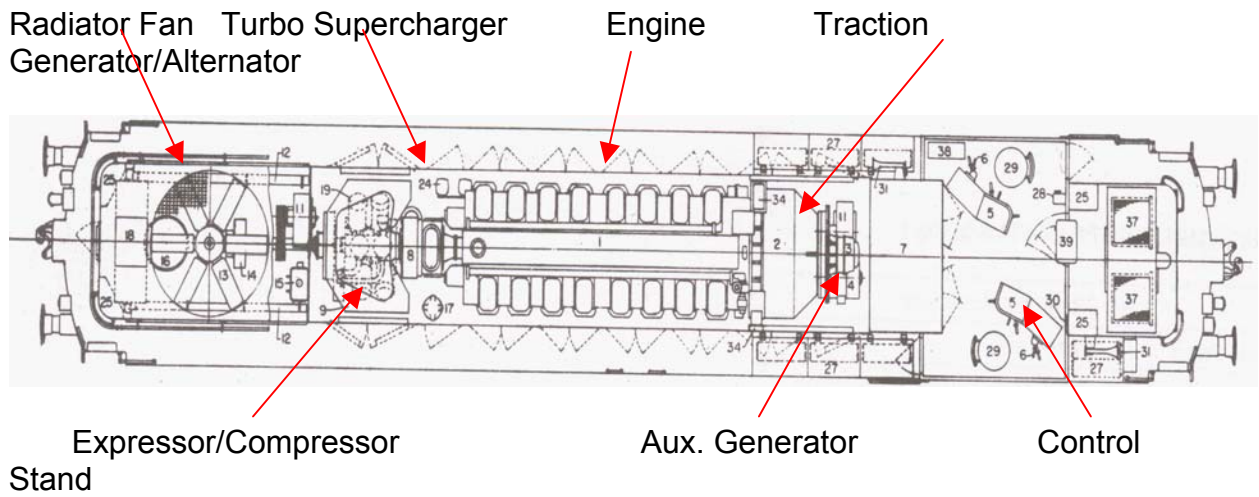
Some of the major components are :

- ❖ Engine or power pack to produce power for transmission.
- ❖ Governor to regulate fuel input according to Generator demand and to maintain constant engine RPM at each notch.
- ❖ **Throttle** - to vary engine RPM and power out put
- ❖ **Traction Generator** - to convert mech. energy into electric energy.
- ❖ **Expressor** - to produce compressed air for locomotive braking and to operate various contractors in the control circuit, and vacuum for the train brake system.
- ❖ **Radiator Fan** - to cool engine cooling water
- ❖ **Traction Motor** - to convert electric energy to mechanical energy (for driving the wheels)
- ❖ **Turbo Super Charger** - to compress air before input into engine for combustion

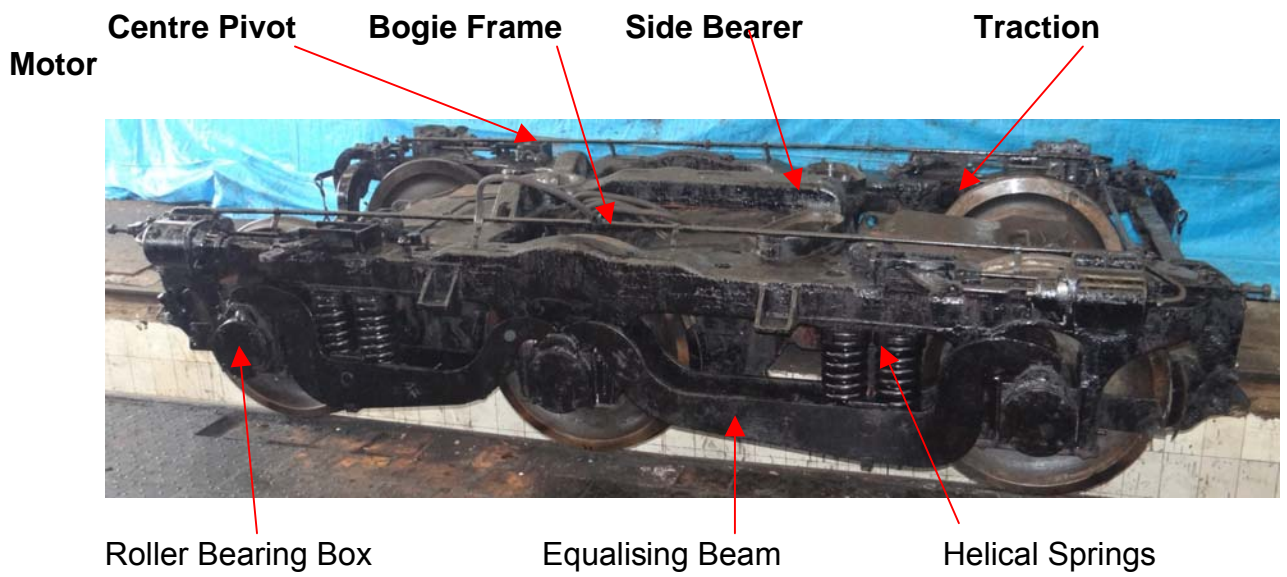
DIESEL LOCOMOTIVE-LAYOUT



LOCATION OF ASSEMBLIES



WDM2 Locomotive Bogie



Some of the Safety Components are:

Over Speed trip mechanism – it trips the power if engine RPM exceeds the predetermined limit.

Wheel slip relay – it reduces the power to traction motor if wheel slip takes place.

Hot engine alarm – it gives alarm if cooling water temperature exceeds the predetermined limit and cuts off the power if engine remains hot for a specific time.

Sand gear – to sprinkle sand on the rail to improve adhesion.

Classification and Codification of diesel locos.

Diesel loco are classified on wheel arrangement by 2-4 letter codes.

- B Bi- axle bogie with mechanical coupled axles
- C Tri- axle bogie with mechanical coupled axles
- BO Bi-axle bogie with independently driven axles
- CO Tri-axle bogie with independently driven axles

Diesel locos are coded to indicate gauge, traction mode, end use and model number. This is four letter code.

1st letter : Gauge (W-BG,Y-MG,Z-NG(2'6') and N-NG(2')

2nd letter : Traction Mode (D-Dsl, A-AC,C-DC)

3rd letter : Service (P- Pass, G- Goods, S-Shunting, M-Mixed)

4th letter : Suffix number; Design/ Model no.

e.g. **WDM2** – A broad Gauge Diesel Locomotive suitable for mixed services i.e., both passenger & goods train operation.

Classification, code & wheel arrangement of IR diesel locos are shown in table below :

Locomotive Code	Classification	Horse Power	Transmission
-----------------	----------------	-------------	--------------

WDM 2	CO- CO	2636	Electric
WDM3A	CO- CO	3100	Electric
WDG3A	CO - CO	3100	Electric
WDP3A	CO - CO	3100	Electric
WDP1	BO-BO	2300	Electric
WDG4	CO-CO	4012/4500	Electric
WDP4	A-A-1, 1-A-A	4012	Electric
WDP4D	CO-CO	4500	Electric
WDG4D	CO-CO	4500	Electric
WDG5	CO-CO	5500	Electric
WDS 4	O - C - O	600	Hydro-mech (Suri)
WDS 4A or B	O - C - O	660/700	Hydraulic/Hydro-mech
WDS 5	CO - CO	1065	Electric
WDS 6	CO - CO	1400	Electric
YDM 4	CO CO	1400	Electric
ZDM 5	B ¹ - B ¹	490	Hydraulic

Cost of Diesel Locos

WDG3A – ` 9 crores , WDG4 – ` 12.5 crores ,WDM2 - Rs. 4.5 crores
(Indicative Price)

Codal life of Diesel Locos : 36 Years (with a Re-powerpacking after 18 years,
Viz. Mid-life rehabilitation/ Rebuilding done at DMW/Patiala)

8. Operation & Maintenance Of Diesel Loco

Haulage capacity of a WDM2 Locomotive

Starting Tractive Effort = 30.4 tonnes

Continuous Rated Tractive Effort = 24.6 tonnes

It can haul a train of 4700 tonnes on level track with a balancing speed of 59 kmph.

Fuel & Lubricating Oil Consumption Targets- The bulk of main line B.G. diesel Locos on Indian Railways are WDM2 Locos. The fuel consumption of a WDM2 loco under idle conditions is 20-25 lit/ hrs, but at 8th notch fuel consumption is about 450 litres / hr. But specific fuel consumption on IR is generally measured in terms of litres/ 1000 Gross Ton Km which depends upon load, average speed, grade & curvature of section etc.

The target for level section is 2.5 lit/ 1000 GTKM for goods operation & 4 lit/ 1000 GTKM passenger for Passenger operation.

Lubricating oil consumption is generally measured in terms of percentage of fuel oil consumption and its target is less than 1.5% of Diesel Oil.

Diesel Loco Maintenance

When steam locomotives were introduced, India was lagging in engineering industries and hence the concept of having Railway Workshops was created. The stress was on repair of sub-assemblies rather than replacement and discarding of old components. This concept has undergone a revision for diesel loco maintenance. Most of the items are purchased from trade and the worn-out parts are replaced rather than repaired. This has emerged due to the nature of parts, viz. rubber fittings, gaskets, filters, electrical contactors, precision machined valves, etc. Even for major assemblies, the concept is to change the complete assembly in shed rather than repair in position. The assembly is then sent to the particular section for overhauling and testing. For this purpose, a pool of important sub- assemblies (unit exchange spares) is kept in each diesel shed/shops for this purpose.

Diesel locos are allotted a specific homing shed, which is responsible to maintain it properly. Suitable preventive maintenance schedules, specifying part to be checked, repaired and replaced are specified to ensure trouble free service on line.

Various locomotive maintenance schedules, the periodicity and time required for undertaking them is given below :

Schedule	Periodicity	Place
Trip	20/30/40 days*	Any shed
M4	4 months	Home Shed
M8	8 months	Home Shed
M12	12 Months	Home Shed
M24	24 months	Home shed
M48	48 months	Home Shed
POH	8 years	Workshop

Rebuilding 18 years DMW

* As per RB letter 2003/ M(L)/466 dated 27.6.08, Loco with pure air brake, microprocessor control system and roller suspension bearing. Loco should be kept under monitoring. Also as per RDSO letter no.SD.WDM.2.9 dated 24/27.05.13

After 18 years, locomotive is sent to DMW/ Patiala for rebuilding/ remanufacturing.

Diesel shed records- Important records maintained by diesel sheds are:

Daily position sheet - gives details of loco outage, dead locos on lines, locos undergoing schedules, locos expected to go out and come into shed

Repeated Booking Register

Wheel profile register

History of Repairs carried out - Locowise

Load test results.

Diesel oil Consumption /Specific fuel consumption Register

Lub oil consumption Register.

Availability

A Rolling stock is said to be 'ineffective' if it is not available for the whole day i.e. from 0 hrs to 24 hrs. The present target for ineffectiveness of WDM2 locos is 10% (earlier it was 12.5%). However, its outage (availability for train operations) is also watched on 4- hourly basis for which a further allowance of 10% is given for running repairs. So, the sheds are required to maintain on 4- hourly basis an outage of 81% of Diesel Locomotives for Train operations. However for Passenger Locomotives the outage is to be maintained as per Locomotive Links.

Target Outage calculation

Total holding of diesel shed ----- = X

10% allowance for heavy repair----10% of X = 0.1X

Available for traffic= X-0.1X = 0.9X

Passenger link say	= Y
Available for freight operation	= 0.9X-Y
Running repair 10%	= 0.1(0.9X-Y)
Net target freight outage	= (1-0.1)(0.9X-Y)

Multiple Unit Operation

The Diesel-electric locos are capable of being coupled together to work in Multiple Unit Operation in which only Leading Loco is required to be manned , whereas all the trailing locos are controlled by Leading Loco to run at the same notch and produce power accordingly. In case of multiple loco operation trailing locomotive can be notched up or down from the same controls available with the driver of leading locomotive. Similarly Brake application on trailing locomotive will be as per brake aspects on the leading locomotive.

GM/EMD Locomotives:

Indian Railways have purchased the following:

1. 13 assembled WDG 4 locomotives
2. 9 partly knocked down WDG 4 locomotives.
3. 10 assembled WDP 4 locomotives.
4. Technology for manufacturing of these locomotives at DLW/Varanasi from M/s General Motors, USA.

DLW has started manufacturing this loco,



WDG4 loco, 4000 hp (1998)

Features of GM/EMD Locomotives:

1. 4000 HP locomotive equipped with 16-710 G 3B engine.
2. 540KN starting Tractive Effort.
3. 270 KN Braking Effort.
4. 4% improvement in fuel efficiency.
5. AC-AC technology.
6. Micro processor based traction control.
7. Electronic brake system.
8. High adhesion and high speed bogie.
9. 90 days trip schedule.
10. Bogie overhauling after 1.6 Million kms.

COMPUTERS

GM locomotive is provided with 3 computers:

1. Main computer named as EM 2000 which –
 - a. Does total control over diesel engine performance including safety aspects.
 - b. Does trouble shooting and self diagnosis.
 - c. Alpha numeric display.
 - d. Archive memory and data logging.
2. Siemens computers which controls converters.
3. Knorr computer.

Comparative Performance of WDM2 and WDG4 (GM) is as under:

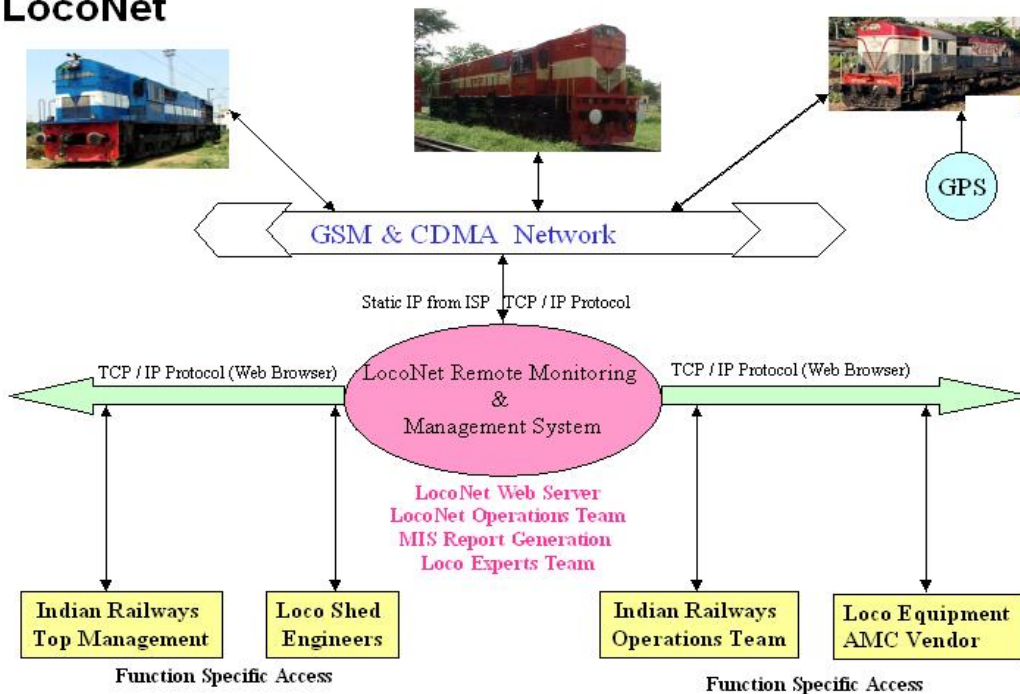
S.No.	Indices	WDM2	WDG4 (GM)	% Gain
1	Weight of train that can be hauled on level track (Tons)	4500	9400	109
2	Weight of train that can be hauled on 1:200 gradient	3085	5455	77
3	Balancing speed with 4700 ton	59	85	44

	trailing load			
4	Availability (Locos on line/locos owned)	81%	>90%	12
5	Trip Schedule	20 to 30 days	90 days	
6	Shop attention	8 years	16 years	167
7	Reliability (Track KMs)	1 lacs	4 lacs	300
8	Lube Oil consumption (% of Fuel oil consumption)	1.5	0.5	66
9	SFC (gms/ bhp/hr)	164.24	151	9
10	HP Output	2600	4000	54
11	Starting adhesion	27%	42%	55%
12	Starting Tractive effort	30.4 T	52T	74

TECHNOLOGY PROGRESSION:

Remote Monitoring and Management of Locomotives:

LocoNet



With the help of remote monitoring (ALCO) following are the advantages:

1. On line health monitoring and fault diagnostic of locomotives is possible.
2. Conditional maintenance of locomotive can be done resulting in increased periodicity of shed recall power.
3. Feasibility of advanced train control is possible.

Introduction of IGBT Traction Control Converter: EMD Locomotive

1. Traction Control Converter, the heart of AC-AC traction system, is basically a computer controlled inverter. High voltage GTO is used in existing TCC as main switching device. IGBT has been recently introduced in these applications because of better efficiency, characteristics and reliability.
2. Indian Railways Diesel Traction has timely adopted this new technology and manufactured first locomotive equipped with IGBT based converter in Nov '06.
3. After successful field trials, IGBT has been introduced in series locomotive production from Sept '07 onwards.

4500 HP Power Upgradation:

1. 1st 4500 hp loco (12114) with EMD IBT was commissioned in field in May '2007.
2. Two more locomotives equipped with IGBT were commissioned subsequently.
3. Series production of 4500 hp EMD locomotives has started.
4. Existing fleet with GTO TCC is also being planned to be upgraded to 4500 hp.

Operational advantages:

	Load	Balancing speed (KMPH)	
		4000 HP	4500 HP
Freight operation	58 BOXN	85	92
Coaching	18 Non AC + 6	123	130

Improvements in EMD Passenger Locomotives:

Introduction of EMD IGBT has lead to new series of EMD passenger version named WDP_{4B} with 4500 HP and 6 TMs configuration. WDP_{4B} will have maximum speed potential of 130 kmph.

3. Hotel Load:

Hotel load module of 500 kVA capacity, 750 Volts, 3 phase for BOG rake is being developed.

Benefits:

1. Significantly higher efficiency.
2. Reduced tare weight of train. Additional Passenger capacity will be generated by replacement of power cars.

Two WDP4 locomotives with hotel load have been turned out in 2010 and trials are on.

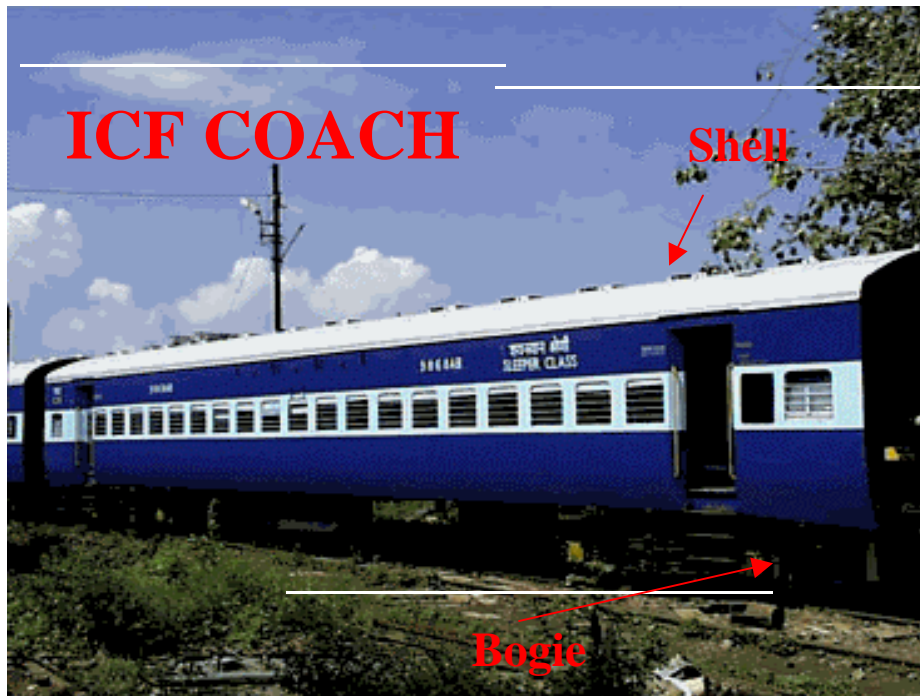
Further improvements planned in EMD locomotives are as under:

1. Electronic Fuel Injection System
 - a. Fuel saving upto 2%
 - b. Engine emission Tier – 2 complaint.

2. Enabling Distributed Power Operation: Following are the advantages:
 - a. Long haul operation of freight trains.
 - b. Train set operation for passenger trains.
 - c. Support 200 Car trains or longer.
 - d. Allow increased average speed, reduced cycle times.
 - e. Reduce coupler forces.
 - f. Push pull train operation.
 - g. Reduce energy consumption, derailment risks, wheel wear.
 - h. Improve safety based upon reduced stopping distance.

9. Coaching Stock - Design And Maintenance

The standard coach which was developed after first World War was a wooden coach on steel under frame (4-wheeled). Later bogie coaches with wooden body and steel under frame were developed (IRS coach). Further developments have since taken place to provide more built-in strength and to make the coach lighter. Now ICF anti-telescopic integral coach with all coil spring bogies have been made a standard design for Indian Railways which has a better riding quality compared to IRS design coach.



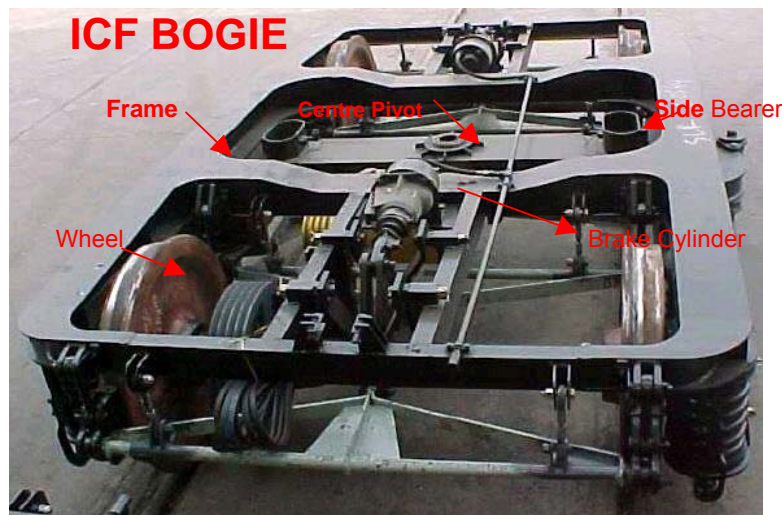
ICF Coaches - IRS coaches were heavy and used to suffer extensive damage in collision / accident resulting in heavy passenger casualties. Integral design was developed in late 30s in Switzerland by M/s Swiss Car and Elevator Mfg. Ltd. Schiliren This could be visualized as a large hollow tube placed on wheels. Extensive use of advanced welding technology for sheet welding was made use of. Indian Railway obtained collaboration with this firm and set up the coach factory at Perambur, Madras in 1950s. The concept of separate coach body and under frame gave way to one piece single shell construction.

ICF shell - The shell consists of pressed steel section welded together with sheet covering. The skeleton of the shell consists of a series of hoops each consisting of floor cross beam, body side pillars and roof carlines. The sole bar, waist rail, light rail, cant rail and roof purlines hold these hoops together. This is covered by roof sheet on top, side panels on sides and corrugated trough floor.

The trough floor offers considerable **resistance to longitudinal crushing loads**, but cannot take high vertical load. On each end, specially designed head stock with compression/destruction tubes are welded. These tubes when subjected to collision shock, get deformed **absorbing most of energy** hence reducing the adverse effect of impact.. Body bolsters are welded on bottom side of trough floor.

The coach ends consist of 4 vertical stanchions box section, transversely connected by Z sections and are welded to the head stock. Collision impact is first received by end stanchions which absorb a large part of it. The residual shock is absorbed by **deformation of compression/destruction tubes**. These features make ICF coaches anti-telescopic. The windows are made separately and screwed on to the double chamber. The coaches can be provided with vestibules for passage from one coach to another in a running train.

ICF Bogie - The bogie frame is made from sections welded together. The axles are located on bogie by telescopic dash pots and axle guide assemblies. Helical springs are used in both **primary and secondary suspensions**. The axle guide **provides damping across primary suspension** and vertical **shock absorber across secondary suspension**. Rubber pad vibration isolation is also provided in primary suspension. Weight is transferred **through side bearers**. Coach/ Bogie pivot **only acts as centering device and transmits tractive/braking forces**. Lateral shock absorbers are provided to **dampen lateral vibrations**



Furnishing - Following are important features of furnishing -

- ❖ Length of seat should not be less than 6'- 6".
- ❖ Width of seat should not be less than 21" for second class and 26" for first class.
- ❖ Hip width per passenger should not be less than 21".
- ❖ Height of seat should be 16" from floor.
- ❖ Knee space between opposite seats should not be less than 21"

❖ Back rest should be slightly inclined.

Coding of coaching Stock - Coaches are coded as per end use and are same for all gauges. There are a large number of codes. Details are available at Appendix B of Conference Rules Part-IV. Important codes are :

AC	AC Coach	P	Postal van
F	First Class	CD	Dining Car
S	Second Class	CW	2 Tier
C	With coupe	CN	3 Tier
G	Self Generating	CG	3 Tier + Sitting
L	Luggage	R	Guard
W	Vestibuled Coach	CB	Pantry Car

Coaching Stock Maintenance - Coaches are based at a primary maintenance depot which is responsible for maintenance of those coaches. A set of coaches which are combined to form a train is called a rake.

Rakes are given Primary maintenance by the owning railway / base depot and Secondary maintenance at the other terminus. No secondary maintenance is required if the round trip of the train is less than 3500 kms. Other depots en-route undertake safe-to-run examination of the train. While primary maintenance involves complete inspection and attention to the rake, secondary maintenance involves cleaning, washing and inspection of safety fittings.

The target availability for non-AC coaches is 90%, i.e. 10% ineffective is permitted- 6.5% on workshop account for POH and repairs, 1% for waiting in yards and 2.5% on open line repair account. For AC coaches 12% ineffective is permitted- 9% on workshop account and 3% on open line repair.

LHB Coaches



Contract was made with LHB in 1995 to supply the following:

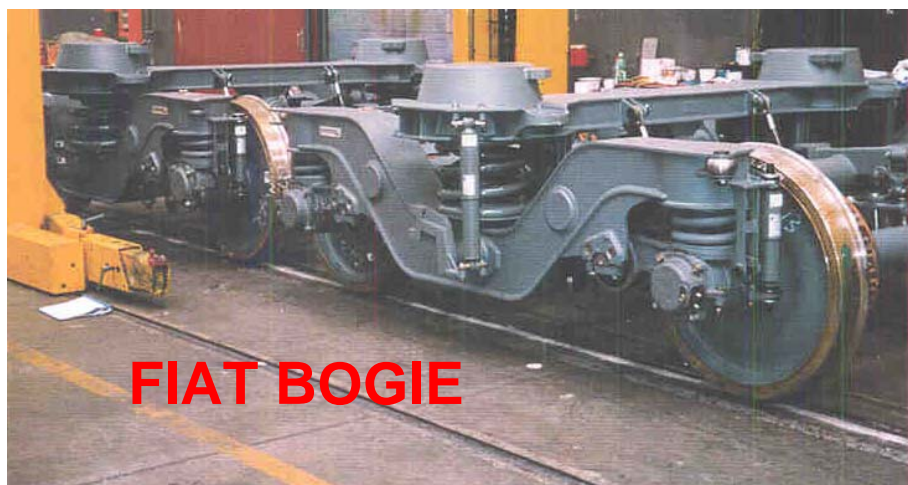
1. 19 AC 2nd class chair car
2. 2 AC Executive class chair car
3. 3 Generator cum brake van

TOT is available for

1. AC first class sleeper
2. AC second class sleeper
3. AC pantry car
4. AC 3 tier developed by IR

Double Decker AC Chair Car

1. Designed by RDSO, Lucknow
2. Manufactured by RCF, Kapurthala
3. 128 seating capacity
4. Oscillation trials successfully conducted upto 180 kmph
5. Certified to run up to 160 kmph
6. Disc brake
7. FIAT bogie with air springs
8. LED destination board
9. Start working on Zonal Railways.



Features of LHB/FIAT coaches are as under:

1. Shell manufactured by LHB and bogie by FIAT
2. Speed potential 160 kmph can be raised to 200 kmph
3. AAR 'H' Type tight lock coupler
4. Window with double glazing with inert gas in between
5. Noise and heat insulation
6. Two microprocessor roof mounted air conditioned unit
7. Axle mounted EP type disc brake with wheel slide protection
8. Interlocking type of joint between vertical and longitudinal stiffener
9. Use of stainless steel to minimise corrosion
10. Modular design interior
11. Hygienic toilets with controlled discharge
12. Catridge roller bearings

Comparison of LHB and ICF Coaches:

S.No.	Item	LHB	ICF
1	Sitting capacity		
	II class	78	67
	I Class	56	46
2	Length of body (m)	23.54	21.337
3	Width (m)		
	External	3.24	3.24
	Internal	3.07	3.03
4	Weight of coach (t)	40.2	47
5	Bogie wheel base (m)	2.56	2.896
6	Maintenance periodicity (in lakh km)	10	3-4
7	Riding index	2.75	3.5

Preventive maintenance schedules -- Preventive maintenance schedules followed for coaching stock in the form of examination and repair and POH are :

- (a) Trip Schedule (Primary and Secondary maint.). - Every trip.
- (b) Schedule "A" by primary maintenance depot. – (Monthly) +/- 3 days
- (c) Schedule "B" – (do - Quarterly) +/- 7 days
- (d) Schedule "C" – (do - Half-Yearly) replaced by IOH – 9 months +30/-0 days

(e) POH by Coach Repair Workshop of Owinging Rly.

POH Periodicity of Coaches :

POH Schedule (New)

COACH CATEGORY	PERIODICITY IN MONTHS		
	IOH in Depot	IOH in work shop	POH in work shop
New Coach turned out by PU or A coach turned out after MLR	12	--	24
Rajdhani / Shatabdi	--	9	18
Mail/Express, Garib Rath, Jan Shatabdi & OCV forming part of standard rake composition of Mail/Express Trains	9	--	18
Passenger	9	--	18
Other OCV	12	--	24

Ref: Railway Board Letter No 2007/M(C)/141/1 dated 26.9.08

68

Major items attended during trip Schedule- Time allowed in 6 hours (to be done at washing line)

- ❖ Washing & Cleaning
- ❖ Oiling if required (oiling to be done every 15 days)
- ❖ Lubrication of all moving parts
- ❖ Wheel, suspension, draw & buffing gear examination .
- ❖ Change brake block, if needed, and adjust brake rigging slack.
- ❖ Alarm signal apparatus testing.
- ❖ Examine and provide passenger amenity fittings.
- ❖ Check for proper flow of water in all pipes.

"A" Schedule (to be done on washing line)

- ❖ All items of trip examination.

- ❖ Flush water tanks.
- ❖ Disinfection of coach.
- ❖ Check train pipe & brake system for leakage.
- ❖ Grease alarm chain apparatus.
- ❖ Clean Direct Admission Valve.
- ❖ Examine & replace brake gear pins.
- ❖ Check & fill oil in ICF side bearers & dash pots.

"B" Schedule (at washing line)

- ❖ All items of "A" schedule.
- ❖ Overhaul alarm testing apparatus, release valve.
- ❖ Touch up painting.
- ❖ Check and fill oil in ICF side bearers.

"IOH' Schedule - The coach is to be marked sick and taken to sick line for this schedule.

- ❖ All items of "B" Schedule.
- ❖ Lift coach, Run out bogies, Overhaul bogies./ Use workshop overhauled bogie
- ❖ Painting if, needed.
- ❖ Overhaul Vacuum cylinder.
- ❖ Check slack adjuster, shock absorbers etc.
- ❖ Check & repair vestibules.
- ❖ Corrosion repair.
- ❖ Brake system
- ❖ Draw/ Buffing gear

Cost of new coaches

- ❖ Cost of AC Coaches – Rs. 60 to 80 lakhs (depending upon type of coach AC2T, AC3T, End on generator or Self generating car etc.)
- ❖ Cost of non-AC coaches -- Rs. 25 to 40 lakhs.

Codal Life of Coaches

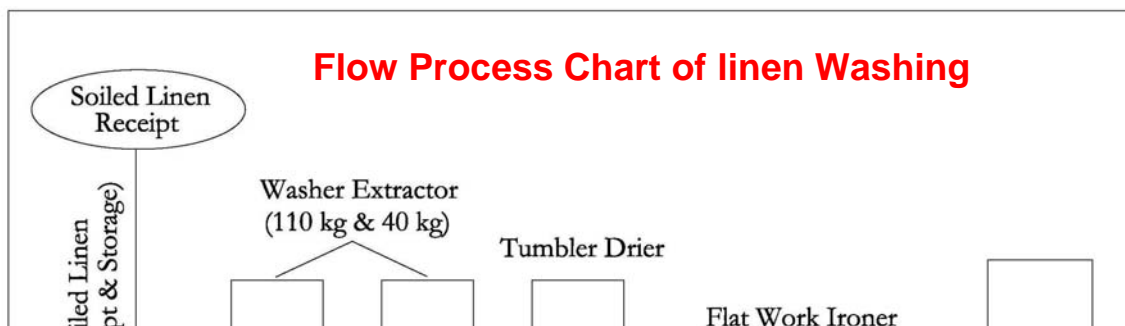
- ❖ Steel-bodied coaches (ICF type)-- 25 Years
- ❖ Wooden- bodied coaches (IRS type)– 30 Years
- ❖ Lightly utilized coaches - 40 years

10. Linen Management

Linen management has become one of the important and sensitive activities in Passenger services. The linen management involves the procurement of linens, blankets, pillow covers pillows and face towels , washing and packing and distribution to the station and in turn to passengers in the coach.

The linen management had been carried out, traditionally by the commercial department from the introduction of linen supply in AC coaches. The linen management is now being carried out by different departments in various Railways based on the Zonal Railway guidelines. To standardize the Linen Management on Indian Railway, Board has taken a decision to entrust the Comprehensive Linen Management to Mechanical department(C&W) in the year 2009. By this order, Mechanical department has to undertake the comprehensive linen management i.e., Purchasing, washing, storage, supply & distribution of the linen kit to the passengers In AC coaches.

Different methods	ACTIVITY	DONE BY	DONE BY
Type 1	PROCUREMENT	MECHANICAL	DEPARTMENTAL
	WASHING	MECHANICAL	
	DISTRIBUTION	ELECTRICAL	
Type 2	PROCUREMENT	MECHANICAL	DEPARTMENTAL
	WASHING	CONTRACT	OUTSOURCING
	DISTRIBUTION	CONTRACT	
Type 3	PROCUREMENT	CONTRACT	OUTSOURCING
	WASHING	CONTRACT	
	DISTRIBUTION	CONTRACT	
Type 4	PROCUREMENT	MECHANICAL	DEPARTMENT
	WASHING	CONTRACT	BOOT MODEL
	DISTRIBUTION	CONTRACT	



11. BIO TOILETS

- ❖ An environment Friendly Toilet System
- ❖ Green toilet aims at – Zero – defecation on the ground

Problem with present system- Discharge on track creates environmental problems as well as problem in working to work man.

Bio Toilet - Bio-digester is provided, effluent is discharged on track after bio de-gradation

Action Taken

A multi-directional strategy has been implemented for adoption in IR-Passenger Coaches.

MOU has been signed with DRDO for joint technology development

The first rake with bio-toilets developed with DRDO is running in Bundelkhand Express since 18th January -2011.

05 more rakes fitted with DRDO technology toilets have been allotted to NR, NCR, NER, NFR, CR, WR, WCR and SECR.

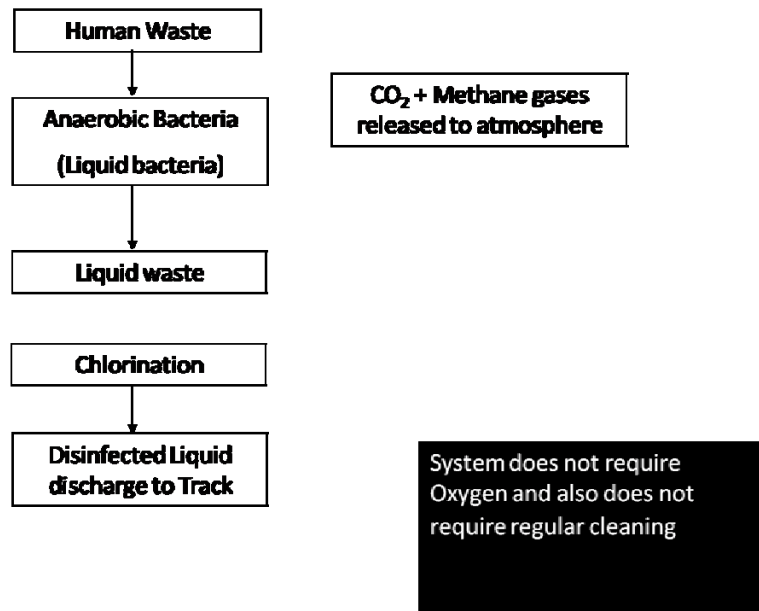
2500 more coaches will be fitted with DRDO toilets during 2013-2014.

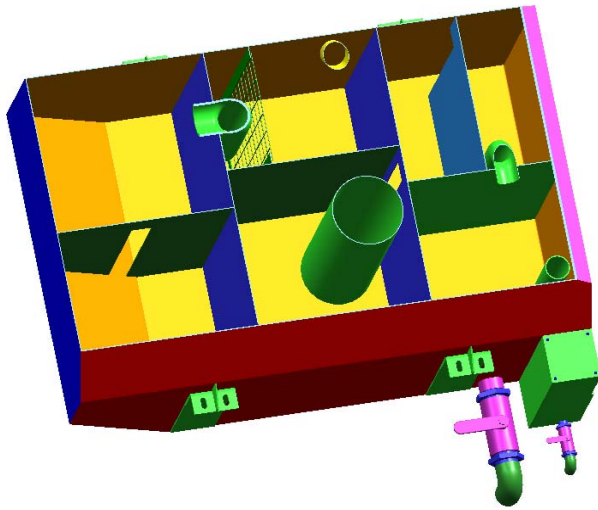
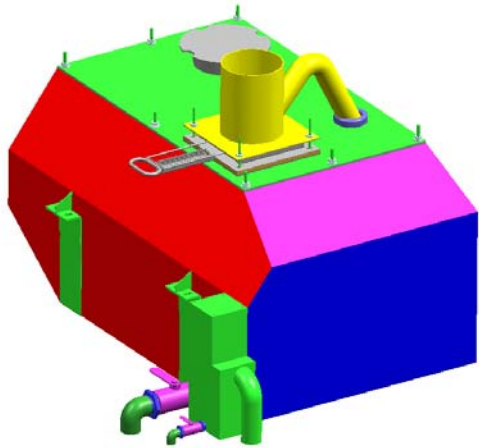
Advantages

1. No bad smell in toilets from the tanks
2. No infestation of Cockroaches & flies
3. Fecal matter in the tank not visible
4. No clogging of digester
5. Effluent is free from off odour and solid waste

6. No maintenance required
7. Reduction in organic matter by 90%
8. No requirement of adding bacteria/ enzyme
9. No need of removal of solid waste

Working of Anaerobic System





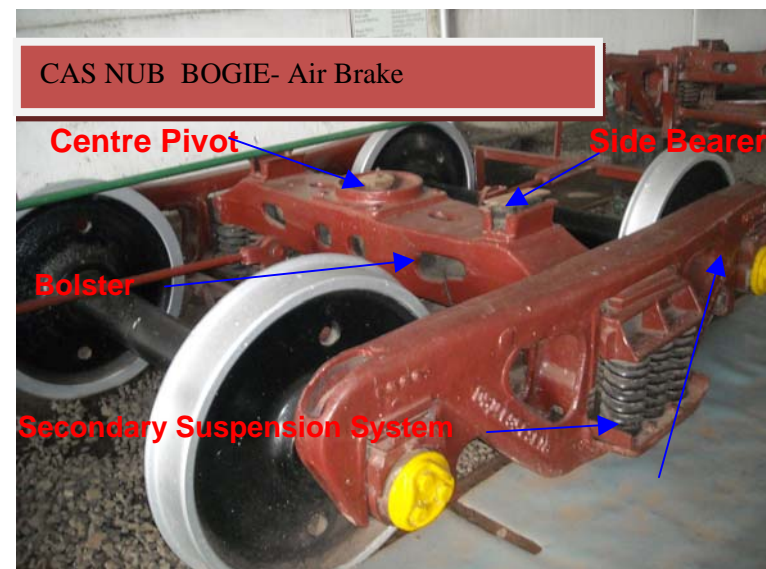
BIO TOILET

12. Wagon Stock - Design Features And Maintenance

The IRS wagon construction is similar to IRS coach. The under frame is similar and the body is built on the under frame with steel sections. The 4 wheeler suspension is exactly similar; however, in case of bogie type the bogie design is different.

In 1960s, BOX wagon with UIC design bogies was put in service. This has roller bearing axle boxes, fabricated bogie, centre buffer coupler. These are capable of higher speed, need less frequent attention and heavier trains could be formed.

In 1980s, IR introduced the BOX "N" wagons with **catridge roller bearing, cast steel bogie, helical spring suspension, CBC and air brakes**. The length of this wagon is less than BOX wagon for the same payload and hence still heavier trains are possible as more wagons can be added for same length of train. These are practically maintenance free for long runs and higher speeds.



Cartridge Roller Bearing →

Bogie Frame

Codification of wagons : Wagons are coded as per the design feature and end use. The details are given at Appendix "B" of Conference Rule Part III. Some important codes are :

General Purpose Wagons			
K Or O	Open	BOX	Bogie open (UIC bogies)
C	Covered	BOXC	BOX with CBC
B	Bogie	BOXT	BOX with transition coupling.
X	Explosive	BOXR	BOX with screw coupling
V	Brake Van	BCX	Bogie covered – UIC bogies
T	Tank	BTPN	Bogie Tank Petroleum (Casnub bogie/ air-braked)
W	Well	BOXN	Bogie Open (Casnub bogie/ air-braked)
F	Flat	BCN	Bogie Covered; - do -
CRT	4 wheeler covered with transition coupling & roller bearing	BRH	Flat wagon with UIC bogie.

Special Purpose Wagons

BOBS : Open hopper wagon (side discharge)
BOYS : Open are wagon (CBC)
BOBX : Hopper with centre & side discharge
BOBC : Hopper with centre discharge.
BOBR : Open hopper wagon with bottom discharge, CASNUB bogie, air braked
BFKI / BFKX - Flat wagon with CASNUB bogie.

Wagon Maintenance : Unlike locomotives and coaches, wagons are not based at any depot. These are pooled stock and move all over Indian Railways. They are, however, regularly checked for defects at train examination points. The wagons are combined and formed into trains which are given " Intensive" and "Safe-to-run" examination before loading and after unloading.

Railway Board have issued instructions to do away with Safe-to-run examination; i.e. only Intensive examination of goods trains to be done.

The availability target laid down for wagons is 96 %, i.e. in-effective of 4 % is permitted - 1.5 % on workshop account and 2.5 % on open line repair account.

Preventive Maintenance Schedules -

For Bogie wagons the following schedules are undertaken :

ROH (Routine Overhaul) - 18 months periodicity. It involves lifting of the wagon and proper attention to the bogies and underframe members.

POH - 4 ½ years for vacuum braked wagons. In case of air-braked wagons, it is 6 yrs or 4 ½ yrs. Frequency for POH of BCNA wagon is 6 yrs. In case for BOXN wagon, 1st POH is after 6 yrs, but subsequent POH is after 4 ½ years. POH is done in Wagon Repair Workshops, whereas ROH is done on nominated wagon depots on the open-line.

The POH / ROH particulars are painted on the left side sole bar of every wagon indicating the date and the station code of the wagon depot which undertook these schedules.

In addition, the wagons are checked for development of defects at many other points and attended if need arises. These are :

Rolling in examination while entering yard. This is a visual examination to check for -

- ❖ Loose parts - Flat tyre - Overheated axle- box
- ❖ Broken spring - Abnormal behavior

Terminating examination after the train has terminated in the yard to check:

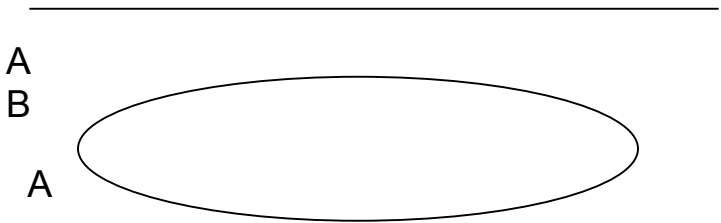
- ❖ Warm boxes
 - ❖ Examine under gear fittings
 - ❖ Tap wheel for dull sound - Check tyre defects
 - ❖ Test vacuum brake cylinders, brake rigging
- Adjust brake rigging slackness and replace brake blocks if needed.
 - Check suspension and draw & buffing gear.
 - Buffer height

Outgoing examination after formation of train :

- ❖ Above checks.
- ❖ Create vacuum & test for leakages.
- ❖ Destroy vacuum and test brake effectiveness.
- ❖ Release valve and see piston descend
- ❖ Record vacuum level in loco & brake van.

The following are the types of examination in the freight system:

1. End to End



2. Closed Circuit



3. Premium rake



D

Issue of Brake Power Certificate are as under:

1. Standard format of Brake power certificate for VAC brake stock, air brake stock and close circuit rakes is to be used.
2. Brake Power Certificate Color of VAC brake and air brake stock, will be pink and green respectively.
3. Originating effective brake power for VAC brake trains is 85% or higher.
4. Min. originating brake power for air brake trains is 85% or higher,
5. Min. originating air braked stock running in close circuit is 100%.

Brake Pipe pressures in air brake train with locomotive should be as follows:

No. of wagons	On locomotive	On Last wagon
Up to 56	5.0 kg/cm ²	4.8 kg/cm ²

Beyond 6	5.0 kg/cm ²	4.7 kg/cm ²
----------	------------------------	------------------------

Minimum level of VAC shall be 46 cm on loco and 38 cm in the brake van.

End to End (Air Brake Rakes)

1. Nominated colour of BPC for End to End (Air Brake Rake) is green.
2. After intensive examination validity of BPC remains upto the unloading point.
3. Normally the empty rake after unloading should be offered for intensive examination before next loading.

End to End (Vacuum Brake Rakes)

1. Nominated colour of BPC for End to End (Vacuum Brake Rake) is Pink.
2. After intensive examination validity of BPC remains upto the unloading point.
3. Normally the empty rake after unloading should be offered for intensive examination before next loading.
4. The empty rake must reach the loading point within 4 days of the issue of BPC including the day of issue, otherwise, the rake will have to be re-examined.

Closed Circuit:

1. Nominated colour of BPC for Closed circuit is Yellow.
2. Meant for only Air Brake rakes – 100% brake power
3. After intensive examination validity of BPC remains valid for 6000 Kms (20 days), 7500 (35 days) on nominated routes.
4. Meant for multiple loading/ unloading between two successive intensive examinations.
5. Meant for stock maintained only at nominated CC bases with required infra-structural facilities.
6. Meant for operating over a pre-determined circuit.

Premium rake

Meant for only Air Brake rakes.-

–After intensive examination validity of BPC remains valid for 15 days (including 3 days for loading)

–Meant for multiple loading/unloading between two successive intensive examinations.

–Minimum 95% brake power

Cost of new Wagons: Approx. Rs. 15 – 20 lakhs (Depending upon the type of wagon)

Codal Life of Wagons :

Generally - 35 years ,

For Tank Wagons - 45 years

13. Important Components Affecting Safety

Following assemblies of rolling stock have vital bearing on safety and hence their functioning should be carefully watched.

- ❖ Wheel assembly
- ❖ Suspension Arrangement
- ❖ Draw and Buffing gear
- ❖ Brake system.

Wheel Assembly : Wheels of railway vehicles are made up of

- i. Axle rolled from steel to specification R-16
- ii. Wheel centre - solid rolled or cast steel to R-19
- iii. Tyre - Rolled Steel to specification Rs-15
- iv. In lieu of (ii) and (iii) solid wheel disc may be used. This is made from rolled steel to R-19
- v. Bearing and axle box.

Axle : Railway axles are first rough rolled from steel to specification R-16 and then precision machined in workshop.

In case of plain bearing axle, a collar is provided at the end which acts as retainer of the bearing shell. In case of roller bearing axle boxes collar is not provided, but, bearing is secured by studs fixed on the end of axle.

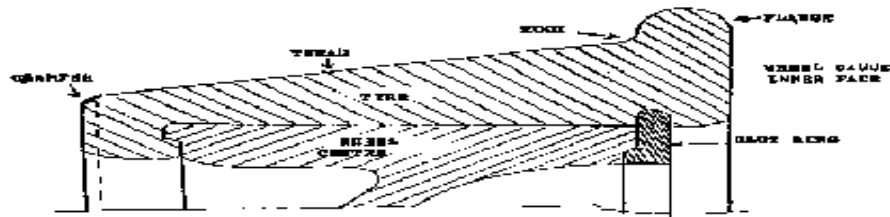
The journal portion constantly rubs against the bearing and need very smooth surface without ovality. This is achieved by smooth machining followed by burnishing. The wheel seat is the place where the wheel centre/ wheel disc is fitted on the axle.

The **Wheel** disc is bored and pressed on to the axle at the wheel seat by using a hydraulic press.

Tyre : It is bored accurately. The bore of tyre is also kept 0.1% less than wheel centre diameter. The tyre is heated to 300 degree C, hence it expands in diameter. The heated tyre is slipped on the wheel-centre and allowed to cool. Thus it grips the wheel centre firmly. In addition some fastening devices are used to hold the tyre on wheel centre even if grip becomes loose due to constant brake application and resultant rise in tyre temperature. Fastening devices are :

- ❖ glut ring
- ❖ mansell ring
- ❖ stud fastening

Glut ring fastening is most common and shown in sketch below :



A TYRED WHEEL

Axle Boxes. The bearings can be plain or roller bearing . Plain bearing are oil lubricated with the help of packing rolls soaked in oil. Roller bearings are lubricated by grease.

Older stock on IR has plain bearing which require frequent maintenance for oiling & repacking. Incidences of hot / warm axle boxes in such stock are also high. In comparison, Roller Bearings' Stocks require very less maintenance & incidences of warm / hot boxes are also very less.

Roller bearings should be opened for examination in dust free rooms only. Over or under filling of grease in roller bearing axle is harmful. Care is also necessary during welding of rolling stock, so that return current doesn't pass through bearings as it can adversely effect the performance of bearings.

Wheel defects : Wheels should be regularly checked for wheel defects. Most of the defects can be checked **by wheel defect gauge**. Wheels defects are :

Wheel gauge - Distance between inside of two wheel centre/Tyres, it may be less or more than the prescribed limits.

Loose tyre - Checked by tapping with a hammer. A ringing sound indicates good tyre whereas a dull sound indicates loose tyre.

Tyre/Disc on condemning size - checked by wheel defect gauge.

Sharp or thin flange - Flange excessively worn out.

Root wear - Root radius less than minimum allowed.

Hollow Tyre - The wheel tread develops a dent/depression

Flat tyre - Flatness on tread caused due to brake binding on run

Excessive play in axle box

Scored journal

Warm box

Suspension : The desired suspension characteristics are :

- ❖ To transfer vertical load to rail
- ❖ To transfer tractive and braking forces
- ❖ To dampen the vertical and lateral vibrations being passed on from road to car body.

Suspension system consists of -

- ❖ Springs
- ❖ Spring links and pins
- ❖ Axle box guides
- ❖ Central pivot in case of bogie wagons
- ❖ Shock absorbers.

Spring -- Laminated / Leaf and Helical/Coil springs are used in railway vehicles.

Centre pivot is used to transmit vertical and longitudinal forces. Some designs use it for centering and transfer of tractive & buffing forces in longitudinal direction

Coaches need more comfortable suspension. This is achieved by :

- ❖ Providing coil springs in series in primary Suspension and secondary suspension.
- ❖ Providing vertical & lateral shock absorbers.

- ❖ Providing longer swing links.

Suspension defects

- ❖ Broken springs
- ❖ Uneven springs on different wheels
- ❖ Leaky shock absorbers
- ❖ Broken or excessively worn out links and pins

Draw and Buffing gear : The train consists of many vehicles. There has to be a means to couple these vehicles together and uncouple with ease. This aim is achieved by providing draw gear. Buffing gear is provided to save the car body from damage from braking forces.

Two types of draw and buffing gear are in use on I.R :-.

- ❖ Draw Bar assembly with screw coupling and buffers on both sides on each head stock.
- ❖ Both the functions combined into one assembly called CBC (Centre Buffer Coupler)

Advantage of CBC over conventional draw bar:-

- ❖ Higher capacity enabling to run heavy trains
- ❖ Easy operation
- ❖ Automatic coupling
- ❖ No damage to head stock

Draw & buffing gear should be watched for following defects:

- ❖ Homed buffer
- ❖ Broken buffer casting/spindle
- ❖ Buffer height from rail level
- ❖ Broken draw bar springs
- ❖ Worn out/broken screw coupling or parts.
- ❖ Wear of knuckle of CBC
- ❖ Locking device of CBC
- ❖ Condition of rubber springs of CBC

14. Brake Systems

An efficient and reliable brake system is needed for stoppage of vehicle in minimum possible distance. The system should be such that vehicle should not experience jerks and should stop smoothly.

The railway brake system should have the following features :

- ❖ **Automatic application.** The brakes should apply automatically in case of train parting, or failure of power system.
- ❖ The brakes should apply as fast as possible.
- ❖ The brake should simultaneously apply on each vehicle of the train.
- ❖ The brake force should not reduce with passage of time.

Indian Railways have employed the following brake systems for its rolling stock :

Earlier most of our rolling stock are fitted with AVB (Automatic Vacuum Brake).

Air Brakes - Twin- pipe system of air brakes have been used in Mail/Express/Passenger trains and single- pipe system in our freight trains. Air Brakes are also used on the locomotive.

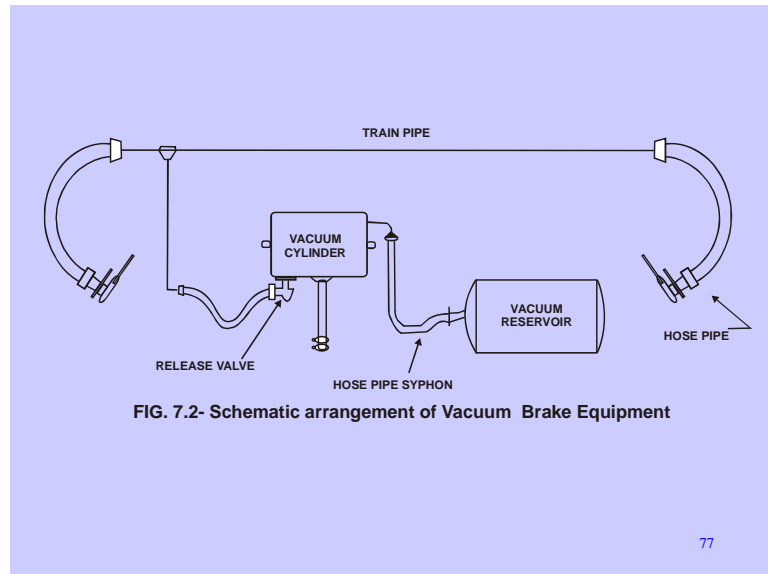
All wagons are fitted with hand brakes for stabling. Locomotives and brake van are fitted with hand brakes which can be applied while the train is in motion.

All locos are provided with compressor and or exhauster for brake system of loco and other vehicles of the train.

A-9 and SA-9 brake valve - In WDM2 loco, by application of A-9 handle simultaneous control of loco & train brakes is done. However, only loco brakes can be applied or released through Independent brake handle SA-9.

Dynamic Brake - Some Diesel and Electric locomotives are fitted with dynamic brakes for continuous application on down grades. On down gradient the traction motors are used as generators and thus Kinetic energy of train gets converted to electrical energy creating a retarding or braking effect. Electric energy so produced is fed to resistance grids where the electrical energy is converted to heat energy. This is ideal for controlling the train on Ghat sections or lowering the speed of train, but becomes quite ineffective at low speeds.

Vaccum Brake System



Vacuum Brake system consist of following component /assemblies - Vacuum Cylinder - Piston and Piston rod - Brake shaft - Brake rigging - Brake shoe

The vacuum brake system derives its brake force from the atmospheric pressure acting on lower side of piston while a vacuum is maintained above the piston. The vacuum is created in the system by exhauster provided in the locomotive.

The vacuum cylinder is divided by piston and rolling ring into two air tight chambers called upper chamber and lower chamber. The volume of upper chamber is kept as large as possible by providing a dome. The release valve is connected to train pipe by flexible siphon pipe, the lower end of piston rod is connected to brake shaft arm. When vacuum is created, release valve allows withdrawal of air from both chambers and piston by its own weight comes to rest at the bottom of cylinder and brakes are released. When vacuum in train pipe is destroyed, air enters the lower chamber, raising the piston. At this time upper chamber is disconnected by rolling ring. So vacuum is still there in upper chamber. The brake shaft arm is lifted with the movement of piston and brake shoes are jammed against the tread of wheel with the help of brake rigging. The release valve when operated allows air admission to upper chamber so that pressure is equalized on both sides of piston and brakes are released.

Vacuum Cylinder --IR has made many improvements in AVB to overcome its inherent drawbacks. These are discussed briefly.

Use of F type cylinder with Vac reservoir-- With the upward movement of piston in the traditional E type cylinder, the volume of upper chamber decreases, causing fall in vacuum level and drop in effective force. To partially overcome this drawback, a large vacuum Reservoir is attached to the upper chamber. The percentage change in vol. of upper chamber due to piston movement is negligible and hence brake force is not reduced.

Direct Admission Valve : The brake application takes quite some time and propagation rate is slow as air has to travel from locomotive to each vacuum cylinder throughout the train. To reduce this time delay, DA valves are fitted on each cylinder. The DA Valve connects the lower chamber to atmosphere immediately on drop in train pipe vacuum till lower chamber vacuum becomes equal to train pipe. Thus, brake application and propagation is faster.

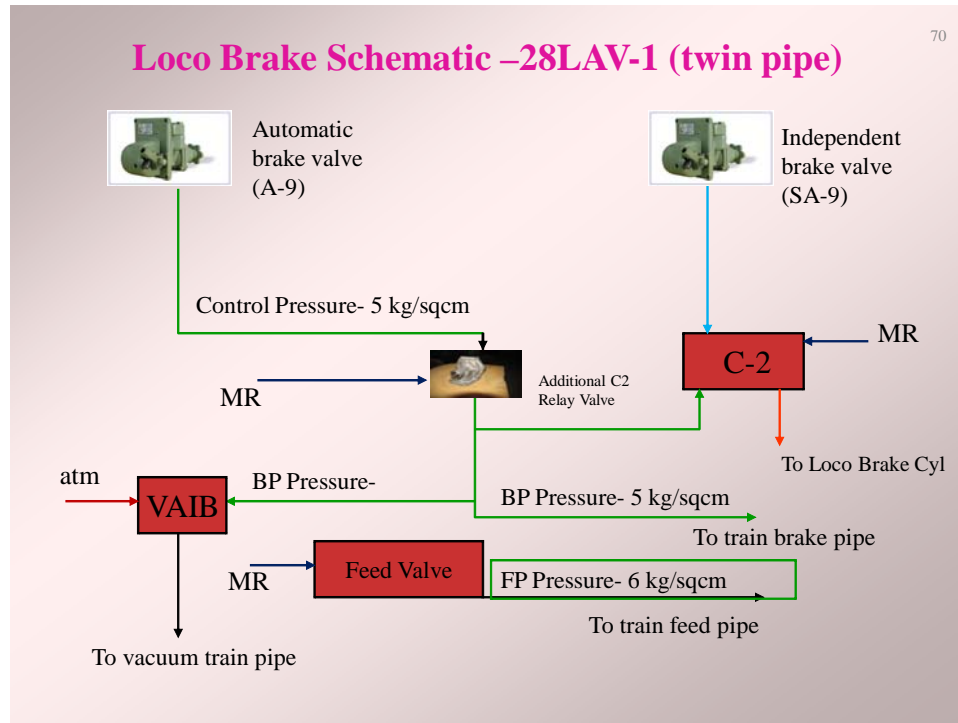
Slack adjuster : With the frequent brake application, the brake blocks wear out. The pins also wear and develop slack in the system. This absorbs part of piston movement and brake application is delayed and brake force reduces. The slack adjuster is a device which maintains brake shoe-wheel clearance to predetermined value even with the wear in the system.

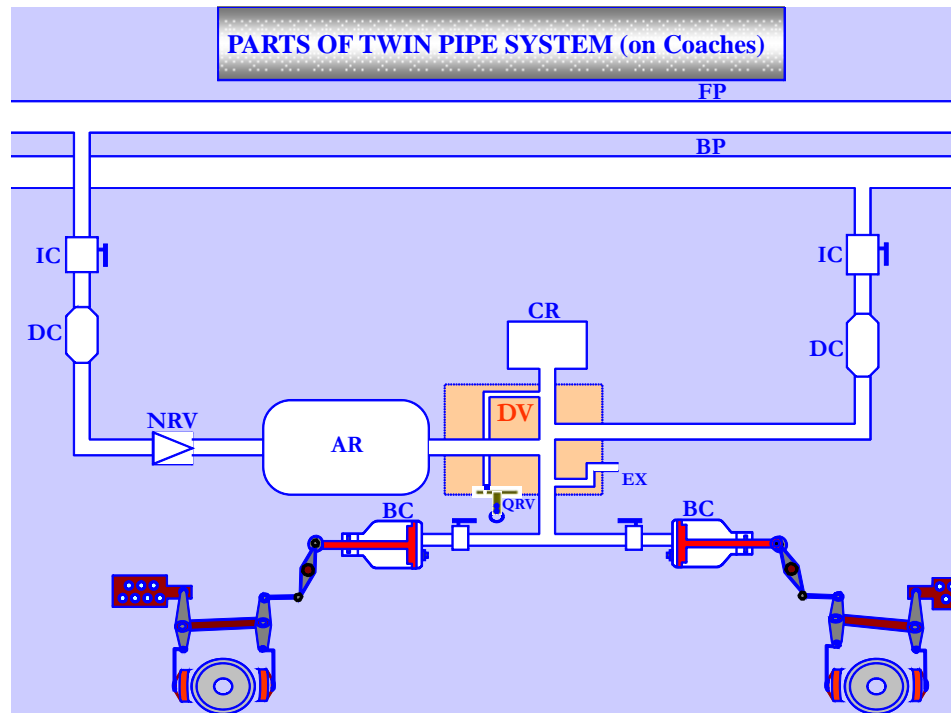
Empty load box: There is huge variation between tare and loaded weight of BOX and BOXN wagons. The brake rigging designed for one situation is not suitable for another situation. Empty load box is a device which alters the mechanical advantage of brake rigging for loaded and empty situations by simply operating a lever or wheel. It thus helps to get optimum brake force in loaded and empty conditions.

Alarm Chain Pulling signal fitted on Passenger coaches: The alarm chain running longitudinally along the coach length, when pulled, opens air delivery to vacuum system and rotates a disc at each end to identify the coach from which alarm chain was pulled.

The destruction of vacuum applies brakes to the train. Driver and Guard come to know of some emergency. This system is provided to enable passengers to be able to stop the train in case of an emergency. The system was misused by roof travellers, who used to operate the clappet valve at the coach-end and stop the train. This system is being modified so that the valve cannot be operated from outside the coach.

Air Brake System:





Working of twin pipe air brake system

The feed pipe and brake pipe which run throughout the length of the train have air pressure at 6kg/cm^2 and 5kg/cm^2 respectively.

The compressed air is supplied by the compressor/ expressor on the locomotive and the pipes of adjacent coaches are joined by using flexible couplings. For application of brakes, the air pressure in the brake-pipe is reduced (the drop in pressure being proportional to the braking effort required).

This drop in pressure is sensed by the Distributor valve (DV) which allows compressed air from the Auxiliary Reservoir into the Brake cylinder and results in brake application.

When the discharge of air from the brake pipe is stopped, the pressure of 5kg/cm^2 is restored and DV cuts off supply of air to the brake cylinder, thereby releasing the brakes. The brake cylinder develops a maximum air pressure of 3.5kg/cm^2 during emergency brake application.

The function of the feed pipe having air pressure of 6kg/cm^2 is to restore the air pressure in the brake pipe and the auxiliary reservoir after brake application so that the brakes get released quickly and the train can restart. Our goods trains are working on single pipe system in which only brake pipe is present & therefore charging of Auxiliary reservoirs is also through brake pipe.

Advantages of Air brake over Vacuum brakes –

- ❖ More efficient and powerful braking.
- ❖ Reduced braking distances - Uniform braking effort over the length of the train (in vacuum brake trains there is a 15to 20% reduction in brake power along the train length).
- ❖ Brake power maintained over long runs there by enabling end to end running (Vacuum brake trains experience a 10 to 15% deterioration in brake power within 500 kms. of run.)
- ❖ Requires less time for examination thereby reducing Pre-departure detention of trains for brake power certification Vacuum brake trains - takes 2 hours. Air Brake trains - takes 1 hours.
- ❖ Lighter weight of brake equipments thereby enabling higher pay loads for vacuum brakes - 685 kgs. per wagon. for Air brakes - 275 kgs. per wagon.

Alarm Chain Apparatus - Air Braked trains are also having alarm chain apparatus to enable stoppage of trains by passengers during emergency. However, to avoid incidence of train parting in certain conditions of chain pulling, a choke has been provided to reduce its effectiveness. But driver gets the indication through '**Air flow Indicator**' provided in the Locomotives and should apply brakes for expeditiously stopping the train.

15. 140 TON Diesel Break Down Cranes

All BG 'A' class accident relief trains (ART) are required to be equipped with 140 tons diesel crane or 65/ 75 ton steam train. However earlier most of ARTs were only equipped with only 75/ 65 ton steam crane which could not lift a loaded bogie wagon. Therefore, prior unloading of wagon was required before lifting loaded wagons, which led to lot of delay in carrying out restoration of traffic.

To overcome this problem in mid 80's, Indian railways have procured a few 140 tons diesel break-down cranes from M/s Gottwald, Germany and Cowans Sheldon, U.K. (also known as Jessops crane because of their collaboration with Jessops).

Maxm. Permissible Speed of these cranes are as under: Gottwald - 90 Kmph
Jessops - 75 Kmph.

These cranes are required to be hauled by locomotive to reach the accident site, but at the site the cranes can move without loco. The self propelled speed of these cranes without load is 12 Kmph whereas with load it is 6 Kmph.

Safe Working Load: Though the cranes are designed to lift a maximum load upto 140 tons, but in actual working condition the safe working load will be limited on account of

- ❖ Working Radius
- ❖ Outriggers position
- ❖ Slewing Angle
- ❖ Counter weights

Charts are available in the cranes to indicate safe load limit under various conditions.

Features - Both the cranes are totally different in design.

Working Of Crane

- ❖ Crane should travel with jib lowered and in alignment with centre of track.
- ❖ **In Electrified Sections** - Power Block must be obtained & OHE should be switched off before crane operation.
- ❖ After counter weights are placed, the crane should not be swiveled without propping up the crane.
- ❖ Lifting of entangled loads should be avoided .
- ❖ Safe Load Limit should not be exceeded.



140 t Crane, 285 hp (1986)

16. Workshops:

Production Units and Workshops are manpower intensive Establishments under overall supervision of Mech. Dept. which are like backbone in the working of Mech. Dept. Basic philosophy followed in Workshops is Preventive Maintenance. The other system of maintenance is Breakdown Maintenance

Preventive Maintenance can be as under:

- Time Based
- Use Based
- Condition Based

System of Time Based Preventive Maintenance is mostly followed by Mechanical Department. There are various time based maintenance schedules for –

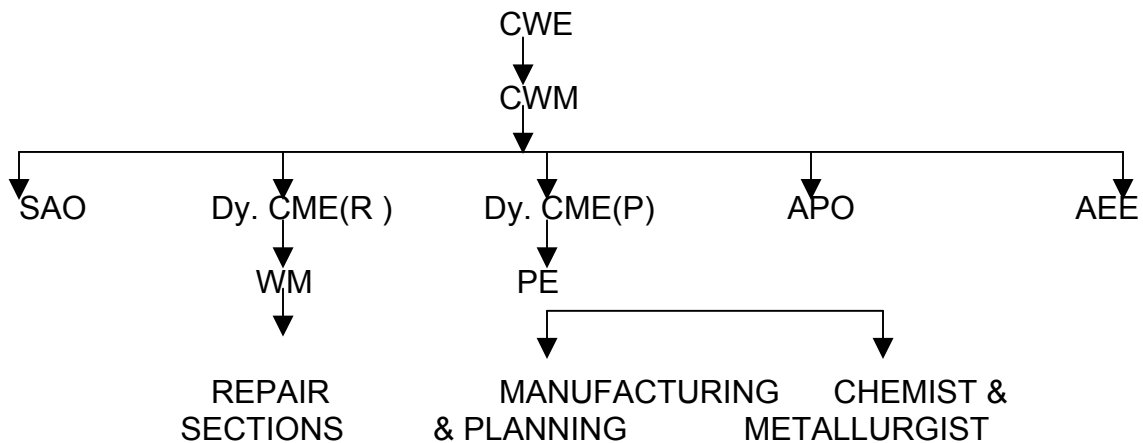
- Locomotives
- Coaches
- Wagons
- Machines & Plants
- Breakdown cranes

Heaviest maintenance schedules are as under

- Periodic Over Haul (POH)
- Midlife Rehabilitation (MLR)

Both these are performed in Railway Workshops. After POH the concerned Rolling Stock should ideally become as good as new.

A TYPICAL WORK SHOP ORGANISATION



Typical Organization Structure of a Workshop is as under:

The Workshop is headed by Chief Workshop Manager. He is in charge of the following:

a. Mechanical

Following are the sections under Mechanical department:

- Repairs

- Production Control
- Manufacturing – Machine Shop , Foundry
- Machinery & Plant – Millwright Section
- Inspection
- b. Stores
- c. Electrical
- d. Accounts
- e. Personnel
- f. Projects
- g. Chemist & Metallurgist
- h. Security

Engineering and S&T activities are controlled by concerned Divisional Officers. Union activities are mainly managed by workshop units of recognized unions.

Production Planning & Control in Workshops & Production Units

Production Engineer is in charge of production planning & control. Following are the departments under PE

- Drawing office
- Planning
- Progress office
- Tool Room
- Inspection
- Time office

Planning and Production Control

1. Pre planning activities- drawing and specifications
2. Drawing office activities- preparation of manufacturing drawings, jig & fixtures, dies
3. Planning Activities-
 - a. Processing- sequence of operation, material, load centre, machine etc.
 - b. Rate Fixing-allowable time fixing
 - c. Efficiency- watch on general efficiency
4. Production Control-release of work orders, preparation of production schedule,
5. Progress office - watch over production, Liaison with stores department for material Inspection-of components, assemblies, certification of job card etc.

Time Office deals with maintenance of record of attendance which is the basis of payment.

Following are the documents maintained by time office:

- a. Time punching card
- b. Attendance
- c. Workmen's ticket number
- d. Overtime requisition

Incentive Scheme

Incentive Scheme was started in 1960 It is also called Chittaranjan System. In this

Basic wages are guaranteed. Time is the basis for incentive earnings.

- Time saved = Allowed Time – Time Taken
- Allowed Time is calculated on Work Study principles

Time Study

Work is divided into distinct elements

$$\begin{aligned} \text{Normal Time} &= \text{Average of Observed Timings} \\ &= \frac{\text{Observed Element Time}}{\text{Rating}} \\ \text{Allowed Time} &= \text{Normal Time} + \text{Allowances} \end{aligned}$$

Following are the Allowances

- Bonus – 33.3%
- Fatigue – 12.5%
- Contingency – 10%
- Gauging – 5% if required

$$\begin{aligned} \text{Allowed Time} &= \\ &= \text{Normal Time} \times 1.125 \times 1.333 \times 1.10 \times 1.05 \\ &= 1.732 \text{ Normal Time} \end{aligned}$$

Following are the Type of workers under Incentive Scheme

- DW** (Direct Workers) – Full incentive
- EIW** (Essentially Indirect Worker) – like supervisors, material handling staff etc. whose work indirectly helps production
– 80% of average savings of DWs
- IW** (Indirect Worker) – No incentive

Following are the Production documents

- **Work Order**

- **Route Card**
- **Job Cards**
- **Group Work Card**
- **Material Card**

Monthly Capacity of a Direct Worker = **8 hours/day x 25 working days x 1.33 Av Incentive = 267 hours**

Monthly capacity of a Machine = **267 – 10%(27) = 240 hours = 480 hours for 2-shift working**

Following are the components of Expenditure in Workshops & PUs-

- **Staff cost**
- **Material cost**
- **Overheads**
- **Energy**
- **Machinery & Plant**
- **Consumables**

17. RUNNING

CREW Control

Following are the running Crew

- LOCO PILOT
- ASSISTANT LOCO PILOT
- GUARD

CREW LOBBY

The crew lobby is Controlled by Chief Crew Controller. In every shift there is a shift crew controller . The Running crew sign on and sign off in the crew lobby. They have to read various instructions and Report any unusual. A large number of records are maintained in the crew lobby.

SIGN ON

• **At the time of signing on the following registers have to be seen and signed by the crew.**

1. Learning road
2. He has to read all circulars.
3. Speed restrictions, and safety bulletins.
4. He has to make various entries in the sign on register.

Crew controller also ensures that the crew takes complete rest before reporting on duty. He should also take the breathalyzer test to ensure that the crew is in sober state.

SIGN OFF

Breathalyzer test is conducted at the time of signing off. The loco pilot has to make entries in the punctuality register, signal and track defect register, unusual register, loco condition register, rest register.

Following records are kept in Crew Lobby

Crew controller charge diary	PC message register
Learning Road Register	Bio data register
Sign On and Sign Off register	Speed restriction register
Safety bulletin register	Unusual register
Signal and tract defect register	
Loco defect register	10 hrs duty register
Spectacle register	Leave register

Crew links
Counseling record

Diverted trains list
Progressive hours register

Duty at a stretch (10 Hrs duty Rule)

1. Overall duty at a stretch from sign on should not exceed 12 hrs
2. Running duty at a stretch from sign on should not exceed 10 hrs from the departure of train.
3. In operational exigencies running duty may be extended beyond 10 hrs within overall limits of 12hrs. Notice is to be given to driver before completion of 8 hrs duty.
4. If relief arranged, crew changing point is one hour journey away, overall limit of duty may exceed 12 hrs by one hr.

In exceptional emergencies like accident duty may exceed,

CREW LINKS(LPP)

- Maximum running duty should not exceed 10hrs
 - Average fortnightly hours should not exceed 104 hrs
 - Rest at HQ and Out Station
- HQ - for duty less than 8 hrs –12hrs
- for duty more than 8 hrs- 16 hrs
-Periodical rests- five 22hrs or four 30 hrs in a month
(with night in bed 22hrs to 6 hrs)
- Out Station- for duty 8 hrs or more-8hrs(staff may opt for 6hrs
- for duty less than 8 hrs – 6hrs
- Continuous night duty should not exceed 6 night at a stretch.

Grading of Loco Pilot

- Loco pilots are Categorized into A, B &C grades. C grade pilot is not allowed to drive passenger train
 - The basis of Grades given by loco inspectors is as under:
- | | | |
|----------------|--|------|
| • Knowledge of | driving technique | - 25 |
| | Safety and operational rules | - 30 |
| | technical knowledge and trouble shooting | - 15 |
| | personal habits | - 10 |
| | accident record are checked for grading | - 20 |
- A- 80 and above: B- 60-80 :C- below 60
 - Periodicity of review is A – 3yrs, B- 2yrs, C-6 months. The Promotion is not effected however promotion is implemented after acquiring superior grade.

LOCO PILOT EQUIPMENT-

Following are the Main items

- G & R or driver rule book
- Loco operating and trouble shooting, Driver hand book
- Electric torch
- One flare signal
- Hand signal lamp , LED based red and green flashing lamp cum torch
- Detonators
- Operating manual
- Engine lamp to exhibit head and tail light
- Red and green signal flag
- Emergency tools, test plate, duster, spare hose pipe etc.

IMPROVEMENT IN RUNNING ROOMS AND LOBBIES

A committee of Executive directors submitted report. The Railway Board accepted some recommendations in 2003.

Following are the recommendations for the Running Room

- Two bed per room/cubicle
- three star like facilities
- DOT/ Railway phone
- Meditation room
- Reading room
- Stand by power arrangement

For LOBBY

- Integrated lobby
- Counseling room
- Rest Room
- AC, water cooler, proper furniture
- Railway and DOT phones
- Power back up

Question Bank of Mechanical Engineering Objective Type Questions

Part1 :

True or False Type Statements

Organisation of Mech. Engg. Deptt.

1. The Mechanical Engineering Department employs 25% of the overall staff strength of Indian Railways.
2. RCF is situated in Patiala.
3. Repower-packing of Diesel Locos is carried out in DLW.
4. COFMOW deals with New Maintenance Practices for Workshops.
5. Diesel sheds are under the administrative control of CWE
6. ICF's staff strength is nearly double that of RCF although production levels are same.
7. CRSE stands for Chief Rolling Stock Engineer.
8. CMPE stands for Chief Manpower Planning Engineer.
9. Under the system of unified control, the WAO/SAO of a workshop reports to the CWM/DY.CME.
10. The post of Advisor (Mech.) in Railway Board has been re-designated as Additional Member (Mech.)
11. On Indian Railways we have mostly condition based prevention maintenance of our rolling stock.

Locomotives

1. A CO-CO type of locomotive would have 6 axles coupled together.
2. A CO-CO type of locomotive would have 8 wheels.
3. A BO-BO type of locomotive would have 4 axles individually driven.
4. The maximum power of WDM2 locomotive is 2100 HP.
5. The maximum power of WDS4 locomotive is 700 horse-power.

6. Sanding facility is provided in locomotives for reducing the friction between the wheel and the rail.
7. The Engine Repair Book is a necessary document for every individual loco.
8. One would find a washing line in a diesel loco shed.
9. We are importing 4000 hp diesel locos from Germany.
10. In a multiple Unit operation involving two diesel locomotives, both the locos have to be manned.
11. When diesel locos work in MU operation, only the leading loco is manned.
12. A pit-line occupation chart is prepared by diesel sheds.
13. The maximum usable tractive effort of a locomotive is limited by the adhesion.
14. The radiator fan of a WDM2 locomotive is situated in the long hood.
15. Our diesel locos have both types of traction motors - AC and DC.
16. The WDM2 locomotive has an electrical transmission system.
17. The WDS6 locomotive has a hydraulic transmission system.
18. Diesel Locos are provided with an Expressor to compress air before input into engine for combustion.
19. Diesel Locos are provided with an Expressor to create vacuum for train brakes and compressed air for loco brakes.
20. Diesel Locos are provided with a Turbo-charger to compress air before input into engine for combustion by utilising exhaust gas heat.
21. Throttle of a Diesel loco controls the engine RPM
22. Lube oil consumption of locos is monitored as a percentage of the fuel oil consumption.
23. In case the speed of locomotive exceeds the specified limit, its power get tripped by ' Overspeed trip mechanism'
24. In case the speed of diesel engine exceeds the specified limit, its power get tripped by ' Overspeed trip mechanism'
25. Diesel locos are not capable of hauling heavy trains, so Electrification is must.

26. Governor of a Diesel loco controls the opening & closing of contactors in Control Circuit.
27. Governor of a Diesel loco regulates the fuel supply to match the engine RPM and power requirement.
28. Three yearly schedule or IOH of Diesel locos is carried out in Workshops. Flasher light is provided on locomotives as a warning signal.
29. The 8th notch throttle position in a WDM2 locomotive gives the maximum power output
30. WDM2 bogies are manufactured by casting.
31. ZDM3 locomotive has an electrical transmission system.
32. The codal life of a Diesel loco is 36 years.

Coaches

1. Coaches of super fast trains have been provided with CBC coupler.
2. If a coach is numbered SR 5622 Y, it would have a 24 volt system of train lighting.
3. The Target for ineffectiveness of Non- AC coaching stock is 10%
4. Present design of coaches are called Integral because the entire structure is welded in the form of a tube.
5. Coach body is made of Aluminum.
6. The function of a dashpot/shock absorber is to damp the oscillations of the springs
7. The Axle box springs in a coach are part of the secondary suspension system.
8. In coaches we have adopted solid wheels in place of tyred wheels.
9. Coaches built presently are telescopic in design.
10. Rake links are prepared for locos hauling mail/express passenger trains.
11. Periodic overhaul of coaches is carried out by coaching depots.
12. Periodicity of POH of Mail/ Express coaches is 18 months.
13. Ineffectiveness of AC coaches is prescribed as 12.0 %.
14. Periodicity of POH of Rajdhani Coach is 18 months or 4 Lakhs Kms

15. According to current instructions, primary maintenance of rakes is not required if the round trip is less than 1000 Kms.
16. Secondary maintenance of rake is required irrespective of distance between starting & terminating stations.
17. New coaches are provided with roof mounted AC system.
18. Brake blocks of a coach are examined/ replaced during trip examination
19. Oil level in side bearers & dash pot of ICF Coaches is checked during 'A' schedule.
20. Weight Transfer of ICF Coach takes place through centre Pivot.
21. Centre pivot of ICF Coach only acts as centering device & transmits tractive /breaking force.
22. Damping in Primary suspension of an ICF Coach is by means of a shock absorber.
23. Damping in Primary suspension of an ICF Coach is by means of a oil filled dash-pot.
24. Damping in Secondary suspension of an ICF Coach is by means of a shock absorber.
25. Damping in Secondary suspension of an ICF Coach is by means of an oil filled dash-pot.
26. Side bearers of ICF coaches are provided with rubber pads to damp the forces.
27. ICF Bogies are manufactured by Fabrication.
28. ICF bogies are manufactured by casting.
29. The ICF coaches are provided with corrugated flooring
30. ICF Coaches are provided with compression tubes near head stock which can collapse in case of collisions after absorbing considerable shock energy.
31. Periodicity of 'B' schedule for a coach is 6 months
32. Periodicity of 'C' schedule for a coach is 6 months.
33. WACCN is a vestibuled AC 3 Tier coach.

34. SLR is a coaching vehicle in which symbol R indicates that it has a brake van.
35. The Codal life of an ICF coach is 30 years.

Wagons

1. ROH of wagons is done in wagon repair workshops.
2. KC is a 4 - wheeler covered wagon.
3. BOXN wagons have laminated bearing springs.
4. TP & TK are 8 wheeler tank wagons.
5. CRT is a 4- wheeler tank wagon.
6. The BOY wagon is an air braked wagon
7. The BOX wagon is an air braked wagon.
8. The BOBR wagon is an air braked wagon.
9. BOX wagon are provided with fabricated UIC bogies
10. BCX is a bogie type covered wagon for carrying 'Explosives'.
11. The UIC bogie is a fabricated bogie.
12. The CASNUB Bogie is a fabricated bogie
13. A wagon of Western Railway can be given POH by any wagon repair workshop on Indian Railways.
14. Wagon having screw coupling do not have buffers.
15. Buffers are provided on wagons having CBC.
16. POH of BCNA wagons is done at intervals of 6 years
17. First POH of BOXN wagons is done after 6 years.
18. ROH of wagons is done at intervals of 36 months.
19. Maximum ineffectiveness prescribed for wagon stock is 6%.
20. Repacking of Plain bearing stock is required to be done every 6 monthly
21. Feeling of axle boxes to detect warm/ hot boxes is mandatory during 'outgoing' examination.
22. The codal life of a general purpose wagon is 30 years.

Components

1. Tyres are fitted on wheel centres by shrink fit process.
2. WAP, Bangalore manufactures wheels by the process of forging.
3. Axles for wagons made by casting process in wheel & Axle Plant.
4. If a collar is provided at the end of an axle, it indicates that it is plain bearing axle.
5. Roller bearing axle do not have collars at the end.
6. Plain bearing are lubricated by grease
7. Roller bearing are lubricated by grease
8. Distance between two outer surfaces of wheels is known as Wheel Gauge
9. Ringing sound produced on tapping of wheel by hammer, indicates good tyre.
10. Brake Blocks are made of mild steel.
11. Workshops are generally provided with under floor wheel lathes.
12. Helical springs are also called Coil springs.
13. On Indian Railways preventive maintenance of rolling stock is condition based.

Brake System

1. We are having a twin pipe system of working on our air braked freight trains.
2. The pressure of air in the brake pipe of air brake system is 5 Kg/Cm².
3. The pressure of air in the feed pipe of air brake system is 5 Kg/Cm².
4. During emergency braking the maximum air pressure in brake cylinder is 5 Kg/ Cm.sq.
5. Air Flow indicator is provided on each coach to find out from which coach Alarm Chain has been pulled.
6. In case of train parting, the brakes get applied automatically.
7. DA Valves are provided in coaches for expediting brake application.
8. The weight of brake equipments on a wagon are nearly same for air brake and vacuum brake systems.

9. Train speeds could be increased by introduction of air brakes.
10. Brake fading is experienced with vacuum brake system on sustained up gradients.
11. Empty load device is provided only on air braked wagons.
12. Slack Adjusters are provided only on coaching stock for maintaining the gap between the wheel tread and the brake block.
13. The Empty Load Device is provided in Wagons as well as Coaches.
14. Quick Release Valve is provided in coaches as well as wagons for expediting release of brakes in vacuum brake system.
15. Simultaneous application of brakes on trains and loco can be done by application of SA-9 handle of WDM2 loco.
16. Dynamic Braking in diesel locos becomes quite ineffective at low speeds.
17. Diesel Hydraulic locos cannot be provided with Dynamic brakes.
18. Slack Adjusters are provided only on coaching stock for maintaining the gap between the wheel tread and the brake block.
19. Minimum 85% effective brake power is required for giving fitness certificate to a goods train.

Train Dynamics

1. Due to air resistance, the resistance to the motion of a train is proportional to the square
of the velocity of the train
2. If Tractive Effort is less than Adhesion, the wheels will start slipping.
3. The balancing speed of a WDM2 locomotive on a tangent level track with a load of 4700 tons is 59 Km. per hour.
4. The force exerted by locomotive at Rail Wheel contact is called Adhesion.
5. The resistance offered by a bearing will always be higher during the starting of a train than during run.

6. The resistance offered by a bearing during the running of a train remains almost constant irrespective of the train speed.
7. As the speed of the locomotive increases , it develops higher tractive effort.
8. The speed at which Tractive effort developed by the loco equals the Train Resistance is called Balancing Speed.
9. The resistance of a BOXN wagon train will be higher than that of a 4-wheeler train if all other parameters such as speed, load, section etc. are same.
10. The resistance of a BOXN wagon train will be higher than that of a coaching train (with ICF coaches) if all other parameters such as speed, load, section etc. are same. **Diesel Break Down Cranes**
11. The maximum capacity of Steam break down cranes on Indian Railways is 75 tons.
12. The capacity of diesel break- down cranes provided on Indian Railways is 200 tons.
13. The maximum time allowed for dispatch of ART crane during day time is 30 minutes.
14. A Diesel brake down crane is likely to get toppled, if it is swiveled with full load without propping up.
15. Maximum counterweight provided on Diesel break down crane is 28 tons.
16. Match wagon of a Diesel Brake down is to be detached from main carriage during crane operation.
17. The Two designs of diesel cranes used on Indian Railways are of Gottwald and Karl Schank.

Part II

Multiple-choice Questions. Pick out the correct answer. More than one answer may be correct.

Organisational Structure & Prod. Units

1. IRCAMTECH deals with a) Research on maintenance practices of Railway equipments b) Rehabilitation of diesel locos c) Modernization of rolling stock d) Specifications and procurement of machines
2. COFMOW deals with a) Research on maintenance practices of Railway equipments b) Rehabilitation of diesel locos c) Modernization of rolling stock d) Specifications and procurement of machines
3. COFMOW is located in a) Bangalore b) Calcutta c) New Delhi d) Secunderabad
4. IRCAMTECH is located in a) Bangalore b) Calcutta c) New Delhi d) Gwalior
5. The population of diesel locos on Indian Railways is around a) 3400 b) 4300 c) 5600 d) 7000
6. The production capacity of DLW is ____ locos/year a) 135 b) 150 c) 165 d) 190
7. ICF and RCF have a combined production capacity of a) 500 coaches per year b) 1000 coaches per year c) 2000 coaches per year d) 5000 coaches per year
8. Pick out the odd designation a) EDME b) MM c) JDME d) CME
9. Pick out the odd designation a) EDME b) CRSE c) CMPE d) CWE

Locomotives

1. The WDM2 engine has ____ cylinders a) 8 b) 12 c) 16 d) 24
2. In Diesel loco, engine RPM and power output is varied by a) Reversor handle b) A-9 c) SA-9 d) Throttle

3. Which of the following information is available in the diagram book of a diesel locomotive ? a) The sheds homing such locomotives b) The performance characteristics c) The load hauling capacity d) Equivalent horsepower electric locomotives
4. The engine of diesel locos is supposed to be shut down if the expected detention is more than a) 10 minutes b) 30 minutes c) 1 hour d) 4 hours
5. The target for Lube oil consumption of a diesel loco as a % of the Fuel oil consumption is a) 0.5 b) 1.0 c) 1.5 d) 2.0
6. Consumption of Fuel oil by individual locos is monitored by diesel sheds in a) Kilo-Litres per year b) Tonnes per year c) Litres per hour d) Liters per 1000 GTKM
7. Traction Motors used on our diesel locos are a) DC Motors b) AC Induction motors c) AC/DC motors d) Squirrel cage motors
8. The WDS4 is a a) an electric loco working on DC traction b) a diesel loco working slow trains c) a diesel main line loco d) a diesel shunting loco
9. Which of the following schedules would be done in the Running Repair section of a diesel shed a) Trip Schedule b) Monthly schedule c) Quarterly schedule d) Yearly schedule
10. The 4000 hp diesel locos have been imported shortly from a) LHB, Germany b) Mak, Germany c) General Motors, USA d) General Electric, USA
11. Find the odd term out of the following a) Radiator fan b) Fire box c) Hot engine alarm d) Over speed trip mechanism
12. The target for Lube oil consumption of a diesel loco in Liters per 100 Engine Kms. is a) 1.5 b) 4.5 c) 6 d) 10
13. The horse power of a WDM2 locomotive is a) 800 b) 1380 c) 2600 d) 3100
14. The target for ineffectiveness for diesel loco is _____ a) 10% b) 12.5% c) 15% d) 19%
15. The horse -power of a WDP1 of a locomotive is _____ a) 800 b) 1380 c) 2300 d) 3100

16. The horse -power of a WDG2 of a locomotive is _____ a) 800 b) 1380 c) 2300 d) 3100
17. Which part of the locomotive regulates fuel input as per generator demand & Engine RPM a) Turbo charges b) Expressor c) Governor d) Throttle
18. The WDM2 is a a) Diesel locomotive for mail express train b) Diesel shunting locomotive c) Diesel locomotive for both passenger & goods operation d) Diesel loco for only goods operation
19. Maximum speed of the diesel engine of WDM2 Loco is at a) 8th notch b) 10th notch c) 15th notch d) 20th notch
20. The fuel consumed by a WDM2 Loco at 8th notch under full load is a) 100- 120 litres/hour b) 200- 250 litres/hour c) 400- 450 litres/hour d) 500- 550 litres/hour
21. The fuel consumed by a WDM2 Loco under idle condition is a) 10- 15 litres/hour b) 20- 25 litres/hour c) 30- 35 litres/hour d) 45-50 litres/hour

Coaching Stock

1. The code of AC 3 Tier coach is a) ACCW b) ACCN c) AC3T d) ACTT
2. The codal life of an ICF coach is a) 20 years b) 30 years c) 45 years d) 25 years
3. The code of a sleeper class Coach is a) ACCW b) ACCN c) GSCNY d) FCS
4. The Code of a 2 Tier AC Coach is a) ACCW b) ACCN c) GSCNY d) AC2T
5. Type of Couplers used in superfast coaches are a) IR-20 b) Screw coupling c) CBC d) UIC
6. The POH of mail/express coaches is done at a periodicity of a) 18 months b) 3 years c) 12 months d) 6 years
7. For working out the requirement of coaches at various depots, what allowance is kept over the bare requirement as spare coaches a) 10% b) 12% c) 16% d) 20%

8. Which design feature in a coach makes it safer for passengers in case of a collision a) provision of roof mounted AC system b) Anti-telescopic feature c) feature of providing air brakes d) all coil suspension feature
9. The suspension arrangement in the present design of ICF coaches is a) single stage suspension with coil springs b) Single stage suspension with laminated bearing springs c) Double stage suspension with LB springs d) Two stage suspension with helical springs
10. The POH of Shatabdi coaches is done at a periodicity of a) 18 months b) 3 years c) 12 months d) 6 years
11. The Dash-pots are provided in ICF coaches for damping in----- (Primary Suspension/ Secondary/ both)
12. In ICF Coaches, rubber pads are provided in----- to absorb vibrations a) Primary suspension b) Secondary suspension c) Both d) None
13. Corrugated Section is provided on the trough floor of ICF coaches to a) enhance strength b) for retaining timber pieces provided on the flooring c) for preventing slipping of passengers
14. The passage from one coach to another in a running train is provided by a) Stanchions b) Dampers c) CASNUB d) Vestibules

Wagons

1. The cost of a BOXN wagon is around a) Rs. 10 lakhs b) Rs. 15 lakhs c) Rs. 20 lakhs d) Rs. 25 lakhs
2. Which type of bogie is used in BOXN wagons ? a) CASNUB b) IR 20 c) BO-BO d) UIC
3. BKH wagon is a) 4 wheeler vacuum braked wagon b) 8 wheeler air braked wagon c) 8 wheeler vacuum braked wagon d) 4 wheeler air braked wagon
4. Hand brakes are provided in a) 4 wheeler wagons b) 8 wheeler wagons c) AC coaches d) Non AC coaches
5. Which type of coupler is used in BOXN wagons ? a) CASNUB b) Screw coupling c) CBC d) UIC

6. BOX wagon is a) 4 wheeler vacuum braked wagon b) 8 wheeler air braked wagon c) 8 wheeler vacuum braked wagon d) 4 wheeler air braked wagon
7. BOBR wagon is a) 4 wheeler vacuum braked wagon b) 8 wheeler air braked wagon c) 8 wheeler vacuum braked wagon d) 4 wheeler air braked wagon
8. The target ineffectiveness for wagon stock is a) 4% b) 6% c) 10% d) 12.5%
9. Which of the following features are not present in a BCNA Wagon a) Air Brake b) CASNUB Bogie c) Cylindrical Roller Bearing d) Helical Spring
10. Which of the following features are not present in a BOX Wagon a) Vacuum brake b) UIC Bogie c) Cylindrical Roller Bearing d) Helical Spring
11. Which of the following features are not present in a BOXN Wagon a) Air Brake b) CASNUB Bogie c) Covered wagon d) Cartridge Roller Bearing
12. BOXN Wagon has -----advantage over a BOX Wagon a) More no. of wagons can be accommodated in a rake b) requires less maintenance c) permits higher speed of trains d) all the above

Safety Components

1. A roller bearing may fail prematurely because of following reasons a) ingress of dust during examination b) overfilling of grease c) deterioration in grease condition d) lack of earthing during welding in sick line e) All the above reasons
2. Axle Box Roller Bearings are lubricated by a) Oil b) Grease c) None d) Both oil and grease
3. The Working range of enhanced screw coupling is _____ tons .(22/30/36/60/80).
4. Buffing gear is provided to a) Save the car body from damage from braking forces b) Transmit tractive effort c) Joining two cars
5. A wagon with transition coupling is one having a) CBC with Knuckle b) CBC with Knuckle & two buffers c) CBC with baby coupling & two buffers d) Screw coupling with buffers

6. Which of the following is not a defect of CBC a) defective locking device b) worn out knuckle c) Homed buffer
7. Which of the following is not a part of suspension system a) Spring b) Centre pivot c) Shock absorber d) Swing link e) None of the above
8. Modern Rolling Stocks prefer Coil Spring over Laminated Spring because Laminated spring a) do not have linear load- deflection characteristics b) do not have self-damping characteristics c) are not reliable in Service
9. One disadvantage of a Coil Spring over Laminated spring is a) Non-linear load-deflection characteristics b) poor Self Damping property c) Lack of Centering characteristic d) Unreliability in Service

Brake Systems

1. DA valve is now provided in all vacuum braked----- (Wagons / Coaches/ Locos/ all)
2. The phenomenon of brake fading takes place a) In vacuum brakes on sustained up gradients b) In air brakes on sustained down gradients c) In air brakes after 1000 Kms. Run d) In vacuum brakes on sustained down gradients
3. Incorrect position of Empty- load Box Device can result in a) Poor utilisation of wagon space b) Skidding of wheels c) Poor brake power d) Either (a) or (b) e) Either (b) or (c) f) All of (a), (b) & (c)
4. In vacuum brake cylinder, the piston comes to release position due to a) spring pressure b) Air pressure c) Its own weight d) All of the above
5. F type Vacuum brake is superior to traditional 'E' type since a) It uses release valve for fast release of brakes b) It has better rolling ring to reduce leakages c) Its upper chamber is connected to a large vacuum reservoir for increasing effective brake force. d) Its piston stroke is large to increase brake power
6. The Maximum brake cylinder pressure in air brake system is a) 6 kg/ cm.sq. b) 5kg/ cm.sq c) 3.5 kg/cm.sq d) 2.5 kg/ cm.sq

7. Which of the following is not a part of Single pipe Air Brake System a) Distributor valve b) Control reservoir c) Feed pipe d) Brake Cylinder
8. The basic purpose of DA valve is to a) Expedite brake application only b) Expedite brake release only c) Expedite both application & release d) None of the above
9. The basic purpose of Slack Adjuster is to a) take up slack due to wear & tear of bearing brass b) to maintain wheel gauge irrespective of wear of flange c) to maintain brake shoe- wheel clearance d) to maintain brake cylinder stroke
10. Empty load Box provided in BOX/ BOXN wagons alters brake force under loaded & empty condition by a) Altering mechanical advantage of brake rigging b) Altering brake cylinder pressure c) Altering piston stroke of brake cylinder d) Altering brake shoe to wheel clearance
11. In a long vacuum good train, the brake power of rear wagons can be lower than brake power of front wagons by a) 10 to 15% b) 15 to 25% c) 2 to 5% d) Almost Nil

Train Dynamics

1. The balancing speed achieved by a locomotive depends on a) the horse power of the locomotive b) the tractive effort of the locomotive c) the type of bearings provided in the rolling stock being hauled d) all the above factors
2. The resistance to the motion of a train is proportional to a) The tractive effort b) The speed of the train c) The horse power of the locomotive d) The square of the velocity of the train
3. The coefficient of friction between wheel and rail is normally around a) 0.1 b) 0.25
c) 0.40 d) 0.75

4. In the formula :Train Resistance = A + B v + C v² ,A depends on a) resistance in the bearings b) resistance due to flange, swaying etc. c) air resistance
5. In the formula :Train Resistance = A + B v + C v² ,B depends on a) resistance in the bearings b) resistance due to flange, swaying etc. c) air resistance .
6. In the formula :Train Resistance = A + B v + C v² ,C depends on a) resistance in the bearings b) resistance due to flange, swaying etc. c) air resistance
7. The starting resistance of a train depends upon a) resistance in the bearings b) resistance due to curves. c) resistance due to grades d) all the above
8. For obtaining a higher balancing speed we can a) Use a higher horsepower locomotive b) Use Roller Bearing stock in place of plain bearing c) Improve the aerodynamic profile of the rolling stock d) All the above factors.
9. The balancing speed of a WDM2 locomotive on a tangent level track with a load of 4700 tons is a) 59 Km. per hour b) 65 Km. per hour c) 74 Km. per hour d) 80 Km. per hour
10. The force exerted by locomotive at Rail Wheel contact is called a) Adhesion b) Tractive effort c) Buffing force d) Balancing force

Part III

Fill in the Blanks Type Questions

1. The WDS4 locomotives employ _____transmission. (electric, Hydraulic)
2. In Diesel-Electric Locos fitted with Dynamic Brake, the Current generated is_____ (stored in the battery/ dissipated as heat in resistors).
3. The maintenance schedules for diesel locos are laid down on _____. (Km basis /Time basis).

4. Compared to the IRS coach, the ICF coach is _____ (heavier / lighter).
5. The difference between the tractive Effort of the Locomotives and the Train Resistance is the Force available for _____ (accelerating / braking the train).
6. C.B.C. stands for _____
7. Wheel gauge is the distance between the _____ faces of the two wheels on the Axle. (inner / outer)
8. POH interval for coaches running on Mail / Express train is _____
9. Codal life of an ICF coach is _____years.
10. Codal life of an IRS coach is _____years.
11. Codal life of a tank wagon is _____years.
12. Codal life of a BOXN wagon is _____years.
13. The BOXN is _____in length compared to a BOX wagon.(longer / shorter)
14. In Diesel -Electric Locos fitted with Dynamic Brake, the current generated is _____ (Stored in the battery/ dissipated as heat in resistors).
15. In YDM 4 Loco, Y & M stands for _____ & _____ resp.
16. Code of an 8- wheeler tank wagon for liquefied Petroleum Gas is _____
17. Code of an 8- wheeler flat wagon for containers is _____
18. The equipment provided in BOX/ BOXN wagons to alter brake force under loaded & empty condition is called-----.
19. Full form of DA valve is _____

Subjective Questions- Short Answer Type

Briefly Answer following Questions.

1. Briefly show the Organisational chart of Mech. Engg. Deptt. In the Zonal Headquarter.
2. Briefly show the Organisational chart of Mech. Engg. Deptt. In the Railway Board.
3. Briefly show the Organisational chart of Mech. Engg. Deptt. In the Division..
4. What are the various duties of Chief Workshop Engineer
5. What are the various duties of Chief Mechanical Engineer (Planning).
6. What are the various duties of CMPE (Diesel)
7. Which department co-ordinates the M&P Programme and which agency deals with centralised procurement of M&P?
8. Name the major departments in a Workshop?
9. Briefly describe the difference in the wheel arrangements of CO-CO and B-B Bogies.
10. Briefly describe the difference in the wheel arrangements of WDM2 & WDS4 Locos.
11. Why it is necessary to have a transmission system in a diesel locomotive?
12. Name the different types of transmission systems used in a diesel locomotives.
13. Briefly describe the Electrical transmission System of a diesel loco.
14. Briefly describe the Hydraulic transmission System of a diesel loco.
15. What is the function of a turbo-charger in a Diesel locomotive?
16. Name any 5 major sub-assemblies of a Diesel Loco
17. Name any 5 safety fittings of a Diesel Loco
18. What is the frequency of maintenance of diesel locomotives under various maintenance schedules?
19. List some of the important records maintained in a Diesel Loco Shed.

20. What are the various features of an ICF coach which make it 'Anti-telescopic'?
21. What are Primary & Secondary Suspensions?
22. Briefly describe Primary suspension of an ICF coach.
23. Briefly describe Secondary suspension of an ICF coach.
24. What is the maximum ineffectiveness prescribed for the Non- AC coach?
25. What arrangements have been made in ICF coaches for damping Primary & Secondary suspensions?
26. What are the various schedules for maintenance for a main line passenger coach?
27. Briefly list the various items which are attended, examined during 'A' schedule of a coach
28. Briefly list the various items which are attended, examined during 'B' schedule of a coach
29. Briefly list the various items which are attended, examined during 'C' schedule of a coach
30. What are PRO particulars for a 4-wheeler wagon and what type of wagon is CRT ?
31. What are the advantages of BOXN wagon over BOX wagon?
32. What items are attended during rolling-in examination of a goods train.
33. What items are attended during terminating examination of a goods train
34. What items are attended during out going examination of a goods train
35. Explain briefly the difference between safe to run examination and intensive examination.
36. How the ineffectiveness of Rolling stock is calculated? What is the maximum ineffectiveness prescribed for the wagon stock?
37. What are the advantages of Roller Bearing Stock over plain bearing stock ?
38. How is a wheel tyre fitted over a wheel centre?
39. Why Helical Springs are preferred over Laminated Springs in Modern Rolling Stocks ?

40. What are the advantages of CBC coupler over Screw Type coupler?
41. Draw a sketch of a typical Wheel profile and indicate its root, flange and tread.
42. List various defects of a Wheel Assembly.
43. List various defects of a Suspension System
44. List various defects of a Coupling System.
45. What is the Function of an Empty load Box Device and how does it work?
46. What happens when Alarm Chain is pulled in a vacuum Braked passenger Coach?
47. Name major components of a vacuum brake system.
48. Name major components of an air brake system.
49. Mention any 3 advantages of Air brake over Vacuum brake.
50. What are the various factors which determine the starting resistance of a train?
51. What are the various factors which determine the rolling resistance of a train?
52. What is Adhesion and what are the factors which affect it?
53. What do you understand by Balancing Speed?
54. What are the various factors which determine that how much trailing load can be attached to a locomotive.
55. Name the 2 parameters which determine the starting tractive effort of locomotive.
56. Name the various parameters which determine the safe lifting load of a crane.
57. Why a match wagon has been provided in 140 ton Diesel Breakdown crane?
58. What is the purpose of outriggers provided in a 140 ton diesel breakdown crane?