Analysis of The Indian Maintenance Centre for Diesel – Electric Locomotive and Improve for New Railways Service

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Abstract:

The aim of the thesis is to analysis and improve in order to reach new railway service for the diesel-electric locomotive here were will analysis the old level of maintenance and implement the new technique in order to reach the new level of maintenance and also the steps that should take and to improve maintenance accuracy for diesel-electric locomotive.

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Contents

CHAPTER-1 Diesel- Electric Locomotive

The Diesel -Electric Locomotive Has Been Improved from Wikipedia And from Indian Railways Website.

Although diesel locomotives first came to American railroads in the 1920s, their use was confined to switch engines, and later to passenger train locomotives. It wasn't until 1940 that the Electro Motive Division of General Motors (EMD) demonstrated that diesels could practically replace steam locomotives in heavy-duty service. A pioneer freight diesel, model "FT," toured the nation's railroads and changed history. Much like its sister passenger locomotives of the day, it was styled with an automobile-like nose and windshield, a design that prevailed until the late 1950s.

Although commonly called "diesels," the locomotives are electrically driven. The diesel engine drives an alternator, which produces electricity to run electric motors mounted on the locomotive's axles. The internal combustion engine was a dramatic improvement in efficiency over the steam locomotive, making substantial savings possible in maintenance and the elimination of widespread facilities. Extra units could be coupled together and run by one engineer from the lead unit, creating very powerful combinations.

Many railroads, including Union Pacific, were unable to take quick advantage of the new technology due to material shortages caused by World War II. Union Pacific's fleet of modern steam locomotives and plentiful on-line coal reserves in Wyoming were another factor in UP's late entry into the dieselization race. After the war however, railroads began sweeping the rails clear of the classic steamers. Union Pacific began its sweep in the late 1940s on the line running through the southwestern deserts, where water was difficult to obtain for steam engines. Like an automobile, a diesel locomotive cannot start itself directly from a stand. It will not develop maximum power at idling speed, so it needs some form of transmission system to multiply torque when starting. It will also be necessary to vary the power applied according to the train weight or the line gradient. There are three methods of doing this: mechanical, hydraulic or electric. Most diesel locomotives use electric transmission and are called "diesel-electric" locomotives. Mechanical and hydraulic transmissions are still used but are more common on multiple unit trains or lighter locomotives.

Diesel-electric locomotives come in three varieties, according to the period in which they were designed. These three are:

DC-DC-generator supplying D.C traction motor

AC-DC {AC alternator output rectified to supply dc motors}

AC-DC-AC {AC alternator output rectified to dc and then inverted to 3-phase

The DC - DC type has a generator supplying the DC traction motors through a resistance control system, the AC - DC type has an alternator producing AC current which is rectified to DC and then supplied to the DC traction motors and, finally, the most modern has the AC alternator output being rectified to DC and then converted to AC (3-phase) so that it can power the 3-phase AC traction motors. Although this last system might seem the most complex, the gains from using AC motors far outweigh the apparent complexity of the system. Most of the equipment uses solid state power electronics with microprocessor-based controls. For more details on AC and DC traction, see electric traction power electric locomotives.

In the US, traction alternators (AC) were introduced with the 3000 hp single diesel engine locomotives, the first being the Alco C630. The SD40, SD45 and GP40 also had traction alternators only. On the GP38, SD38, GP39, and SD39s, traction generators (DC) were standard, and traction alternators were optional, until the dash-2 era, when they became standard. It was a similar story at General Electric.

There is one traction alternator (or generator) per diesel engine in a locomotive (standard North American practice anyway). The Alco C628 was the last locomotive to lead the horsepower race with a DC traction alternator

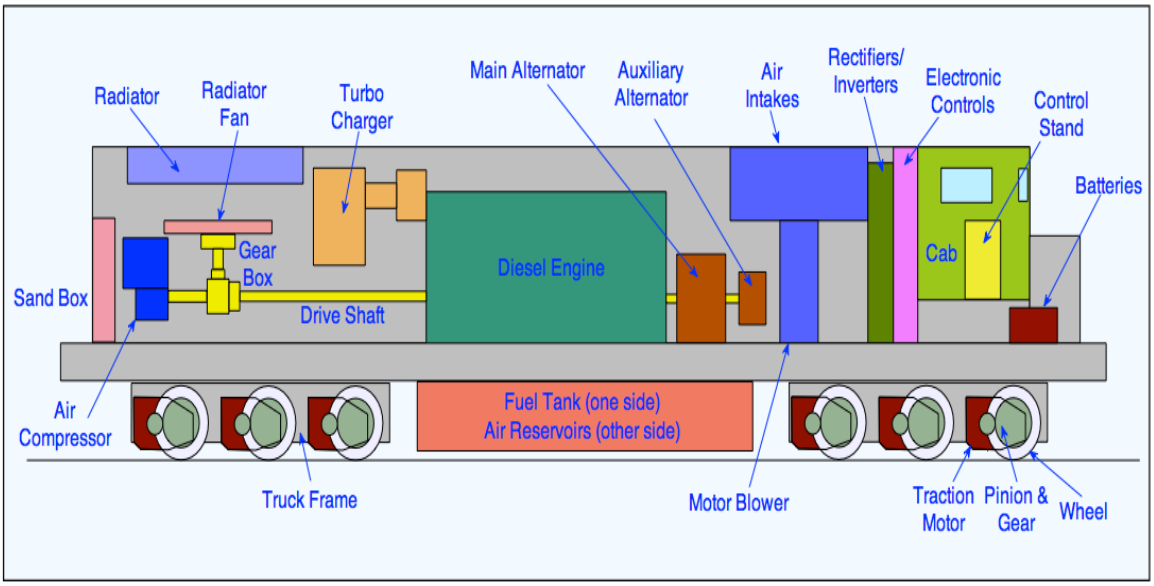


Fig 1 diesel -electric locomotive

The diagram shows the main parts of a US-built diesel-electric locomotive and these are described in the following paragraphs. I have used the US example because of the large number of countries which use them. There are obviously many variations in layout and European practice differs in many ways and we will note some of these in passing.

1.1 DIESEL ENGINE

This is the main power source for the locomotive. It comprises a large cylinder block, with the cylinders arranged in a straight line or in a V. The engine rotates the drive shaft at up to 1,000 rpm and this drives the various items needed to power the locomotive. As the transmission is normally electric, the engine is used as the power source for the alternator that produces the electrical energy to drive the locomotive.

1.2 MAIN ALTERNATOR

The diesel engine drives the main alternator which provides the power to move the train. The alternator generates AC electricity which is used to provide power for the traction motors mounted on the trucks (bogies). In older locomotives, the alternator was a DC machine, called a generator. It produced direct current which was used to provide power for DC traction motors. Many of these machines are still in regular use. The next development was the replacement of the generator by the alternator but still using DC traction motors. The AC output is rectified to give the DC required for the motors. For more details on AC and DC traction, see the Electronic Power.

1.3 AUXILIARY ALTERNATOR

Locomotives used to operate passenger trains are equipped with an auxiliary alternator. This provides AC power for lighting, heating, air conditioning, dining facilities etc. on the train. The output is transmitted along the train through an auxiliary power line. In the US, it is known as "head end power" or "hotel power". In the UK, air-conditioned passenger coaches get what is called electric train supply (ETS) from the auxiliary alternator.

1.4 AIR INTAKES

The air for cooling the locomotive's motors is drawn in from outside the locomotive. It must be filtered to remove dust and other impurities and its flow regulated by temperature, both inside and outside the locomotive. The air management system must take account of the wide range of temperatures from the possible +40°C of summer to the possible -40°C of winter.

1.5 RECTIFIERS /INVERTER

The output from the main alternator is AC but it can be used in a locomotive with either DC or AC traction motors. DC motors were the traditional type used for many years but, in the last 10 years, AC motors have become standard for new locomotives. They are cheaper to build and cost less to maintain and, with electronic management can be very finely controlled. To see more on the difference between DC and AC traction technology try the Electronic Power. To convert the AC output from the main alternator to DC, rectifiers are required. If the motors are DC, the output from the rectifiers is used directly. If the motors are AC, the DC output from the rectifiers is converted to 3-phase AC for the traction motors. In the US, there are some variations in how the inverters are configured. GM EMD relies on one inverter per truck, while GE uses one inverter per axle - both systems have their merits. EMD's system links the axles within each truck in parallel, ensuring wheel slip control is maximised among the axles equally. Parallel control also means even wheel wear even between axles. However, if one inverter (i.e. one truck) fails then the unit is only able to produce 50 per cent of its tractive effort. One inverter per axle is more complicated, but the GE view is that individual axle control can provide the best tractive effort. If an inverter fails, the tractive effort for that axle is lost, but full tractive effort is still available through the other five inverters. By controlling each axle individually, keeping wheel diameters closely matched for optimum performance is no longer necessary.

1.6 ELECTRONIC CONTROLS

Almost every part of the modern locomotive's equipment has some form of electronic control. These are usually collected in a control cubicle near the cab for easy access. The controls will usually include a maintenance management system of some sort which can be used to download data to a portable or hand-held computer

1.7 CONTROL STAND

This is the principal man-machine interface, known as a control desk in the UK or control stand in the US. The common US type of stand is positioned at an angle on the left side of the driving position and, it is said, is much preferred by drivers to the modern desk type of control layout usual in Europe and now being offered on some locomotives in the US.

1.8 CAB

The standard configuration of US-designed locomotives is to have a cab at one end of the locomotive only. Since most the US structure gauge is large enough to allow the locomotive to have a walkway on either side, there is enough visibility for the locomotive to be worked in reverse. However, it is normal for the locomotive to operate with the cab forwards. In the UK and many European countries, locomotives are full width to the structure gauge and cabs are therefore provided at both ends.

1.9 TRACTION MOTOR

Since the diesel-electric locomotive uses electric transmission, traction motors are provided on the axles to give the final drive. These motors were traditionally DC, but the development of modern power and control electronics has led to the introduction of 3-phase AC motors. For a description of how this technology works, go to the Electronic Power There are between four and six motors on most diesel-electric locomotives. A modern AC motor with air blowing can provide up to 1,000 hp.

1.10PINION /GEAR

The traction motor drives the axle through a reduction gear of a range between 3 to 1 (freight) and 4 to 1 (passenger).

1.11FUEL TANK

A diesel locomotive must carry its own fuel around with it and there must be enough for a reasonable length of trip. The fuel tank is normally under the loco frame and will have a capacity of say 1,000 imperial gallons (UK Class 59, 3,000 hp) or 5,000[18927 litres] US gallons in a General Electric AC4400CW 4,400 hp locomotive. The new AC6000s have 5,500[18927 litres] gallon tanks. In addition to fuel, the locomotive will carry around, typically about 300 US gallons of cooling water and 250[946 litres] gallons of lubricating oil for the diesel engine.

1.12 AIR RESERVOIRS

Air reservoirs containing compressed air at high pressure are required for the train braking and some other systems on the locomotive. These are often mounted next to the fuel tank under the floor of the locomotive.

1.13 AIR COMPRESSOR

The air compressor is required to provide a constant supply of compressed air for the locomotive and train brakes. In the US, it is standard practice to drive the compressor off the diesel engine drive shaft. In the UK, the compressor is usually electrically driven and can therefore be mounted anywhere. The Class 60 compressor is under the frame, whereas the Class 37 has the compressors in the nose

1.14 DRIVE SHAFT

The main output from the diesel engine is transmitted by the drive shaft to the alternators at one end and the radiator fans and compressor at the other end.

1.15 GEAR BOX

The radiator and its cooling fan are often located in the roof of the locomotive. Drive to the fan is therefore through a gearbox to change the direction of the drive upwards.

1.16 RADIATOR AND RADIATOR FAN

The radiator works the same way as in an automobile. Water is distributed around the engine block to keep the temperature within the most efficient range for the engine. The water is cooled by passing it through a radiator blown by a fan driven by the diesel engine. See Cooling for more information.

1.17 TURBO CHARGING

The amount of power obtained from a cylinder in a diesel engine depends on how much fuel can be burnt in it. The amount of fuel which can be burnt depends on the amount of air available in the cylinder. So, if you can get more air into the cylinder, more fuel will be burnt, and you will get more power out of your ignition. Turbo charging is used to increase the amount of air pushed into each cylinder. The turbocharger is driven by exhaust gas from the engine. This gas drives a fan which, in turn, drives a small compressor which pushes the additional air into the cylinder. Turbocharging gives a 50% increase in engine power. The main advantage of the turbocharger is that it gives more power with no increase in fuel costs because it uses exhaust gas as drive power. It does need additional maintenance, however, so there is some type of lower power locomotives which are built without it.

1.18 SAND BOX

Locomotives always carry sand to assist adhesion in bad rail conditions. Sand is not often provided on multiple unit trains because the adhesion requirements are lower and there are normally more driven axles.

1.19 MILEAGE OF LOCOMOTIVE

The mileage of a locomotive will be a depends from variant to variant in diesel locomotive. If we consider the mixed type locomotive the mileage will be for 400 litres of diesel per 10 0kms is not uniform and may depends upon a lot of factors like model of the locomotive speed trailing loads gradient of the track etc however it is generally around 4liters /km to 10liters/km.

CHAPTER-2 Level of Maintenance

The Level of Maintenance Has Been Improved from Indian Railways Website

2.1 LEVELS OF MAINTENANCE

2.1.1 First Level Of Maintenance:

- The first level maintenance is trip maintenance when the loco finished the full trip it will go to the maintenance.
- The duration of the first level maintenance is 1 hr
- In the first level maintenance the loco will go for the base check
- After fishing that the loco will go for the wash when it finishes the wash It will go to trial run
- After trail run if the loco is perfect it is ready to departure.

Name of component	Description	Number of component	Picture of the component	Capacity
PORTAL CRANE	The portal crane is the main component to lift and shift the loco	5		5-8 tones
BATTERY CHARING ROOM	This make to charge the battery charge for diesel engine charging battery is very important	5		
TOOL KIT	THE tool kit is used to open and close the loco parts	10-15		

Table - 1 [first level maintenance]

This are the main components required in the first level of maintenance

2.1.2 Second Level Maintenance:

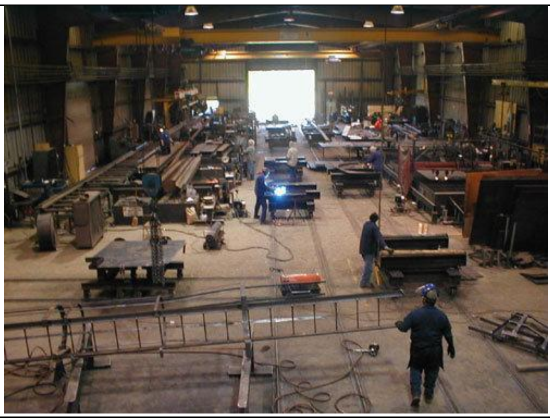
- The second level maintenance will be done after the 50 engine hrs or 5000 kms
- Depends on the time and kilometres the maintenance will be schedule
- The duration of the maintenance is about 2 hours
- In the second level maintenance they will check and oil and braking system of the loco
- After the inspection the loco is ready for the departure.

Name of component	Description	Number of component	Picture of the component	Capacity
JIB CRANE	This component is used to lift and shift the loco	4-6		4-8 tones
PORTAL CRANE	The portal crane is the main component to lift and shift the loco	5		5-8 tones
INSTRUMENTS TEST AND REPARING ROOM	Checking the component working and how to improve its working will be done			
FUEL INJECTORE AND TESTING ROOM	Checking the problem and ratification and testing the component will be taken place here.			
BRAKE TESTING ROOM	Checking the function of the brake and repairing it will be done here			

Table -2 [second level maintenance.]

2.1.3 THIRD LEVEL MAINTENANCE:

- The third level maintenance will be done after 100 engine hrs or 10000 km
- Depends on the time and kilometres the maintenance will be schedule
- The duration of the maintenance is about 24 hours
- In third level maintenance the total loco will be checked properly and if they is any alteration or repair of the part depends on the problem.
- You can see the following work in the table below.

Name of component	Description	Number of component	Picture of the component	Capacity
MOTORISED TROLLY	The motorised trolley is used to shift the component from one shed to another shed	8-10		500-900kg
JIB CRANE	This component is used to lift and shift the loco	5-10		10-15 Tones
GRINDING MACHIEN ROOM	Here they grind the loco parts which has uneven surface they fix it here			
WELIENDING AREA	Here they weld and joint the parts of loco			

LATH AREA	Here they fix the roiling stock remove the excess material around and they shape it			
TOOL ROOM	Here they will check very minor parts like brake shoes etc..			
WAGON MAINTANENCE	Here they fix the wagon and they make alteration of wagon			

Table -3[Third level maintenance]

2.2 CORRECTIVE MAINTENANCE:

- The corrective maintenance is a failure driven type of maintenance approach is a reactive management approach where the corrective maintenance is often dominated by unplanned event and it is performed only after the occurrence of failure or breakages of the system

- The corrective maintenance action can recover the malfunctioning part of the system repairing or replacing the failed component
- If the system is non-critical as easily repairable any potential unplanned crash will cause a minimum impact related to the availability
- In this way the failure -driven maintenance can be a good maintenance approach in case of purely random failure in system it could be a very great impact on the productivity an urgent corrective maintenance.
- The action is required to avoid serious consequences produced by the fault the systematic use of an urgent corrective maintenance often is translated into unpredictable performance of the system
- In this type of maintenance, the locomotive will take time to get ready for and depends of the problems in the locomotive if it is small it will be done in very less time
- If it has very big problem like replacing the part of the locomotive will be a great problem to the locomotive and for the company.

2.3 PREVENTIVE MAINTENANCE:

- The preventive maintenance is also known as time-based maintenance in order to slow down the process of deterioration that leads to a failure a primary preventive maintenance is performed periodically inspecting and controlling the system through scheduled regular activities.
- The time-based maintenance assumed that the estimated malfunctioning of the system mean time between two functional failures [MTBF] means time between failures is statistically or experimentally knows for system and device degradation during their normal use
- The time-based maintenance involves also scheduled shutdown of the system for revision or predetermined repair activities on the system still operating
- This approach allows to prevent functional failure thanks to the replacing of critical components at regular intervals shot than their estimated life cycle
- The system revision and the replacement of critical components at determined intervals represents methodology widely adopted in the maintenance of many modern system
- Although the time-based maintenance can reduce the failure probability of a system or the frequency of unpanned emergency repairs it cannot delete the occurrences of random failures.
- Sometime based maintenance may be obsolete and unable to cope with the current operational requirements of modern automated system
- The maintenance decisions are made by expected planners according to the recommendations of the manufacture of the system failures history malfunctions data operational experience assessment performed by maintenance staff and technicians

2.4 INTEGRTED MAINTENACE:

- For the modern complex industrial system, the attention manager of maintenance shall be focused on the following their aspects.
- How to re-plan and preschedule the maintenance of sophisticated system operating in complex environmental conditions
- How to reduce the high costs of stocks of the replacement's parts
- How to avoid risks of catastrophic failures and eliminate the forced and unplanned interruption in system availability.

2.5 PREDICITIVE MAINTENACE:

- Another approach is represented by the condition-based maintenance as a method to reduce the uncertainty of maintenance activities.
- These activities condition will be performed according to needs indicated by the result of system status monitoring.
- The predictive condition monitoring and according to these plans the maintenance actions
- The goal of condition monitoring is to delete the failures and extend the preventive maintenance intervals
- The condition-based maintenance assumes that the existence of indicative prognostic parameters can be identified and used to quantify potential system failure before the occur
- The prognostic parameter provides an indication of problems and new issues that may cause the deviation of the system from its acceptable level of functioning
- The condition system based fault diagnosis is triggered by the decoction of an evaluated conditions of the system such as deviation from the exported level recognizes and analyses symptomatic information identifies the causes of the malfunctions obtains the developments trend of the fault and predicts the remaining obtains the useful life the system [RVL] remaining useful life.
- In order to obtain a fully automated system for condition monitoring new analysis techniques need to use such as artificial intelligence able to handle large amount of data neural networks

motivation case-based and fuzzy logic equipped with this such predictive still the diagnostic system becomes more reliable.

- A maintenance in advance can be performed in order to avoid an excessive supply of replacements parts
- Therefore, the implementation of an automated condition -monitoring process provides a better and timely determination of the maintenance interventions which will result in a decrease of the life cost of the system thanks to an increment of its availability and to a reduction of operations and maintenance cost.

2.6 TYPE OF INDIAN LOCOMOTIVES:

- They are two kind of locomotives that Indian railways currently using here they are.
- Diesel
- Electrical

  In Indian railways two types of locomotives are there that is diesel locomotive and electrical locomotives and in this locomotives are further being classified as passenger fright and mixed locomotives Starting from electrical locomotives one many have usually spotted the sign over the locomotives like WAP WAG etc so coming to the point W stands for broad gauge A stands for alternating current or simple electric and p stands for passenger while g stands for goods presently in passenger services Indian railways uses wap/4 and wap4E electrical locomotives WAP7 WAP5 and sometime rarely you would see WAP1 in these locomotives WAP4/4E is the most used locomotive of Indian railways in the electric territories about almost every train are being hauled by WAP4/4E locomotives while WAP7 locomotives is used with prestigious surfaces [rajdhain Shatabdi and duronto trains] name of trains while WAP5 is mostly being used with Shatabdi duronto and rajdhain are very rarely with other superfast trains in all these the first super high tech electric locomotive of Indian railways was the WAP1 which are presently being phased out in this wap5 has the highest operational speed of 160 km/hr . in same way WAP7 has the maximum speed of 180km/hr but its operational speed is 140km/hr while in all these wap7 has the highest acceleration capability .that is it can haul attain consisting at speed of 130km/hr Now coming to freight Indian railways also used many freight locomotives like mostly powerful heavy duty freight locomotive is WAG9/WAG9HI these are the most powerful electrical locomotive of in Indian railways by modifying the gear ratio of WAG9 the wap7 electric locomotive is developed .the other freight locomotive are WAG5 WAG7 and WAG7HThis are some electrical locomotives of Indian railways using currently in Indian railways As I was explain the electrical locomotive on before now another type of locomotive that Indian railways using is diesel type The Indian railways has many diesel locomotives that are used for passenger fright and they are another type of locomotives that is called mixed locomotive which I used for the both freight and passenger Here are some models of Indian railways diesel locomotives passenger locomotive [WDP1,WDP2,WDP3,WDP4/4B here we stand for wide gauges D stand for diesel P stand for passenger Goods type locomotives WDG2,WDG3B,WDG3C,WDG3D,WDG4

- Mixed type of locomotive WDM 2,2A,2B,3A,3C,3D, WDM4,6, WDM 7[W STANDS FOR WIDE GUAGE D STAND FOR DIESEL AND M STAND FOR MIXED] this are some models used in Indian railways

2.6.1QUATITIY OF LOCOMOTIVES IN INDIAN RAILWAYS:

Indian railways are the one of the largest networks in Asia here they are

- Diesel type locomotive

MODEL TYPE	NO OF LOCO
WDM1/2	106
WDM3A	1323
WDM3D	511
WDG3A	1150
WDG4/4D	1678
WDG46	02
WDG5	06
WDP1	70
WDP3A	50
WDP4/4B/4D	638

Table -4 [Type of diesel locomotive]

- This are diesel locomotive all in number 5534 diesel locomotive that Indian railways currently using
- Electrical type of locomotives

MODEL TYPE	NO OF LOCO
WAM4	71
WAP	50
WAP4	774
WAP5	130
WAP7	441
WAG5	1025
WAG6	11
WAG7	1959
WAG9	272
WAG9H	745
WCAM2	20
WCAM	43

Table -5 [Type of electrical type of locomotive]

- This are electrical type of locomotive that Indian railways currently using the total in number are 5523
- All together the Indian railways has 11057locomotive are currently in services
- Here the diesel locomotive share is more in Indian railways

2.6.2 CHARECTERISTIC OF WDM/3A:

- The wdm/3a is a mixed type of locomotive which is used for passenger and freight type

TYPE AND ORIGIN

POWER TYPE- DIESEL
BULIDER-DLW DIESEL LOCO MODERNISATION WORKS
MODEL-ALCODL560C VARIANT
BUILD DATE-AUGUST 22,1994 ONWARDS
TOTAL PRODUCED-WDM-3A 1296 AS OF DECEMBER 2015
WDM-3D 510 AS OF DECEMBER 2015
WDM-3A 1145 AS OF DECEMBER 2015
REBULIBER- DIESEL LOCO MODERNISATION WORKS
PATIALA

HIDE SPEICFICATION

UIC-COCO
GUAGE-1676mm [5ft6 in]
BOGIES-ALCO ASYMMETRIC CAST FRAM TRIMOUNT
WHEEL DIAMETER-1092 mm [3ft 7in]
WHEELBASE – 12.834m [42 ft ¼ in]
LENGTH – 17.12m [52 ft 2 in]
WIDTH- 2.864 m [9 ft 4 ¾ in]
HIGHT- 4.185 m [13 ft 8 ¾ in]
AXEL LOAD – 18800 Kg [41400 LB]
LOCO WEIGHT -112.8t [111.0 LONG TONS 124.3 SHORT TONS]
FULE TYPE - DIESEL
FUEL CAPACITY -5000L
PRIME MOVER -ALCO 251-C
RPM RANGE -400-1050 RPM
ENGINE TYPE -V16 DIESEL ENGINE
ASPIRATION- ABBVT304-15 OR NAPIER NA 295 IR TURBOCHAGER
TRACTION MOTORS- BHEL TA 10102CW [NEW] BHEL TG 10931 AZ OLD
CYLINDERS-16
CYLINDER SIZE-228mm* 266mm [8.98in*10.47 in] bore *stroke
TRANSMISSION -DIESEL ELECTRIC
MU WORKING-2
TRAIN BRAKES -AIR VACCUM AND DUAL

HIDE PERFORMANCE FIGURES

MAXIMUM SPEED -120KM/H [75 mph]
POWER OUTPUT – WDM-3A, 3100HP
WDM-3D, 3100 HP,
WDM-3E,3500 HP WDM3F -3600 HP
TRACTIVE EFFORT-30,45 t [30 long tons 34 short tons]
FACTOR OF ADH -0.27

HIDE CAREER

OPERATORS -INDIAN RAILWAYS

NUMBERS -14001-14057 14058-14143 16000, FEW IN 18 SERIES AND 17 SERIES NICKNAMES -CHEETAH, PRABAL, VELOCITI, AWADH, FIREX,SHER PUNJAB,VEER LOCAL- ALL OVER INDIA RAILWAYS PRESERVED -1 DISPOITION – ACTIVE.

Table -6 [Type and origin of locomotive]

2.6.3 TECHINCAL SPECIFICATION:

Manufacturers	DLW, DLMW (DMW/DCW)
Engine	Alco 251-C, 16 cylinder, 3,300 hp (2,500 kW), earlier 3,100 hp (2,300 kW) (3,007 hp or 2,242 kW site rating, earlier 2,900 hp (2,200 kW)) with Napier NA2951R/ ABB VTC-304-VG15/ GE 7s 1716 turbo supercharged engine. 1,050 rpm max, 400 rpm idle; 228.6 mm × 266.7 mm (9.00 in × 10.50 in) bore x stroke; compression ratio 12.5:1. Direct fuel injection, centrifugal pump cooling system (2,457 L/min (540 imp gal/min; 649 US gal/min) at 1,050 rpm), fan driven by current clutch (90 hp or 67 kW at 1,050 rpm)
Governor	EDC / Woodward 8574-650
Transmission	Electric, with BHEL TA 10102 CW alternator (1,050 rpm, 1100 V, 4,400 amperes) (Earlier used BHEL TG 10931 AZ alternator)
Traction motors	BHEL TM 4906 AZ/ 4907 BZ (435 hp or 324 kW) (with roller bearings)
Axle load	18.8 tonnes (18.5 long tons; 20.7 short tons), total weight 112.8 t (111.0 long tons; 124.3 short tons)
Bogies	Alco design cast frame asymmetric trimount (Co-Co) bogies
Starting TE	30.45 t (29.97 long tons; 33.57 short tons) at adhesion 27%, continuous 28.05 t (27.61 long tons; 30.92 short tons)

Length over buffer beams	15,862 mm (52 ft ½ in)
Distance between bogies	10,516 mm (34 ft 6 in)

Table -7 [Technical specification]

2.6.4 TRANSMISSION OF WDM3A DIESEL LOCOMOTIVE:

- The wdm3a is a diesel type of locomotive which is most used mixed type of locomotive in Indian railways.
- This is the most successful locomotive in Indian railways its v16 diesel engine type.
- The diesel engine is self-powered locomotive there is generator which is connected to the fuel tank
- The generator drive shaft is connected to alternator which produces ac current
- The alternator is connected to the rectifier which converts the ac to dc current
- The rectifier is connected to the inverter which is convert the dc to ac current
- The generator is not connected to the traction motor because of the current up and downs in generation
- So, the rectifier supplies the ac current to the traction motor to run the wheel of locomotive
- And the generator of the diesel engine is connected to air compressor for the braking of the locomotive
- A radiator fan is connected to it for keeping it cool
- By this power the light fans are used in the train

Level of Maintenance in Indian Railways

Part-A Portal Crane

- Schedule-1
- Schedule-2 And 3
- Schedule-4
- Schedule-5

Part-B Jib Crane

- Schedule-1
- Schedule-2 And 3
- Schedule-4
- Schedule-5

Part-C Motorised Trolley

- Schedule -1 To 7
- List of Spares
- Acknowledgement

Table -8 [level of maintenance in Indian railways]

Schedule-1 done every day or trip duration time 1 hr

Schedule-2 done after 50 engine hours duration time 2 hrs

Schedule -3 done after 100 engine hours duration one day

Schedule -4 done after 200 engine hours duration two days

Schedule-5 done after 1000 engine hours duration seven days

Fig-2 [Duration of schedule]

Table -9 [complete maintenance schedule]

PART -A PORTAL CRANE

SCHEDULE – I ENGINE

- Check level of lube oil & fill up, if required
- Check fuel level & top up.
- Check the tension of V-belt and adjust, if required.
- Record max. engine temperature of the day.
- Clean engine & premises.
- Check starting of Petrol Engine (Emergency engine).
- Check the function of emergency stop switch.
- Check leakage from fuel pump, injectors, fuel supply & return pipes
- Check engine oil pressure on load after two hrs. working
- Check battery charging.
- Clean additional fuel oil filters

MACHINE GENERAL

- Check nuts and bolts of crawlers.
- Grease vertical and horizontal sliding cylinders.
- Grease rail wheel Up/Down cylinders.
- Grease main beam bearing points on frame.
- Grease transmission gear on driving rail wheel.
- Grease Hooks of hydraulic lifting systems.
- Check hydraulic hoses and valves for leakage.
- Check hydraulic oil level in tank and top up, if required.
- Check for any rubbing of hoses and correct, if necessary.

- Check Hose Clamps and tighten them, if required.
- Check vacuum gauge on hydraulic oil filters.
- Check for any unusual sound from engine & hydraulic circuit.
- Clean complete machine.
- Check all functions of working mechanisms before block.

SCHEDULE- II

ENGINE

- Clean air cleaner element outer with dry air (may be cleaned earlier, if red indicator lights up).
- Check battery terminals & connections for tightness.
- Check connection of self-starter and alternator.

MACHINE GENERAL

- Check functioning of tank level indicator and tank breather.
- Check oil level of crawler motor and top up, if required.
- Greasing and oiling on all movable surfaces.
- Check crawlers belt stretching.
- Check middle hook and lifting chain.

SCHEDULE- III

- Inspect V-belts for any damage. Worn out belts to be replaced.
- Replace Mobil oil.
- Check crawler pads clamping.
- Check all lights it should be in working order.

Note: Item no.2 will be done at 150 engine hrs.

SCHEDULE -I ENGINE:

- Replace engine oil filter.
- Check engine warning system.
- Clean battery terminals and apply petroleum jelly.
- Check electrolyte level and specific gravity of battery. (minimum specific gravity 1.24).

- Change fuel filter.
- Clean diesel tank. Change air filter elements outer and inner.

Note**:** Item no. 5 will be done after 300 engine hrs.

MACHINE GENERAL

- Check oil level of crawler reduction gear and top up if, required.
- Change return filter of hydraulic system.
- Change grease of wheel gear.
- Lubricate valve driving wires with grease.
- Lubricate variable pump driving wires with grease.
- Clean the fins of System Oil Coolers, manually.
- Grease all wheel bearings.
- Change Suction filter

SCHEDULE – V ENGINE

- Clean fuel tank.
- Recondition /Change batteries if required.
- Overhaul the Self-starter and alternator, if required**.**

MACHINE GENERAL

- Clean hydraulic tank.
- Clean Hydraulic oil by Porta filter.
- Change the oil of crawler motors.
- Check wear and tear of parts of crawler.
- Change hydraulic oil.
- Checkup wiring and change defective wire and electrical
- components.

PART - B: JIB CRANE

SCHEDULE-I ENGINE

- Check level of lube oil & fill up, if required
- Check fuel level & top up.

- Check function of V-belts and adjust, if any slackness is noticed.
- Record max. engine temperature of the day.
- Check battery charging.
- Clean engine & premises.
- Check the function of emergency stop push button
- Check engine warning system.
- Check leakage from fuel pump, injectors, fuel supply & return pipes
- Check engine oil pressure after warming up at idle speed and rated
- speed. (Minimum 1.5 kg/sq. cm at idle & 2.5 kg/sq. cm on load at rated RPM).

MACHINE GENERAL

- Check all lights, should be in working order.
- Check hydraulic hoses and valves for leakage.
- Check hydraulic oil level in tank and top up, if required.
- Check all system pressure for rated settings and adjust, if necessary.
- Check for any rubbing of hoses and correct, if necessary.
- Check Hose Clamps and tighten them, if required.
- Check vacuum gauge on hydraulic oil filters.
- Check service brakes.
- Check emergency brake.
- Check all functions of working mechanisms before block.

SCHEDULE-II

- Check oil level of Transmission gear box, top up, if necessary.
- Check the tightness of cordon shaft bolts

SCHEDULE-III

ENGINE

- Check battery condition and electrolyte level.
- Check battery terminals & connections for tightness.

- Change lube oil.
- Check V-belt tension and adjust if required.
- Note**:** Item no. 3 will be done at 150 engine hrs.

MACHINE GENERAL

- Grease pins and control levers.
- Grease on turn table.
- Check air pressure in tires.
- Check the tightness of gearbox bolts and cordon shaft bolts.
- Grease on rail wheel bearings.

SCHEDULE-IV ENGINE

- Change oil filter.
- Change fuel filter.
- Check tightness of screw and joints on engine.
- Note**:** Item no. 1 and 2 will be done at 300 engine hrs.

MACHINE GENERAL

- Check oil level of rotation-reduction gear box.
- Check oil level of axles.
- Change all suction filter on hydraulic system.
- Check bolts on turn table.
- Change air filter.

SCHEDULE -V

ENGINE:

- Clean diesel tank.
- Change alternate drive V Belts.
- Calibrate fuel injector.
- Adjust the engine valve gap.
- Overhaul the self-starter and alternator on condition basis.

MACHINE GENERAL**:**

- Change oil of Transmission gearbox.
- Clean oil tank of hydraulic system.
- Change oil of hydraulic system. Change oil of axles.

PART - C: MOTORISED TROLLEY

SCHEDULE-I

(To be done at 8 hours)

Check oil level and top up, if required.

SCHEDULE-II

(To be done at 25 hours)

Clean air cleaner.

SCHEDULE-III

(To be done at 50 hours)

Change engine oil.

Clean fuel filter.

SCHEDULE-IV

(To be done at 100 hours)

Change air cleaner

.

SCHEDULE-V

(To be done at 300 hours)

Clean spark plug.

SCHEDULE-VI

(To be done at 500 hours)

Change crank case breather.

Change spark plug.

SCHEDULE-VII

(To be done at 1000 hours) Top overhaul the engine

2.7 LIST OF SPARES & TOOLS FOR EMERGENCY:

Description	Part no.	Quantity
Mobil Oil Filters	41150030A	3
Fuel Filters.	45310059A	3
Hydraulic Return Filters.	FBO 500/3	**4**
Hydraulic suction filters.	FBO160/3	4
Hydraulic Pipes.		1 set
Air cleaner element	41130007A	3
V Belt	A57	4
Fuses	7.5 Amp, 10 Amp & 15 Amp	5 each
Relay	529.0233 Model T- 1853 Make SIPEA	10
pin relay		2
Working light bulbs		5
Stop Valve	6020062	1
Battery fully charged 120 AH or 88AH 12V		1
Alternator 24 V		1
Battery terminal +ve and –ve		2 each
Single core 1.5 mm^2 PVC wire.		20 m

Table-10 [list of spares and tools for emergency]

CHAPTER-3 Layout of The Maintenance Centre

Layout of The Maintenance Centre Has Been Improved from Indian Railways website

3.1 GUIDELINES FOR PROVISION OF MAINTENANCE DEPOTS, TOOL AND PLANTS AND TRANSPORT FACILITIES

3.1.1 OHE MAINTENANCE CENTER:

In the overall interest of minimum capital recurring cost with electric traction the number of OHE maintenance depots need be optimized the general conditions that govern the location and the spacing of the OHE maintenance depots are as under the total equipped track kilometres to be maintained by each depot beat of the depot on either side traffic density obtained on the section and the time factor in reaching the farthest point the proximity of major yards with considerable equipped track kilometres availability of educational medical and other infrastructures facilities in the vicinity.

. The total staff required for OHE maintenance for a given section is arrived at, based on the prevalent yardsticks for maintenance and the schedules of maintenance laid down for various equipment. The total staff is distributed amongst the maintenance requirements of OHE under their respective jurisdictions. The .staff requirement for the maintenance as per the yardstick is in no way linked with the number of OHE Depots in a particular sections.

The total equipped track kilometres normally assigned for maintenance to a single OHE depot should be at least 150 track kilometres which amounts to 250 to 300 EETKMs (Electrical Equated Track km) to ensure that the installations to be maintained by a single depot do not become unwieldy. On a normal double line section this would work out to a spacing of 60 RKMs between successive OHE maintenance depots. In the case of depots in the vicinity of terminal/major yards (having large wired km.), the spacing would correspondingly get reduced. In view of the concentration of work load in major yards, it will be necessary to locate maintenance depots in or around the vicinity of the major yards.

The beat of the depot on either side should not normally exceed four block sections (occasionally five) so as to ensure quick transportation of staff to the breakdown spot even if it happens at the farthest end of the jurisdiction of the depot.

The location of the depot should be such that reasonable educational and medical facilities are available at the place as otherwise the staff would be generally reluctant to stay at such a place.

The standard lay-outs of OHE depots have undergone several changes over a period of time, with varied concepts like major depots, minor depots etc. emerging to meet specific requirements. The essential difference between major and minor depot is the provision of a tower wagon with its shed and associated track connections and OHE Depot Workshop in a major depot. The standard OHE maintenance depot need only be provided with a drilling machine, bench grinder etc. be standard layout of OHE depot with workshop is shown at the shop to be provided as an adjunct to one of the OHE depots is shown

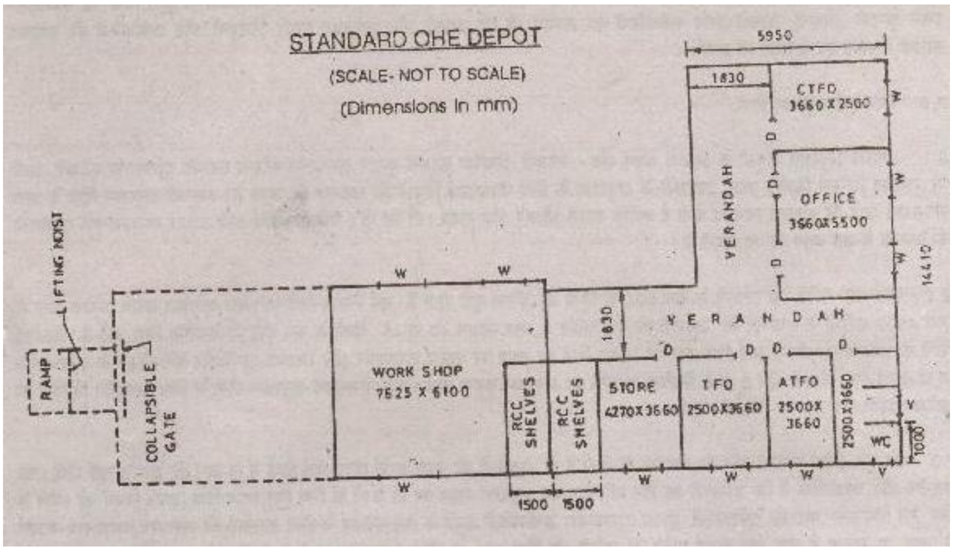


Fig -2 [standard OHE lay out]

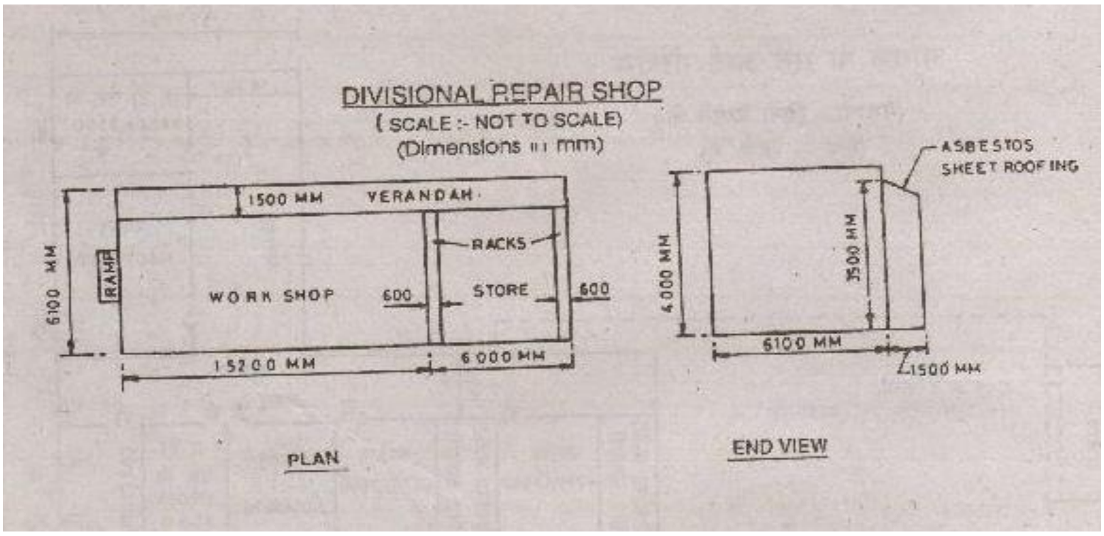


Fig -3 [divisional repair shop lay out]

Secondary activities/facilities in OHE maintenance depots, such as smithy, carpentry, welding etc. can be provided at a central plan either at the Divisional Headquarters or at one of the maintenance depots, depending upon convenience of location. Such a facility will have standard workshop equipment, such as lathe, hacksaw cutting machine, welding set, vertical drilling machine etc. Along with the above, a store can be provided where large quantities of OHE materials which are required for major breakdowns for the entire section can be stored, relieving the other maintenance depots from the responsibility of storing large quantities of materials which are required only occasionally. This would also increase the utilization of staff such as welders, black smiths, carpenters, and incidentally is likely to result in overall savings of the staff in the ancillary categories and equipment.

3.2 PSI MAINTENANCE DEPOTS:

Besides the OHE maintenance depots, PSI maintenance depots are provided for maintaining the various power supply equipment installed at traction substations, switching stations, booster transformer stations, auxiliary transformer stations etc. It is advantageous to locate the PSI maintenance depot along with the OHE maintenance depot to achieve some economy in requirements of T & P, transport and other infrastructural facilities. Normally the average spacing between traction substations is 60/70 km. On trunk routes with high traffic densities, where operation of 45001 trains is to be catered for, sub-stations are provided at reduced spacing of 40 to 45 km. With PSI depots spaced at 60/70 km., each depot will be called upon to maintain one or two traction sub-station and 5 to 6 switching stations, besides booster transformer and auxiliary transformer installations on the sections. A sketch showing the suggested layout for a PSI maintenance depot is shown at

If a Zonal Repair Shop is provided, necessity of transporting the equipment to the PSI depot may not arise. It is desirable and feasible to give all attention that is required for day-to-day maintenance of the equipment at site. For any major attention such as oil circulation of the breakers/auxiliary transformers, booster transformers, interrupters, etc. the equipment can be transported to the nearest traction sub-station, where power supply is available from the 100-kVA auxiliary transformer for working of the oil filtration plant. This results in minimum transportation of these equipment. Major repairs, which cannot be done at the sub-station, should be done only at the Zonal Repair Shop.

By combining the OHE and PSI depots, the OHE transport facility can be conveniently utilized for PSI work

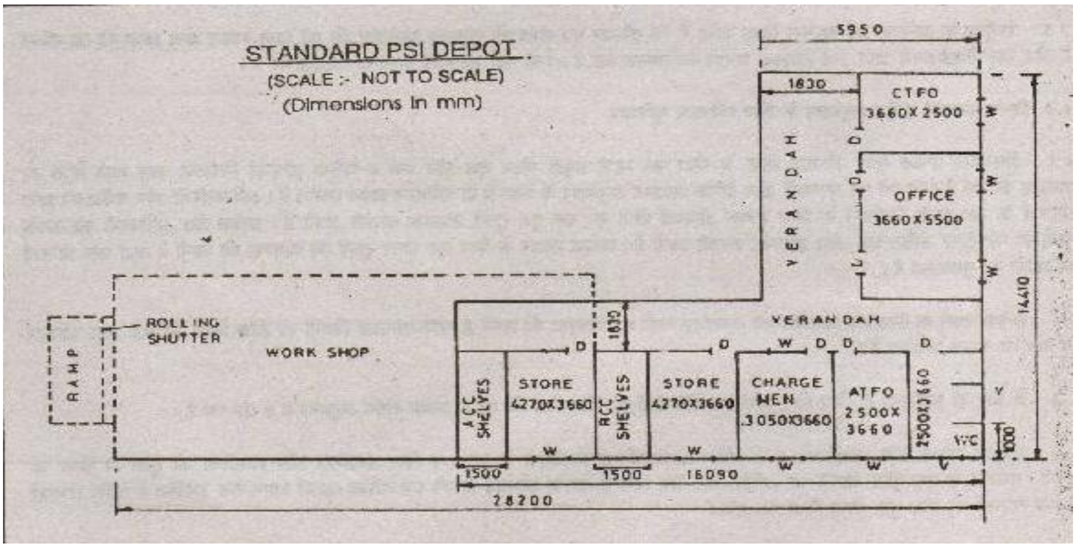


Fig-4[Standard Psi depot layout]

as well. A common depot will be cheaper with a common compound wall and security arrangements. Better coordination and supervision can be obtained between OHE and PSI maintenance staff if both the depots are located together. It is likely to result in faster attention to breakdowns. In addition, it would be desirable to have this combined OHE/PSI maintenance depot at a station where traction sub-station is also located, wherever it is feasible, as PSI maintenance work is more concentrated at a traction sub-station. Keeping in view the set up outlined above, it should be possible to locate the PSI depots at alternate OHE depots (instead of locating the same at each and every OHE depot). This would enable a minimum complement of PSI staff both supervisory and others at each of the PSI

3.3 TRANSPORT FACILITES FOR MAINTAINENCE INCLUDING BREAKDOWN ATTENTION:

At present each major OHE Depot is provided with one heavy duty motor truck and one 4-wheeler OHE Inspection Car. These transport vehicles are adequate for attending to breakdowns and for normal day-to-day maintenance. For push trolley inspections of OHE by supervisors and officers, each OHE depot is to be provided with one push trolley. One Jeep with trailer is to be provided for each field officer at his headquarters. One motor trolley is to be provided for each station where an OHE officer is headquartered. One wiring-cum-breakdown train is to be provided for each Division to meet any major OHE. Transport facilities recommended for TRD maintenance are summarized.

On sections with higher traffic density, eight-wheeler high speed tower wagons would enable quicker transportation of men and materials to the site. With increased emphasis on quick restoration after accident, quicker attention to OHE breakdowns is called for to provide early restoration of OHE power supply.

CHAPTER-4 Equipment Maintenance Centre

Equipment Maintenance Centre Has Been Improved from Indian Railways website

4.1 CHARACTERISTICS OF EQUIPMENT MAINTENANCE CENTER:

4.1.1 FIRST LEVEL OF MAINTENANCE:

- This are the equipment that used in the first level maintenance the components and the capacity of the components have been showed in the below the table.

Name of component	Description	Number of component	Capacity
PORTAL CRANE	The portal crane is the main component to lift and shift the loco	5	5-10 tones
BATTERY CHARING ROOM	This make to charge the battery charge for diesel engine charging battery is very important	5	
TOOL KIT	The tool kit is used to open and close the loco parts	10-15	

Table-11[equipment in first level maintenance]

This are the main components required in the first level of maintenance.

4.1.2 SECOND LEVEL MAINTANENCE:

- This are the equipment that used in the second level maintenance the components and the capacity of the components have been showed in the below the table .

Name of component	Description	Number of component	Capacity
JIB CRANE	This component is used to lift and shift the loco parts	4-6	4-8 Tones
PORTAL CRANE	The portal crane is the main component to lift and shift the loco	4-8	5-10 tones
INSTRUMENTS TEST AND REPARING ROOM	Checking the component and how to improve it will be done here		
FUEL INJECTORE AND TESTING ROOM	Checking the problem and Ratification and testing the component will be take place here		
BRAKE TESTING ROOM	Checking the function of the brake And repairing it will be done here		

Table -12 [equipment in second level maintenance]

4.1.3 THIRD LEVEL MAINTENANCE:

- This are the equipment that used in the third level maintenance the components and the capacity of the components have been showed in the below the table.

Name of component	Description	Number of component	Capacity
MOTORISED TROLLY	The motorised trolley is used to shift the component from one place to another in work shed	8-10	500-900kg
JIB CRANE	This component is used to lift and shift the loco parts	5-10	4-10 Tones
PORTAL CRANS	The portal crane is the main component to lift and shift the loco	4-8	5-10 tones
WASHING AND GRINDING MACHIEN ROOM	Here the loco will be washed Here they grind the loco parts which Has uneven surface they will fix here		
WELIENDING AREA	Here they weld and joint the parts of loco		
LATH AREA	Here they fix the roiling stock remove the excess material around and they shape it		

Table -13 [equipment in third level maintenance]

4.2 List of Machinery & Plant and Tools required for Diesel Sheds:

SNO	DESCRIPTION	NUMBER OF COMPONENTS
1	A. MATERIAL HANDLING/TRANSPORTATION EQUIPMENTS	
2	EOT CRANE OF 50/10 AND 40/10 T CAP VFF DRIVE	6
3	EOT CRANE OF 20/5 AND 10/5 T CAP VFF DRIVE	4
4	EOT CRANE OF 5 AND 3 T CAP VFF DRIVE	6
5	PILLAR CRANE OF 0.5,1.5,2.0AND 3.0 T CAP	12
6	TRAM BEAM CRANE OF 3T CAP	6
7	FORKLIFT OF 5T AND 3T CAP	8
8	BATTERY OPERATED PLATFORM TRUCK OF 2T CAP	4
9	ROAD MOBILE CRANE OF 10T CAP	3
10	SYNCHRONIZED LIFITING JACKS OF 45T AND 35T	6

11	LORRY OF 10 T CAP	2
12	MATERIAL HANDLING VAN FITTED WITH CRANE	3
13	PICK UP VAN	4
14	MONORAIL WITH HOISTS FOR • BATTERY SECTION • CYLINDER SECTION • PISTON ASSEMBLY SECTION	5
15	MATERIAL STACKERS	1
16	TURN TABLE	1
17	B. SPECIAL PURPOSE EQUIPEMENTS	
18	CNC UNDER FLOOR WHEEL LATH	2
19	DROP PRT TABLE	2
20	HYDRAULIC EQUIPEMENT FOR MOUNTING AND DISMOUNTING OF CRABNUT AND MAIN BEARING OF HHP AND ALCO LOCOS	4
21	HUCK BOLT INSTALLATION AND CUTTING EQUIPEMENT	2
22	TRACTION MOTOR PINION EXTRACTOR FOR ALCO AND HHP LOCOS	4
23	CARTRIDE TAPERED ROLLER BEARING /EXTRACTING EQUIPMENT	4
24	SURGE COMPARISON TESTER	2

25	MICROPROCESSOR BASED SOLDERING/DE-SOLDERING STATION	2
26	WATER LOAD BOX	2
27	ENGINE CRANKING FIXTURE	2
28	ENGINE TURNING FIXTURE FOR ALCO AND HHP LOCOS	4
29	TRACTION MOTOR CLEANING PLANT	2
30	VALVE FACE AND SEAT GRINDING MACHINE	4
31	LAPPING MACHINE	2
32	EXHAUST GAS ANALYSER	2
33	NOZZLE RE-CONDITIONER HHP LOCOS	2
34	ELECTRONIC WHEEL DIAMETER MEASURING GUAGE [LHS AND RHS]	2
35	LAPPING MACHINE INJECTOR NOZZLE SEATS	4
36	BUFFING MACHINE [CONTACT TIPS ELECTRICAL SWITCH GEAR	4
37	PRE-LUBE PUMPING SYSTEM	2
38	C.GENERAL PURPOSE EQUIPMENTS	
39	DIESEL GENERATOR SET OF 500 KVA	3
38	EFFLUENT TREATMENT PLANT	2
39	INCINERATOR	4
40	INDUCTION HEATERS FOR FITMENT OF BEARINGS	4
41	BATTERY CHARGER	3
42	CENTRE LATHE	2
43	SHAPING MACHINE	2

44	RADIAL DRILLING MACHINE	2
45	VERTICAL DRILLING MACHINE	2
46	MAGNETIC BASE DRILLING MACHINE	2
47	VERTICAL SURFACE GRINDING MACHINE	3
48	MAGENETIC BASE DRILLING MACHINE	2
49	MARKING TABLE 2M*1.5M	3
50	HYDRAULIC PRESS OF 80T CAP	2
51	GASKET DIE PUNCHING PRESS	2
52	HYDRAULIC PIPE BENDING MACHINE	3
53	AIR ASSISTED SPRAY PAINTING EQUIPEMENT	4
54	AIR COMPRESSORS	2
55	SHOT BLASTING MACHINE	2
56	DEEP FREEZER	3
57	ELECTRIC AIR CIRCULATING OVEN	2
58	DC/AC WELDING PLANT	2
59	PORTABLE GENERATOR CUM WELDING SET	3
60	POWER HACK SAW	2
61	MATERIAL STORAGE RACK	4
62	SLOTTED ANGLE STORAGE RACK	3
63	TOOL STORAGE RACK	4
64	LASER MARKER FOR METALLIC AND NON-METALLIC OBJECTS	2

65	D. TOOLS	
66	KIENE DIESEL ENGINE PRESSURE INDIACATOR TO ALCO CAT	2
67	GRINDER VALVE SEAT BASIC SET TO ALCO CAT	2
68	POWER WRENH SET	2
69	GUAGE ELONGATION CON ROD TO ALCO CAT	4
70	WRENCH FOR INTER MAIN BEARING BOLTS TO ALCO	2
71	WRENCH LH MAIN DRG BELT TO ALCO CAT	2
72	DIGITAL MULTI METER 3.5 AND 4.5 DIGITS	2
73	AUTOMATIC WIRE STRIPPER TO EMD	2
74	ESD WORK BENCH	3
75	TREAD WEAR GUAGE	3
76	LIQUID NITOGEN CRYOCAN	2
77	HOLDING FIXTURE FOR CRANK SHAFT WITH CRANK CASE	2
78	ALIGNMENT GUAGE WITH DIAL INDIACATOR FOR OIL PAN TO CRANK CASE	4
79	ACCESSORY HOUSING ALIGMENT GUAGE	3
80	LINE UP INDICATOR GUAGE TO SET UP STUB SHAFT FROM CRANKSHAFT AND CAMSHAFT	2
81	ARRANGEMET FOR ALIGNMENT OF LEFT SIDE WATER PUMP IN HHP LOCOS	2
82	BACKLASH CHECK GUAGE ON STARTER GEAR AND BRACKET ASSEMLY	3
83	LIFTER FOR AUXILIARY GENERATOR ASSEMBLY	2
84	LIFTER FOR BEARING CAPS	2

85	E. TOOLS [GENERAL PURPOSE]	
86	Boxes containing standard tools such as single/double end spanner, bi-hexagonal ring spanner, reversible ratchet, pipe wrenches, nylon hammer, universal joint extension handle, different sizes of box sockets and socket	4
87	WILLIAM ALCO SPANNER	15
86	HALF MOON SPANNER	16
87	ADJUSTABLE SPANNER	13
88	SOCKETRY	10
87	T HANDLES	6
88	HEX ALLEN KEY	7
89	PIPE WRENCHE	15
90	HAMMERS	13
91	CHISELS	10
92	PUNCHES	11
93	NON-CONTACT TYPE THERMOMETER	12
94	INDUSTRIAL VACCUM CLEANER	10
95	HYDRAULIC JACKS WITH PUMPS OF VARIOUS CAPACITIES	11
96	HYDRAULIC CRIMPING TOOL	4
97	HYDRAULIC CABLE CUTTER	3
98	HAND CABLE CUTTER	4
99	PNEUMATIC ANGLE DIE GRINDER	5
100	ANGLE GRINDER	10
101	DRILLING MACHINE	10

102	CORDLESS DRILLING MACHINE	11
103	ORBITAL SANDER	4
104	CHOP SAW	4
105	SNAP GUAGE	4
106	DIAL BORE GUAGE	2
107	DIGITAL AND AIR BORE GUAGE	2
108	F. TESTING EQUIPEMENT [MECHANICAL]	
109	FIP TEST STAND	2
108	WOODWARD GOVERNOR TEST STAND	2
109	INJECTOR TEST STAND FOR HHP LOCOS	2
110	MUI INJECTOR TEST STAND FOR HHP LOCOS	3
111	OSTA TEST STAND	4
112	MAIN BEARING ELONGATION TEST STAND	5
113	BEARING HEALTH ANALYSER	4
114	SPRING TESTING MACHINE	3
115	DYNAMIC BALANCING MACHINE	2
116	AIR COMPRESSOR TEST STAND	4
117	BOGIE RUNNING AND HECKING TEST STAND	2

118	ENGINE COMPRESSION TESTING EQUIPEMENT	4
119	CYLINDER HEAD TEST STAND	2
120	AIR COMPRESSOR TEST STAND	5
121	ENGINE BLOW -BY TESTING EQUIPEMENT	3
122	CYCLINDER HEAD TEST STAND	2
123	HYDRAULIC SHOCK ABSORBER TEST STAND	4
124	AIR BRAKE TEST STAND	3
125	AIR BRAKE TEST STAND FOR VARIOUS VALVES OF CCB	7
126	G. TESTING EQUIPEMENT [ELECTRICAL]	
127	AC FUEL PUMP MOTOR TEST STAND	4
128	5 KV DIGITAL ANALOG INSULATION TESTER	3
129	TRACTION MOTOR TRIAL RUN EQUIPEMENT FOR ALCO LOCOS	3
130	TRACTION MOTOR TRIAL RUN EQUIPEMENT FOR HHP LOCOS	5
131	BATTERY CONDUCTANCE ANALYSER	3

132	819 LCR BENCH METER	2
133	RAIDATOR FAN AC TRAIL RUN EQUIPMENT	4
134	SPEED SENSOR CALIBRATOR	6
135	TEMPERATURE SENSOR CALIBRATOR	2
136	IC TESTING EQUIPEMENT	5
137	BREAKERS AND RELAYS TEST STAND	5
138	SPEEDOMETER TEST STAND	2
139	HIGH POTENTIAL TEST SET	2
140	GADGET FOR CHECKING SPRING TENSION OF HYDRAULIC GOVERNOR	3
141	TEST BENCH FOR OIL LEAKAGE FROM HYDRAULIC GOVERNOR PUMP AND PIPE	3
142	TEST BENCH FOR ILLUMINATION INTENSITY OF TWIN BEAM HEAD LIGHT	2
143	CIRCUIT BERAKER TEST STAND	2
144	TEST STAND FOR AUTU FLASHER LIGHT	4
145	TEST BENCH FOR CALIBRATION OF LOAD METER	3

146	SENSOR TESTING UNIT EQUIPMENT	2
147	INTERLOCK OVER TRAVEL TEST STAND	2
148	BKT AND REVERSER TEST BENCH	3
149	DYNAMIC BRAKE CONTROLLER EST STAND	2
150	DCL MOTOR TEST STAND	2

Table -13 [List of machinery and plant and tools for diesel sheds]

CHAPTER-5 Predictive Maintenance

The Predictive Maintenance Context Has Been Improved from Wikipedia

5.1 PREDICTIVE MAINTENANCE:

Predictive maintenance techniques are designed to help determine the condition of in-service equipment in order to estimate when maintenance should be performed. This approach promises cost savings over routine or time-based preventive maintenance, because tasks are performed only when warranted. Thus, it is regarded as condition-based maintenance carried out as suggested by estimations of the degradation state of an item.

The main promise of predictive maintenance is to allow convenient scheduling of corrective maintenance, and to prevent unexpected equipment failures. The key is "the right information in the right time". By knowing which equipment needs maintenance, maintenance work can be better planned (spare parts, people, etc.) and what would have been "unplanned stops" are transformed to shorter and fewer "planned stops", thus increasing plant availability. Other potential advantages include increased equipment lifetime, increased plant safety, fewer accidents with negative impact on environment, and optimized spare parts handling.

Predictive maintenance differs from preventive maintenance because it relies on the actual condition of equipment, rather than average or expected life statistics, to predict when maintenance will be required.

Some of the main components that are necessary for implementing predictive maintenance are data collection and pre-processing, early fault detection, fault detection, time to failure prediction, maintenance scheduling and resource optimization. Predictive maintenance has also been one of the driving forces for improving productivity and one of the ways to achieve "just-in-time" in manufacturing

5.2 THE MAIN COMPONENTS OF DIESEL ELECTRIC ENGINE:

- Diesel engine
- Fuel tank
- Traction motor
- Main alternator/auxiliary alternator
- Turbo charger
- Gearbox
- Air compressor
- Radiator
- Wheels
- Truck frame
- Rectifiers/inverters

5.2.1 APPLICATION OF PREDICTIVE MAINTENANCE IN INDIAN CONTEXT:

- For Indian context the locomotive of Indian railways travelling distance is very long it will be minimum 1000-5000km for single trip
- In this condition to reach the predictive maintenance of locomotive
- We should introduce the sensor in the main parts of the locomotive and record the following data of the component
- If this is the satiation the digitalization may cause a problem in this position
- As according to me knowing Indian is not so digitalized so to reach predictive maintenance
- We will install one device in locomotive which will record the data of the component
- When the locomotive goes for the first level of maintenance, we will collect the data
- When we collect the data and analyse the abnormal readings and we can predict the problem.

5.3 AIR COMPRESSOR:

Air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its engineered upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use.[1] The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank. An air compressor must be differentiated from a pump because it works for any gas/air, while pumps work on a liquid.

5.3.1 DESCRIPTION AND FUNCTION OF AIR COMPRESSOR:

The compressor is a two-stage compressor with one low pressure cylinder and one high pressure cylinder. During the first stage of compression it is done in the low pressure cylinder where suction is through a wire mesh filter. After compression in the LP cylinder air is delivered into the discharge manifold at a pressure of 30 / 35 PSI. Working of the inlet and exhaust valves are like that of exhauster which automatically open or close under differential air pressure. For inter-cooling air is then passed through a radiator known as inter-cooler. This is an air to air cooler where compressed air passes through the element tubes and cool atmospheric air is blown on the outside fins by a fan fitted on the expressor crank shaft. Cooling of air at this stage increases the volumetric efficiency of air before it enters the high- pressure cylinder. A safety valve known as inter cooler safety valve set at 60 PSI is provided after the inter cooler as a protection against high pressure developing in the after cooler due to defect of valves.

After the first stage of compression and after-cooling the air is again compressed in a cylinder of smaller diameter to increase the pressure to 135-140 PSI in the same way. This is the second stage of compression in the HP cylinder. Air again needs cooling before it is finally sent to the air reservoir and this is done while the air passes through a set of coiled tubes below the loco superstructure.

5.3.2SENSORS:

- RTD SENSOR

  Resistance thermometers, also called resistance temperature detectors (RTDs), are sensor used to measure temperature Many RTD elements consist of a length of fine wire wrapped around a ceramic or glass core, but other constructions are also used. The RTD wire is a pure material, typically platinum, nickel, or copper.

- VIBRATION SENSOR

  Vibration sensors are sensors for measuring, displaying, and analysing linear velocity, displacement and proximity, or acceleration. Vibration — however subtle and unnoticed by human senses is a tell-tale sign of machine condition.

- ABSOLUTE PRESSURE SENSOR

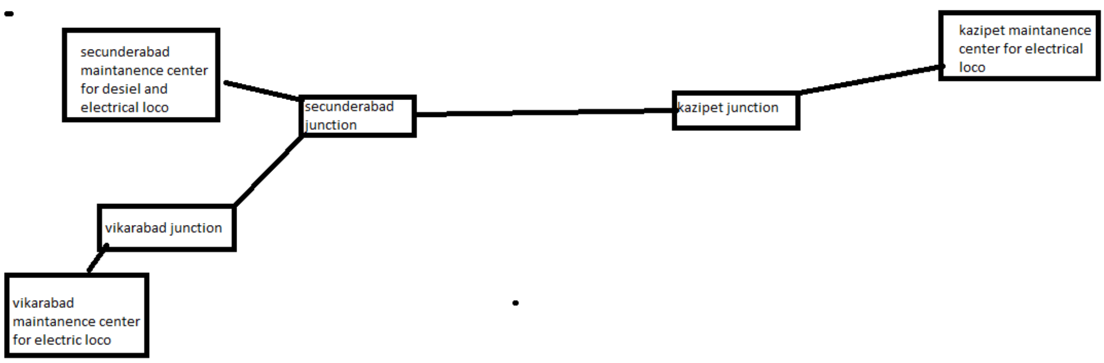
  Absolute pressure uses absolute zero as its reference pressure, measured relative to a full vacuum (outer space). … For example, if you want to measure pressure that is not influenced by changes in temperature you would use an absolute sensor.

CHAPTER-6 Case Study: New Maintenance Service from Vikarabad Junction to Kazipet Junction

Lay out and maintenances centres from vikarabad to kazipet junction

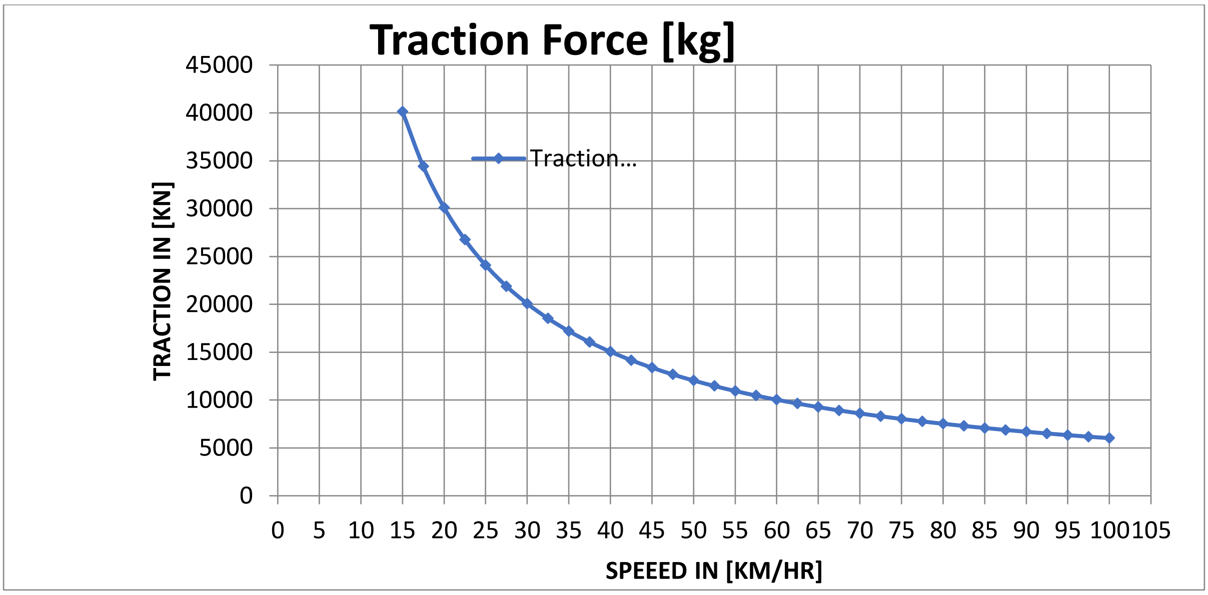
- The following fig show the different type of loco maintenances centres from vikarabad to kazipet
- In this picture you can see clearly that the junction has different type of loco maintenance centre
- The total line is 203 km from vikarabad to kazipet junction and from vikarabad to secunderabad junction line is 72 km

Fig [5] Lay out and maintenances



6.1 MOVEMENT DIAGRAM

6.1.1 TRACTION FORCE:WDMA3A



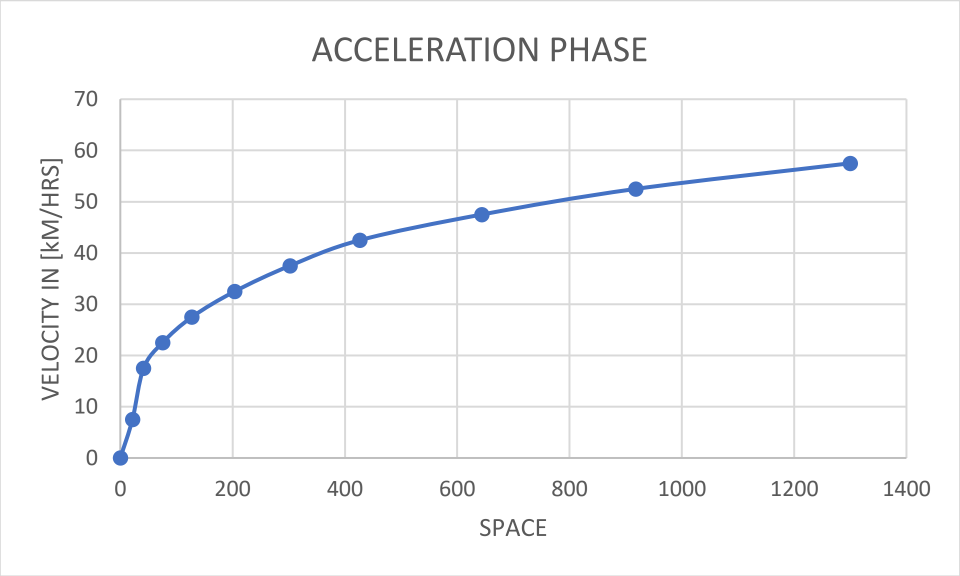
Graph-1 [Traction force for the passenger for diesel – electrical locomotive]

- T=R+M.DV/DT
- R=resistance, M=mass of the loco, DV/DT=Velocity/Time

TRACTION FORCE:

- The force which a locomotive exerts when pulling a train is called traction force and depends on the various factors

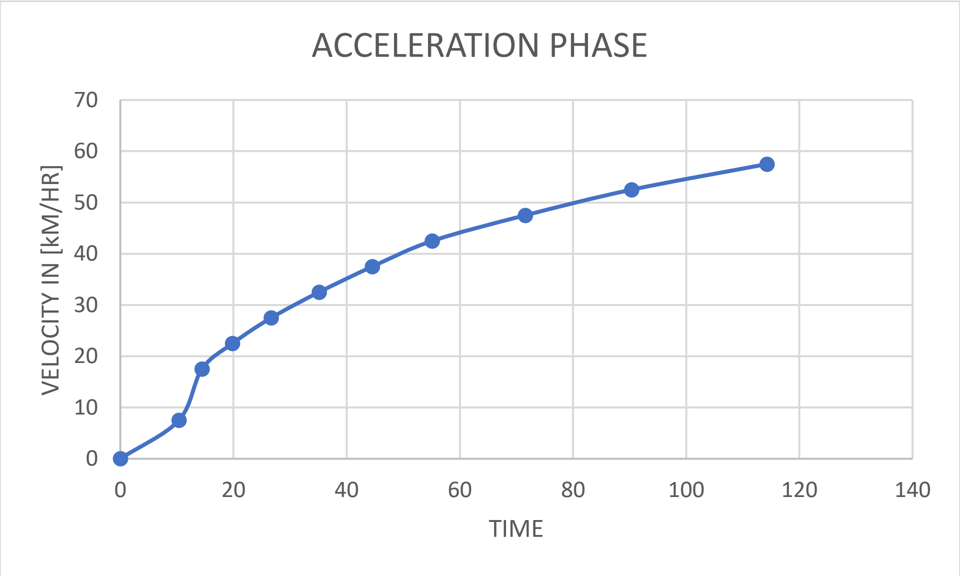
6.1.2 RELATION BETWEEN VELOCITY AND SPACE IN ACCELARATION PHASE



Graph-2 [Relation between velocity and space in acceleration phase]

- VELOCITY[VM]=V INTIAL+V FINIAL/2
- SPACE [S]=PARTIAL DISTANCE +TOTAL DISTANCE

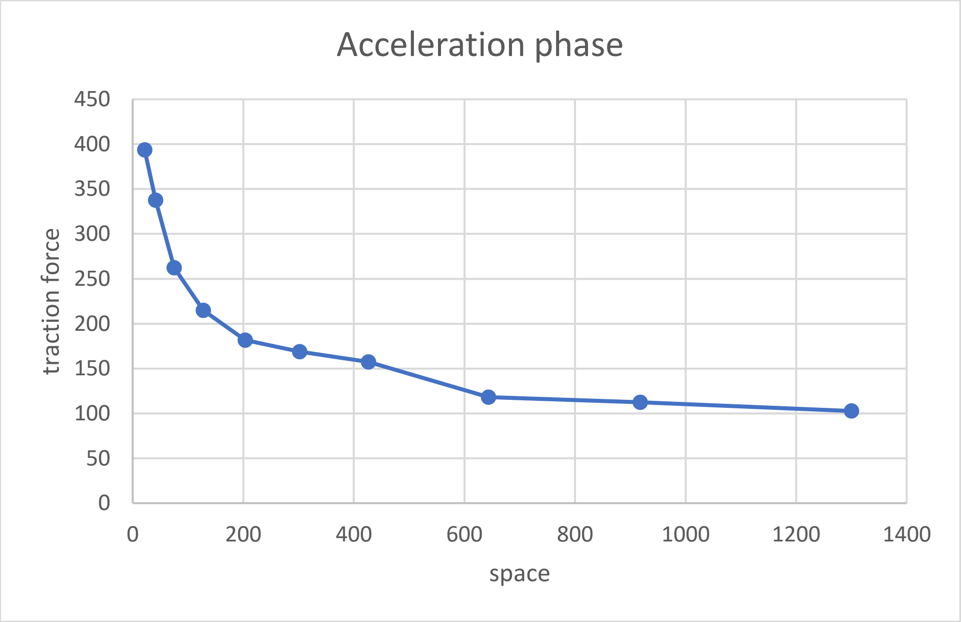
6.1.3 RELATION BETWEEN VELOCITY AND TIME IN ACCELARATION PHASE



Graph-3 [Relation between time and space in acceleration phase]

- VELOCITY[VM]=V INTIAL+V FINIAL/2
- TIME[t]=TIME INTERVAL+TOTAL TIME

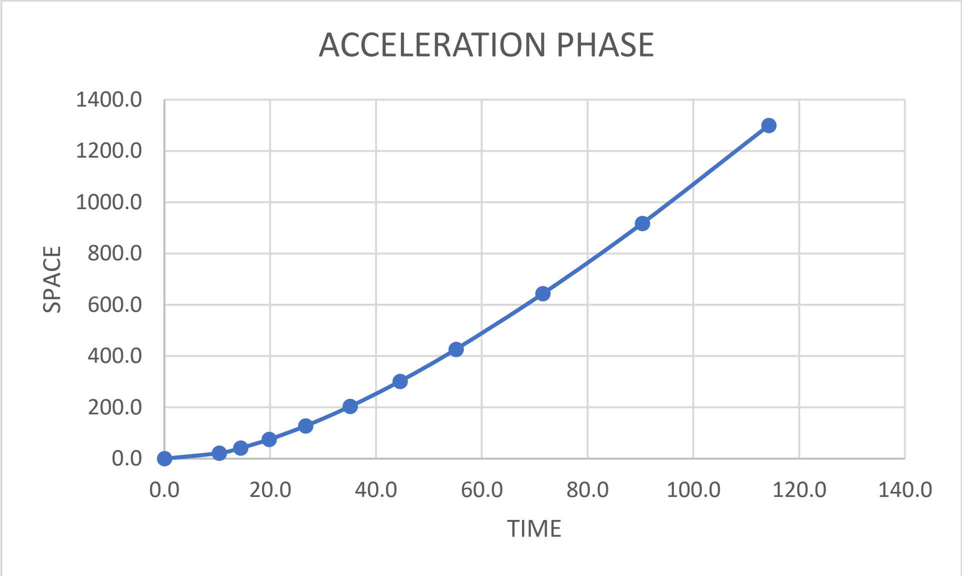
6.1.4 RELATION BETWEEN VELOCITY AND TIME IN ACCELARATION PHASE



Graph-4 [Relation between velocity and time in acceleration phase]

- T=R+M.DV/DT
- R=resistance, M=mass of the loco, DV/DT=Velocity/Time
- SPACE [S]=Partial Distance +Total Distance

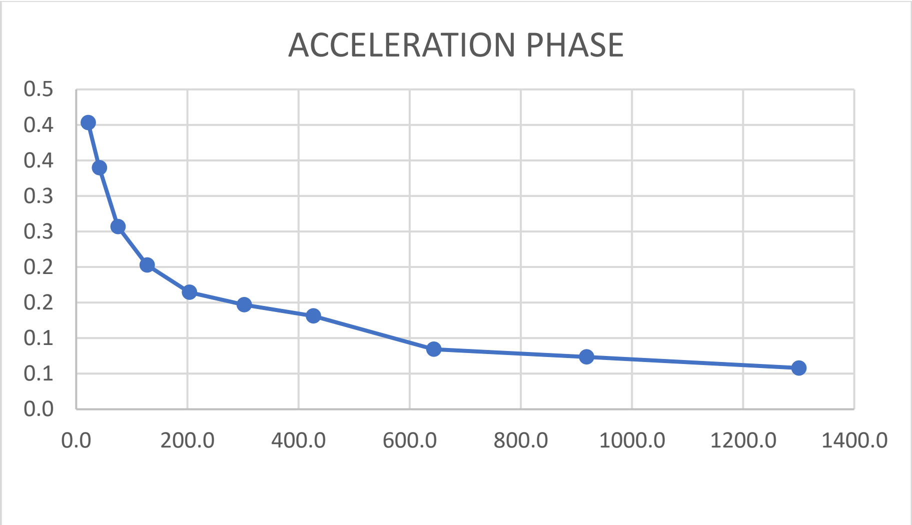
6.1.5 RELATION BETWEEN SPACE AND TIME IN ACCELARATION PHASE



Graph-5 [Relation between space and time in acceleration phase]

- SPACE [S]=PARTIAL DISTANCE +TAOTAL DISTANCE
- TIME[t]=TIME INTERVAL+TOTAL TIME

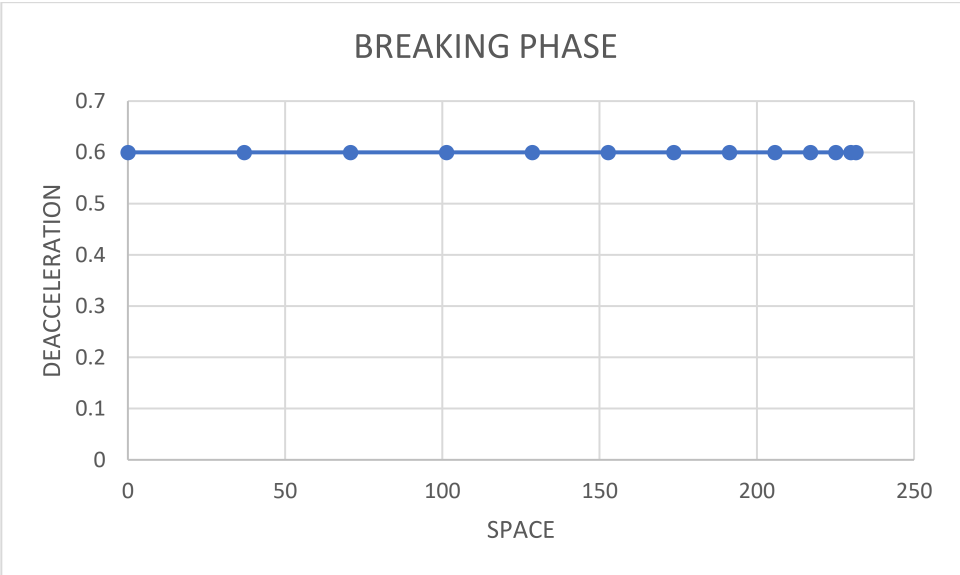
6.1.6 RELATION BETWEEN ACC AND SPACE IN ACCELARATION PHASE



Graph-6 [Relation between acc and space in acceleration phase]

- ACC=TE [kN]-R[kN]/TOTAL MASS
- SPACE [S]=Partial Distance +Total Distance

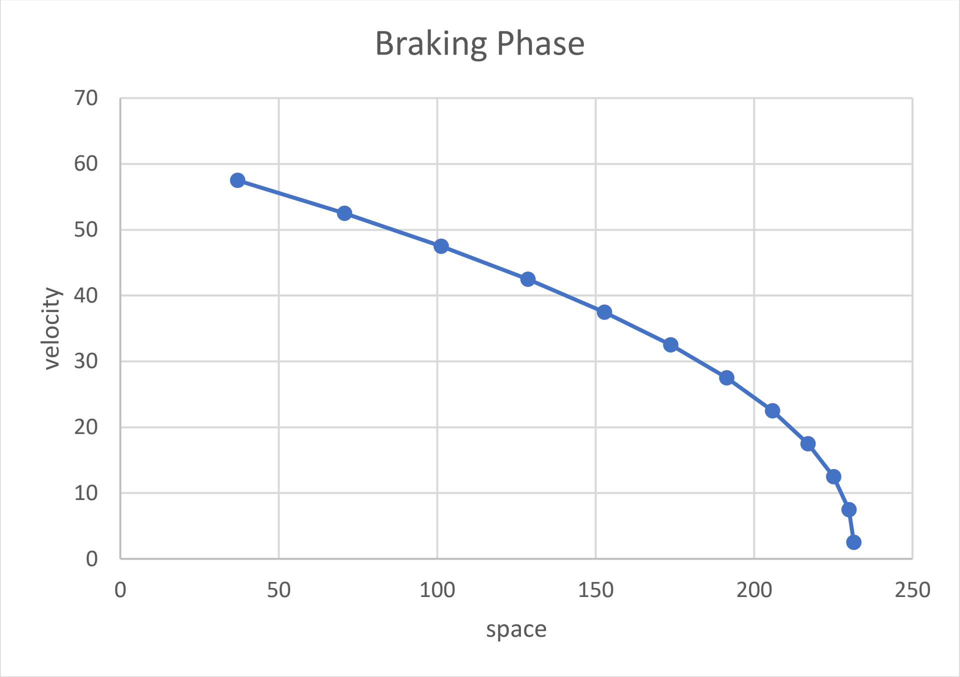
6.1.7RELATION BETWEEN DACC AND SPACE IN BREAKING PHASE



Graph-7 [Relation between deacc and space in breaking phase]

- Deacc Value 0.6 Is Constant
- Space [S]=Partial Distance +Total Distance

6.1.8 RELATION BETWEEN VELOCITY AND SPACE IN BREAKING PHASE



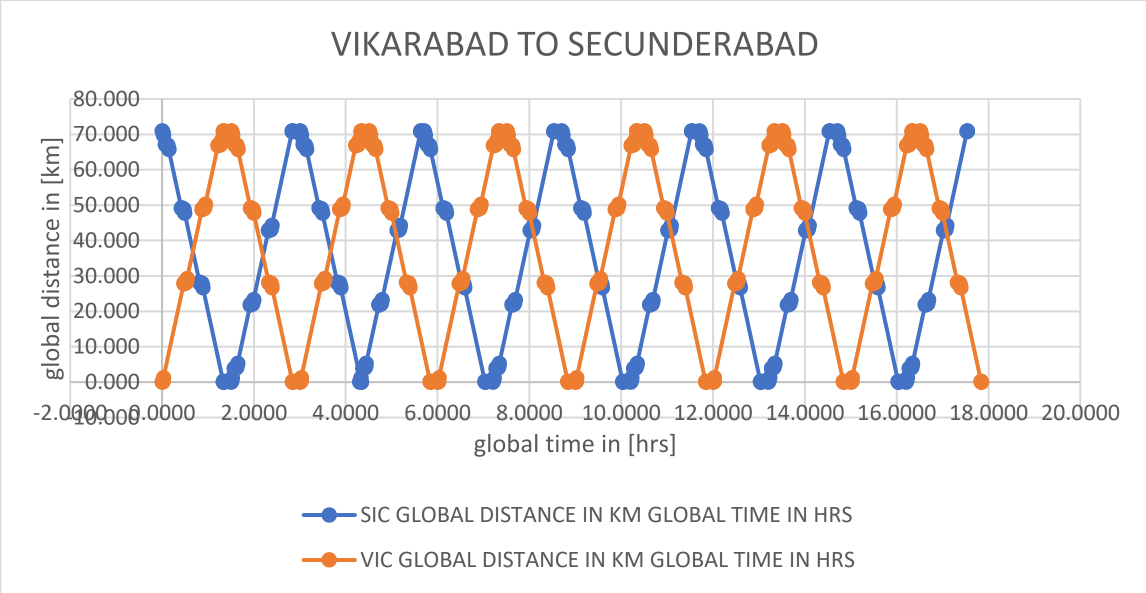
Graph-8 [Relation between velocity and space in breaking phase]

- Velocity [Vm]=V Initial Finial/2
- Space [S]=Partial Distance +Total Distance

6.2 SERVICE PROJECT

6.2.1 SERVICE FROM VIKARABAD TO SECUNDERABAD

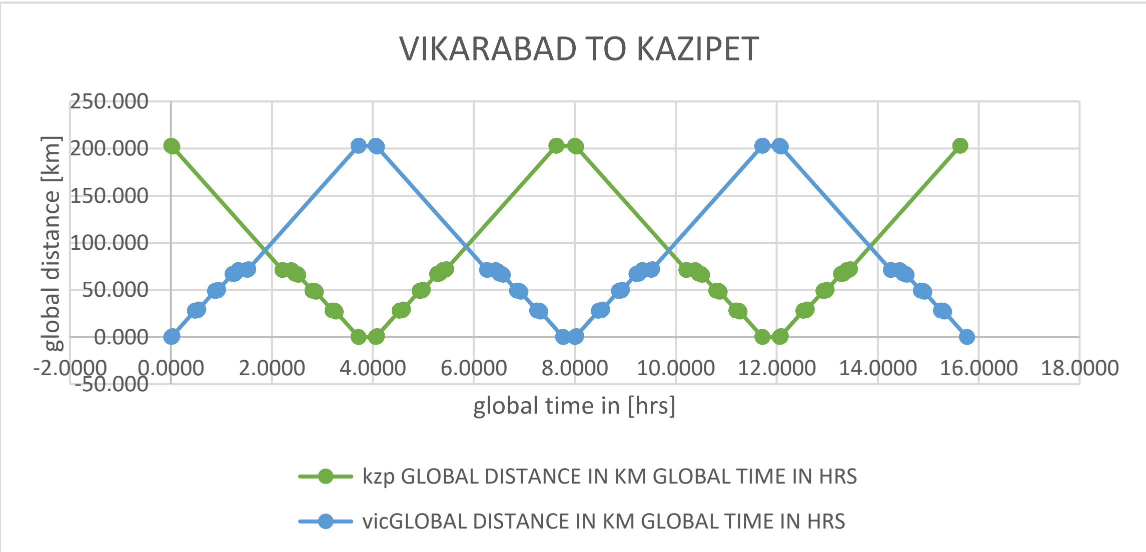
The following graph shown the distance and time covered the train here the blue colour line in the graph show that the service that stared from secunderabad and end at the same place where it has been started the orange colour line in the graph show that the service stared from vikarabad and end of the day I will end at the same place where it has started the following line ha s72 km that had been covered in one and half hour for one-hole tripe It will take about 3 hrs 20 mins here in the graph shows the whole tripe You can see it clearly in the following graph below.



Graph9 - [The graph is the service from vikarabad to secunderabad]

6.2.2 SERVICE FROM VIKARABAD TO KAZIPET

The following graph shown the distance and time covered the train here the green colour line in the graph show that the service that stared from kazipet and end at the same place where it has been started The light blue colour line in the graph show that the service stared from vikarabad and end of the day I will end at the same place where it has started the following line has 203km that had been covered in three and half hour for one-hole tripe It will take about 6 hrs 40 mins here in the graph shows the whole tripe You can see it clearly in the following graph below.



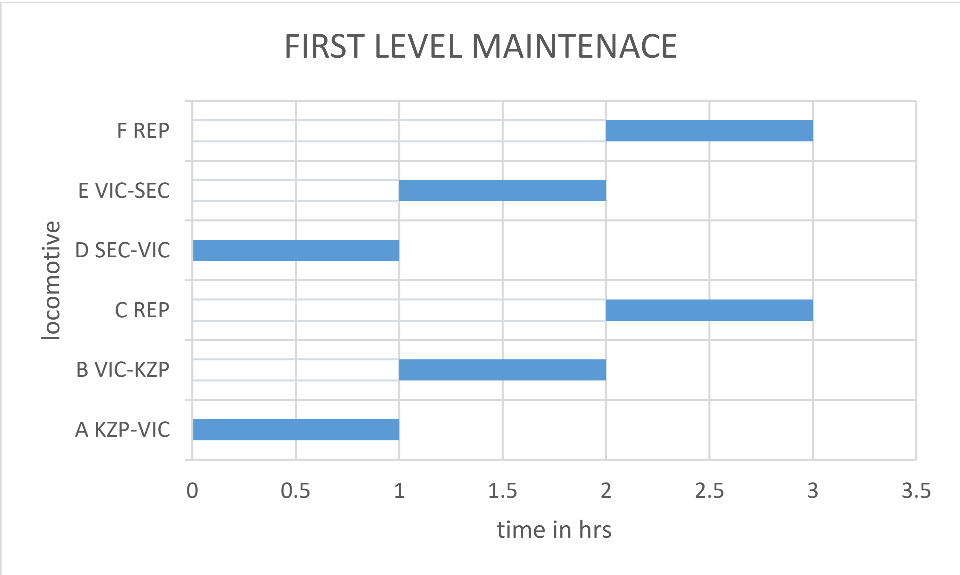
Graph 10 – [The graph is the service from vikarabad to kazipet]

CHAPTER-7 MAINTENANCE PROGRAM

7.1 MAINTENANCE SCHEDULE

7.1.1 SECHEDULE OF FIRST LEVEL MAINTENANCE FROM VIKARABAD JUNCTION TO KAZIPET JUNCTION AND VIKARABAD JUNCTION TO SECUNDERABAD JUNCTION:

- Here in the chart below we can see the schedule of the first level maintenance of the loco which is performed about one hour
- Loco from vikarabad to kazipet service are here in the graph.
- Loco[a] starts from kazipet and loco [b] starts from vikarabad and loco [c] is a replacement loco.
- When the loco is finished the whole trip, it will go for the maintenance as showed in the graph where it has started service the maintenance program will have done them
- Loco from vikarabad to secunderabad service are here in the graph.
- Loco[a] starts from secunderabad and loco [b] starts from vikarabad and loco [c] is a replacement loco.
- When the loco is finished the whole trip, it will go for the maintenance as showed in the graph where it has started service the maintenance program will be done them



Graph 11 – [First level Maintenance graph from vikarabad /kazipet and vikarabad / secunderabad]

7.1.2 SECHEDULE OF SECOND LEVEL MAINTENANCE FROM VIKARABAD JUNCTION TO KAZIPET JUNCTION AND VIKARABAD JUNCTION TO SECUNDERABAD JUNCTION:

- Here in the chart below we can see the schedule of the second level maintenance of the loco which is performed about two hours
- Loco from vikarabad to kazipet service are here in the graph.
- Loco[a] starts from kazipet and loco [b] starts from vikarabad and loco [c] is a replacement loco.
- When the loco is finished the whole trip, it will go for the maintenance as showed in the graph where it has started service the maintenance program will be done them
- Loco from vikarabad to secunderabad service are here in the graph.

- Loco[a] starts from secunderabad and loco [b] starts from vikarabad and loco [c] is a replacement loco.
- When the loco is finished the whole trip, it will go for the maintenance as showed in the graph where it has started service the maintenance program will be done them

Graph 12 – [Second level Maintenance graph from vikarabad /kazipet and vikarabad / secunderabad]

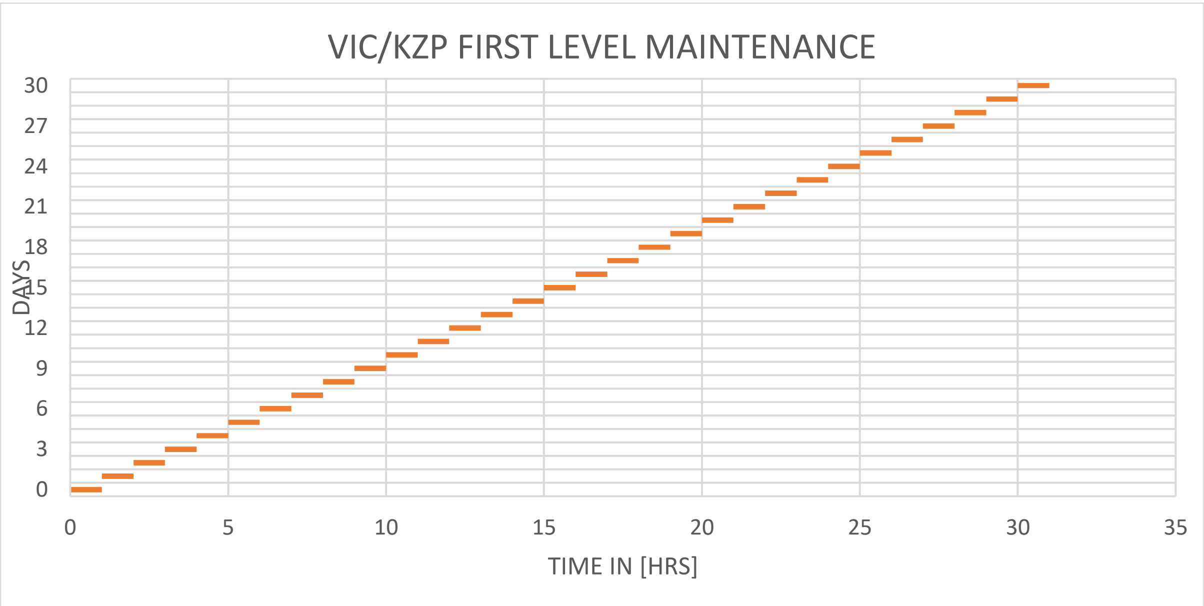
7.1.3 SCHEDULE OF THIRD LEVEL MAINTENANCE FROM VIKARABAD JUNCTION TO KAZIPET JUNCTION AND VIKARABAD JUNCTION TO SECUNDERABAD JUNCTION:

- Here in the chart below we can see the schedule of the second level maintenance of the loco which is performed about twenty -four hour
- Loco from vikarabad to kazipet service are here in the graph.
- Loco[a] starts from kazipet and loco [b] starts from vikarabad and loco [c] is a replacement loco.
- When the loco is finished the whole trip, it will go for the maintenance as showed in the graph where it has started service the maintenance program will have done them
- Loco from vikarabad to secunderabad service are here in the graph.
- Loco[a] starts from secunderabad and loco [b] starts from vikarabad and loco [c] is an replacement loco.
- When the loco is finished the whole trip, it will go for the maintenance as showed in the graph where it has started service the maintenance program will be done them

Graph 13 – [Third level Maintenance graph from vikarabad /kazipet and vikarabad / secunderabad]

7.1.4 ANALYSIS ON FIRST LEVEL MAINTENANCE FROM VIKARABAD TO KAZIPET JUNCTION

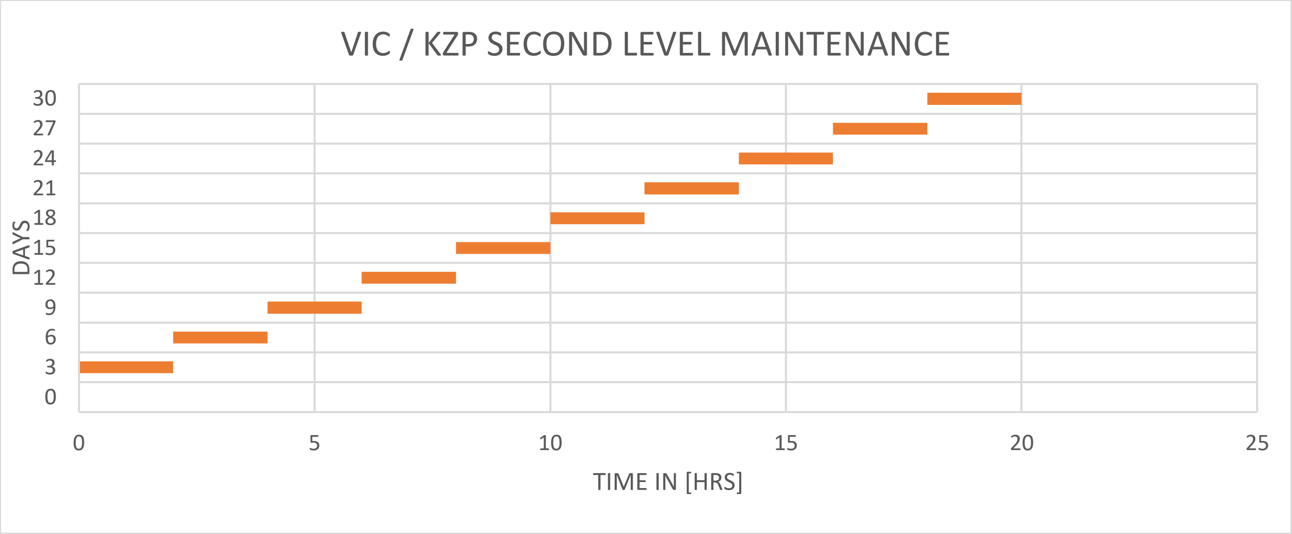
- The first level maintenance is a trip maintenance after every trip it is performed as shown in the below graph
- Here in the below graph the maintenance is schedule for one month.



Graph 14 – [Analysis on first level Maintenance graph from vikarabad /kazipet]

7.1.5 ANALYSIS ON SECOND LEVEL MAINTENANCE FROM VIKARABAD TO KAZIPET JUNCTION

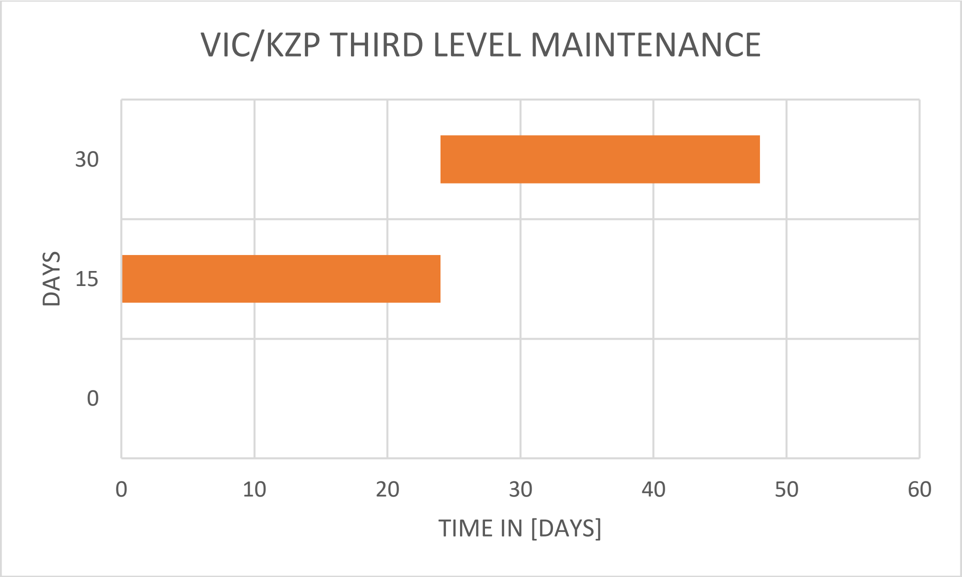
- The second level maintenance is schedule upon on the engine hours and on the kilometres that travelled by the loco
- Here It took on average three days for schedule the second level maintenance.
- The following analysis is done for one month.
- Here in the grape below we can see clearly days and time of the maintenance.



Graph 15 – [Analysis on second level Maintenance graph from vikarabad /kazipet]

7.1.6 ANALYSIS ON THIRD LEVEL MAINTENANCE FROM VIKARABAD TO KAZIPET JUNCTION

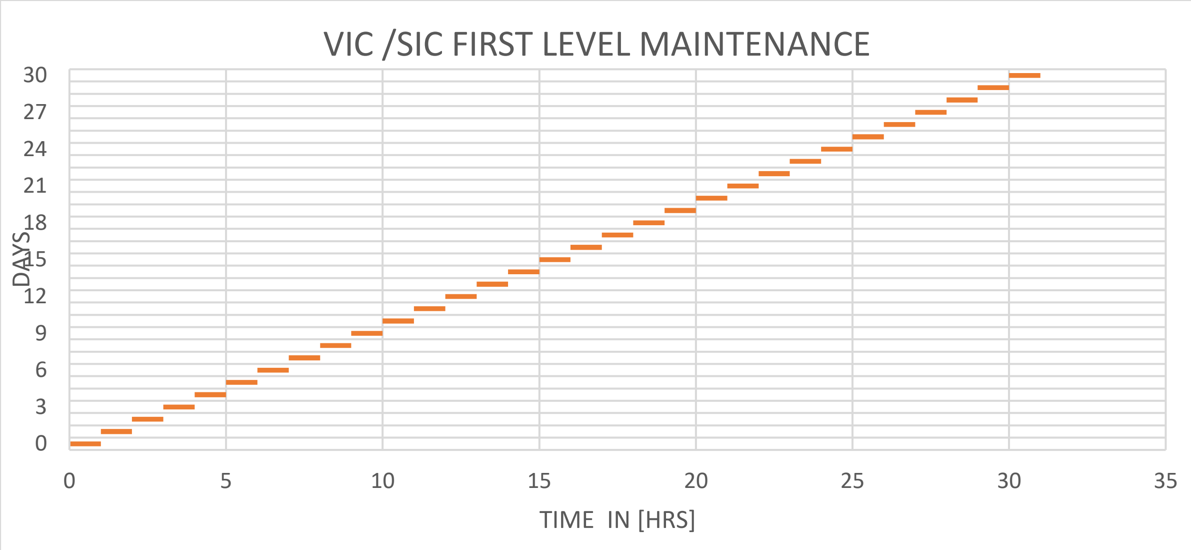
- The third level maintenance is schedule upon on the engine hours and on the kilometres that travelled by the loco
- Here It took on average fifteen days for schedule the third level maintenance.
- The following analysis is done for one month.
- Here in the grape below we can see clearly days and time of the maintenance.



Graph 16 – [Analysis on third level Maintenance graph from vikarabad /kazipet]

7.1.7 ANALYSIS ON FIRST LEVEL MAINTENANCE FROM VIKARABAD TO SECUNDERABAD JUNCTION

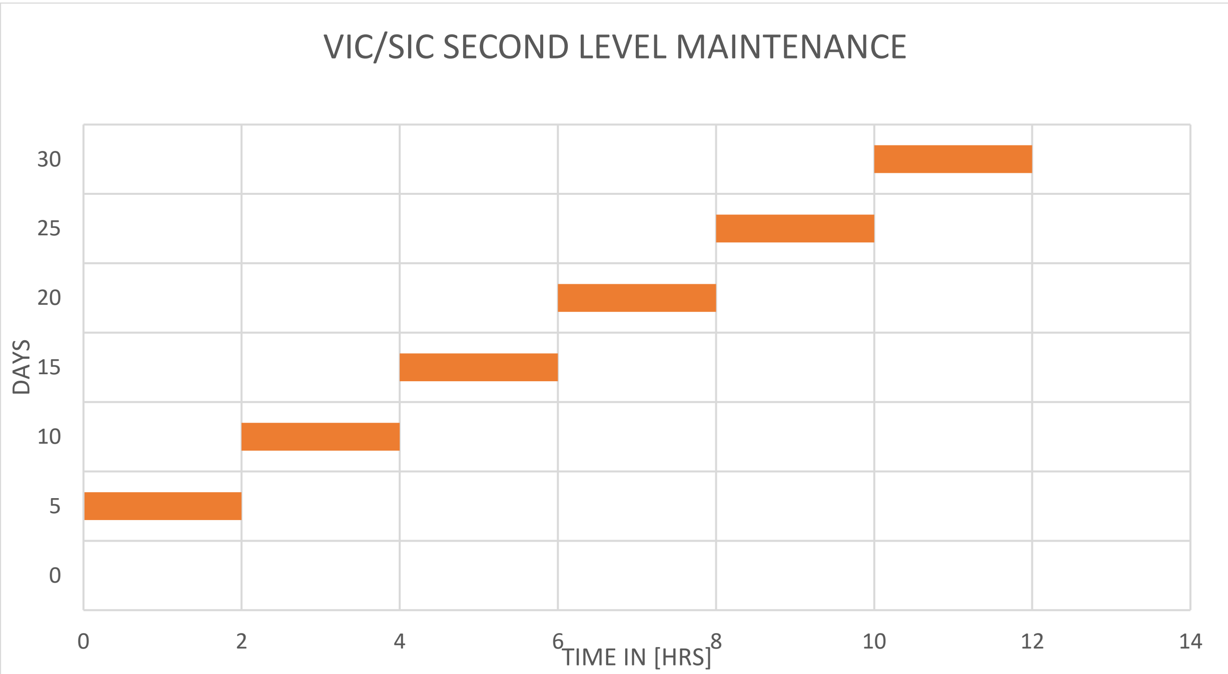
- The first level maintenance is a trip maintenance after every trip it is performed as shown in the below graph
- Here in the below graph we can see days and time and the maintenance is scheduled for one month.



Graph 17 – [Analysis on first level Maintenance graph from vikarabad /secunderabad]

7.1.8 ANALYSIS ON SECOND LEVEL MAINTENANCE FROM VIKARABAD TO SECUNDERABAD JUNCTION

- The second level maintenance is schedule upon on the engine hours and on the kilometres that travelled by the loco
- Here It took on average five days for schedule the second level maintenance.
- The following analysis is done for one month.
- Here in the grape below we can see clearly days and time of the maintenance.

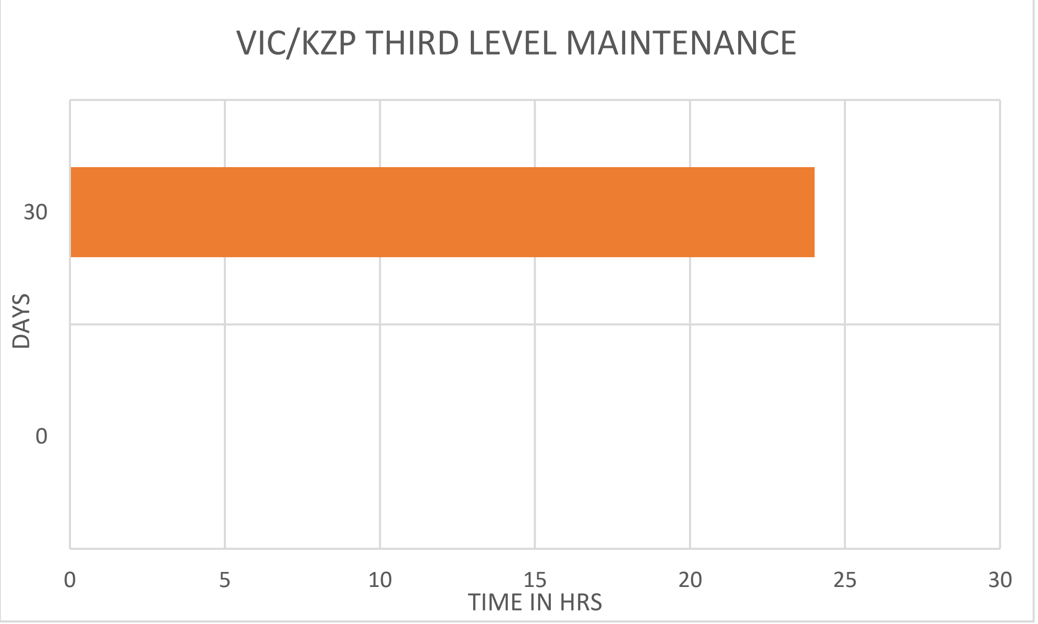


Graph 18 – [Analysis on second level Maintenance graph from vikarabad /secunderabad]

7.1.9 ANALYSIS ON THIRD LEVEL MAINTENANCE FROM VIKARABAD TO SECUNDERABAD JUNCTION

- The third level maintenance is schedule upon on the engine hours and on the kilometres that travelled by the loco

- Here It took on average 30 days for schedule the third level maintenance.
- The following analysis is done for one month.
- Here in the grape below we can see clearly days and time of the maintenance.



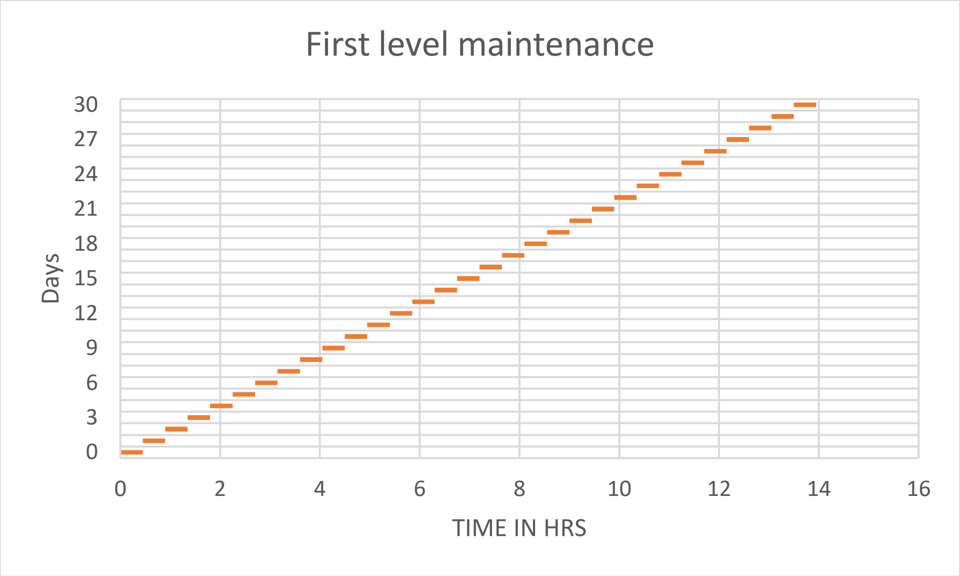
Graph 19 – [Analysis on second level Maintenance graph from vikarabad /secunderabad]

7.2 PERSONS REQUIRED IN MAINTENNACE CENTER

- For the first level of maintenance there should be 5to 6 persons are need in the maintenance shed and there should 2 technicians and 4 helpers for performing the work in the shed
- For the second level maintenance there should be 6to8 persons are need in the maintenance shed here they are 4 technicians and 4 helpers for performing the work in the shed
- For the third level maintenance there should be 8to10 persons are need in the maintenance shed here they are 5 technicians and 5 helpers and one engineer for performing the work in the shed

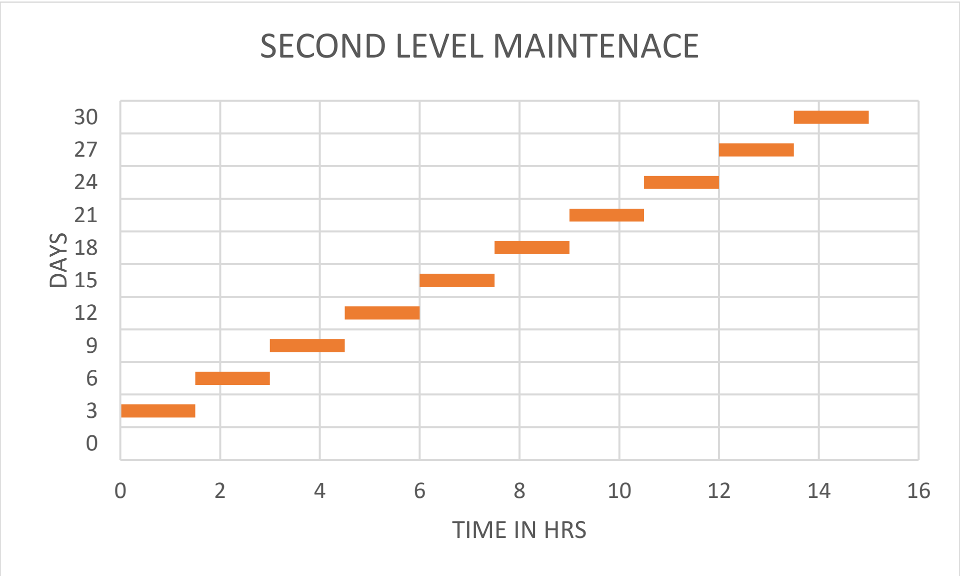
7.3 IMPROVED MAINTENANCE PROGRAMME

- Here is the new maintenance programme for the first level maintenance
- In this new maintenance programme, the time of the maintenance programme has decreased from one hour to 45 mins
- Here we can see clearly in the below graph.



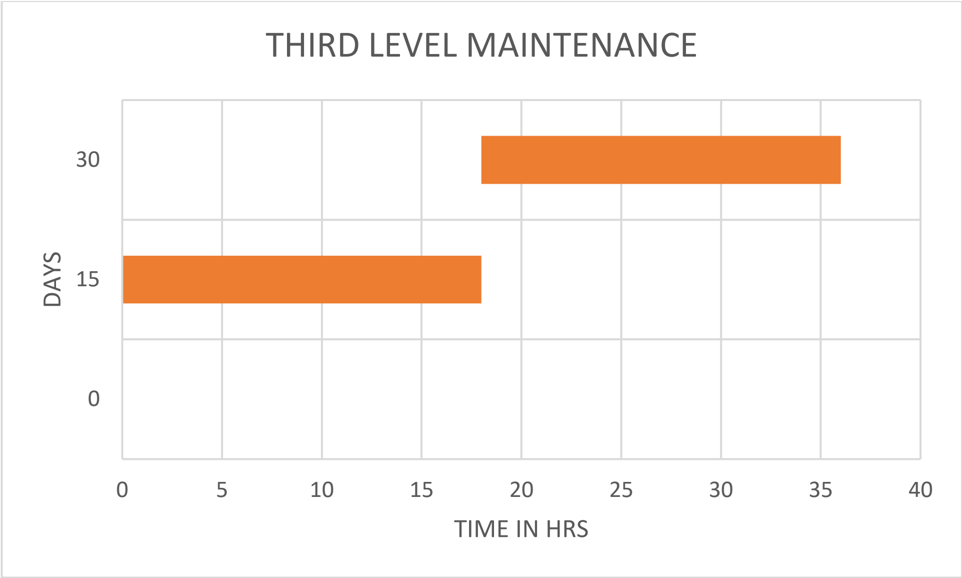
Graph 20 – [Improved first level Maintenance programme]

- Here is the new maintenance programme for the second level maintenance
- In this new maintenance programme, the time of the maintenance programme has decreased from two hour to one and half hour
- Here we can see clearly in the below graph.



Graph 21 – [Improved second level Maintenance programme]

- Here is the new maintenance programme for the third level maintenance.
- In this new maintenance programme, the time of the maintenance programme has decreased from twenty- four hour to eighteen hours.
- Here we can see clearly in the below graph.



Graph 22 –[Improved third level Maintenance programme]

Chapter-8 CONCLUSION OF THESIS

CONCLUSION:

In order to improve diesel electrical loco maintenance that by applying the predictive maintenance system to reach the new locomotive maintenance in Indian railways the following measure that should be take are

- By introducing the sensors in the diesel electrical locomotive and we will install a device that is connected to the sensors
- The sensors that should be install in the main parts of the locomotive
- The main importance part of the diesel -electrical locomotive are traction motor, air compressor, main alternator, radiator wheels rectifiers /inverters turbo charger, gear box
- After installing the sensors to the main parts of the diesel -electrical locomotive the abnormal reading of the sensor is recorded by device which is installed and connected to the sensors
- When the loco is in the maintenance shed the following technician will be collecting the data and analysing the problem by using the data that collected from device
- By using this type of technique for diesel -electrical loco we can predict the problems before and also, we can rectification the problem easy by using this system
- By this type of new maintenance, the working hours also get deceases and work accuracy also will be improved
- By using this kind of new technique, we can schedule the maintenance before and, we can also predict the problem before
- This type of technique is very effective in the all level of the maintenance systems
- By applying this predictive maintenance system, we reach the new railway maintenance service
- By above calculated graph we can see the old and new maintenance services

REFERENCES:

1. https://en.wikipedia.org/wiki/Diesel_locomotive
2. http://www.railway-technical.com/trains/rolling-stock-index-l/diesel-locomotives/
3. www.rdso.indianrailways.gov.in/.../Indian%20Railway%20Maintenance%20Manual%...
4. https://www.irfca.org/faq/faq-shed.html