भारत सरकार

GOVERNMENT OF INDIA

रेल मंत्रालय

MINISTRY OF RAILWAYS

रेलवे बोर्ड

(RAILWAY BOARD)

INDIAN RAILWAYS

MAINTENANCE MANUAL

FOR

DIESEL LOCOMOTIVES

Revised – December 2013

PREFACE

Indian Railways Maintenance Manual for Diesel Loco, popularly known as "White Manual", was published in the year 1978. However, since then a number of technological advancements such as: MBCS, MCBG, PTLOC, Moatti filters, Centrifuges, Air dryers, RSB, Mechanically bonded radiator cores, AC motors, Bag type air intake filters, upgraded compressors, Stiffer Unit Camshafts, 251 + cylinder heads, Steel cap single bolt 11.75 CR pistons, high efficiency Turbochargers, etc, have been incorporated in the diesel loco design.

New variants on WDM2 platform viz: WDM3A, WDG3A, WDM3D, WDM3F have been introduced in the last 15 years. High horse power locos viz: WDG4/4D WDP4/4B/4D, etc., based on advanced technology (AC-AC traction, Computer Controller Brakes, Microprocessor Control System) have been inducted in large numbers. One prototype WDG5 loco, upgraded version of WDG4, has also been manufactured. These HHP locos are going to be the main workhorse of Indian Railways.

Maintenance requirement of these technologically advanced locos is different from old traditional ones. At the same time number of diesel locos homed in diesel sheds has gone up manifold which requires different organization set up.

Introduction of such advanced technology diesel locos on Indian Railways over a period of time has necessitated a paradigm shift in maintenance philosophy, retaining the essence of matured knowledge gained over years.

This new look 'White Manual' shall supplement the long felt need of Transport Engineers of not only having a documented set of guidelines and instructions in consonance with the present scenario, but would also act as a harbinger in their pursuit of knowledge.

Railway Board had nominated a committee of six officers for review of "White Manual" and laid down broad objectives. The revision and updation of this manual has been done accordingly.

Though a large number of officers and staff have contributed in revision of this Manual, we would like to express our special thanks to: Shri R. Vishnoi, Sr.EDS/MP, Shri P.C. Gajbhiye, CME/SCR, Shri Anil Sharma, CME/NER, Shri S.K. Luthra, CME/NFR, Shri A.K. Tewari, DRM/ADI/WR, Shri Shubranshu, CME/IROAF, Shri Vivek Kumar, EDME/Tr. & Shri Anirudh Gautam, ED/ED(CNG) for their guidance and support in the revision of this manual.

We would also like to acknowledge the contribution of Shri Sachin Sharma, ex. DME/Tr., Shri Alok Mishra, DME/Tr. Shri S. Srinivas, Sr. DME(D)/GY/SCR, Shri G.V. Durgaprasad, Dy.CME/D/SCR, Shri T.S.N. Murthy, Dy.CME(R&L)/SCR, Shri T. Dilip, DME/D/BZA/SCR, Shri Adarsh Khare, Dy.CME/D/NER, Shri D.Saibaba, Dy.CME/D/NFR, Shri K. P. Yadav, Jt.Director/Mech/CAMTECH & Shri Sanjeev Kumar, Sr. CTA/Mech/CAMTECH in revision of this Manual.

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NOTE

1. The various stipulations, yardsticks, criteria, etc. given in this Manual are of General Nature. Changes in these may be required depending on the local conditions.

2. Various references of Railway Board's and RDSO's letters given in this manual will stand modified, as and when original issuing authorities of such letters revise them.

3. Introduction of new types of locos, modifications/upgradation in existing locos in future may require addition/deletion in this Manual. This may be done through periodic amendments/revisions, as need be.

4. In case of any contradiction in the instructions contained in this manual and those issued by Board, RDSO, contained in Code, etc, the later will prevail, till such time necessary amendment in these instructions is done.

5. This Manual should necessarily be revised after 10 years from the year of issue.

6. A separate compendium of instructions, issued till date on various subjects related to diesel loco maintenance, operation, fuelling, ARTs, etc. is being separately issued by CAMTECH. This compendium will need to be revised every six months by CAMTECH. For ensuring that CAMTECH receive the latest instructions, RDSO, Railway Board and PUs will mark copies of letters related to diesel loco maintenance, operation and related subjects to CAMTECH on regular basis.

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CORRECTION SLIPS

0.1.1 The correction slips to be issued in future for this Maintenance Manual for Diesel Locos will be numbered as follows:

0.1.2 Maintenance Manual for Diesel Locos (Revised 2013). # XX date -----------

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

CORRECTION SLIPS ISSUED

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

INDEX

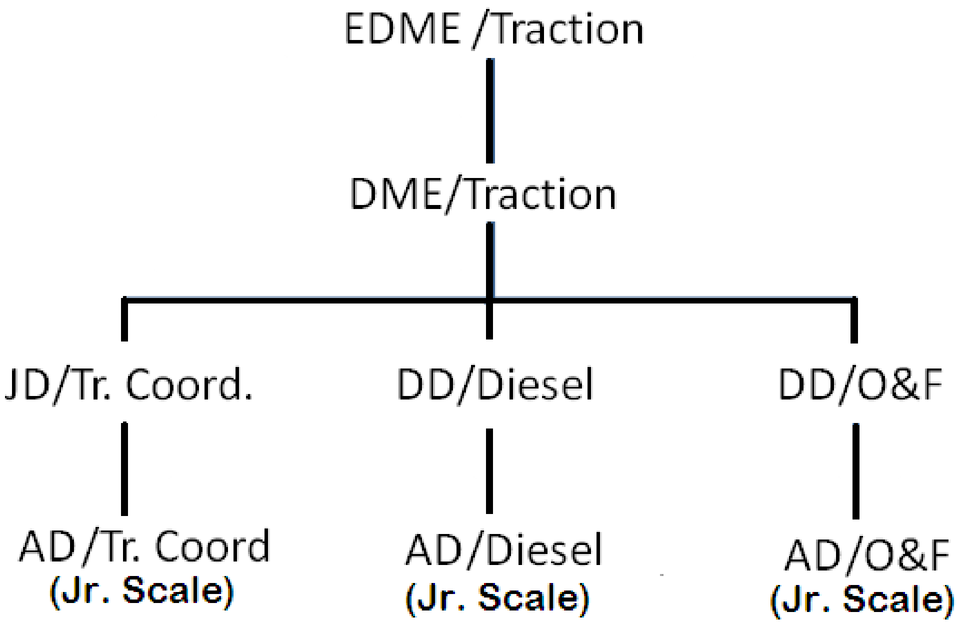
Chapter 1

Organization

1. ORGANIZATION

1. Organization

1.1 The Traction Organization of the Mechanical Directorate in the Railway Board shall be as under:



It will deal with following matters:-

1.1.1 In consultation with the Transportation Directorate draws up an integrated Motive Power programme and indicates to the Zonal Railways the schedule of acquisition of Diesel units furnishing projected holdings with accuracy over a five year time span and broadly over a corporate plan period of 15 years.

1.1.2 Allocates resources for development of maintenance facilities.

1.1.3 Defines maintenance objects in consultation with RDSO, Manufacturers and Zonal Railways. Allocates resources for development of maintenance facilities.

1.1.4 Monitors the performance of the Zonal Railways in meeting the maintenance objectives.

1.1.5 Co-ordinates such assistance as necessary between Railways, Production Units, RDSO & Manufacturers.

1.2 **Role of CME:** The General Manager of a Zonal Railway has the Chief Mechanical Engineer as the principal officer who is solely in-charge and responsible for the maintenance of Diesel Electric Locos, Multiple Units and Railcars. CME liaisons with other Heads of Department for assistance in procurement of material, operation of locos, safety, cost analysis, etc. He has an organization under him for suitably discharging the various functions related to the maintenance and operation of the diesel motive power units.

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1.3 **Principal functions of the CME**: The principal functions of CME, in this regard, are summarized below:-

1.3.1 Liaison with Board for allocation of requisite resources by way of funds, facilities, machinery and plant, managerial inputs, and spares-particularly centrally controlled items such as power packs, motorized truck assemblies, etc.

1.3.2 Liaison with other Heads of Department for obtaining necessary assistance from the various functional organization under the G M of the railway as given below

1.3.2.1 COS –Availability of diesel spares at the maintenance points of right quality and at the lowest possible cost inclusive of cost of service

1.3.2.2 FA & CAO – Continuous and concurrent cost analysis for budgetary control. Expeditious disposal of various proposals received from field units

1.3.2.3 CSC- Provision of Security of diesel maintenance sheds and diesel servicing installations stocking fuels and lubricants. However, gradually, security of such installations is being outsourced, which needs close monitoring by mechanical department, duly taking necessary inputs from CSC.

1.3.2.4 COM – Planning of maintenance and servicing facilities to suit changes in traffic pattern and volume. Effective utilization of diesel loco with suitably planned deployment of locos in various traffic streams ensuring return of locos for attention to base sheds in time, while maximizing services.

1.3.2.5 CWE-Effective support from the workshop for POH of locos with requisite quality of outturn and supply of "repair and return" materials to the maintenance sheds.

1.3.2.6 CE/CE(Con) – Effectively progress construction of new facilities and maintenance of existing facilities.

1.3.3 The CME controls and effectively deploys the Headquarters organization consisting of CMPE/Diesel, CME/O & Dy. CMEs in charge of Operations, Maintenance, Fuel & Lubricants.

1.3.3.1 The Field Executives at the base sheds and servicing installations.

1.3.3.2 The Field Executives in the operating division who are in-charge of the out-station servicing facilities, fuelling facilities, crews and utilization of locos.

1.3.4 Liaison with production units for supply of motive power units, spare parts and specialized repairs

1.3.5 Liaison with Public Sector Undertakings and Trade for repair contracts

1.3.6 Management of the engineering cadre so as to ensure that suitably trained and experienced engineers are placed in-charge of the maintenance installations. Suitable trained reserve to be built up at different levels and age groups within the cadre

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1.4 **Modus Operandi**- While no one plan will fulfill the requirement of every railway, the following system will provide a suitable frame work which can form the basis of a management procedure which will spell out the Corporate Objectives, Monitor progress, Evaluate developments and Reshape Policies, as required. The Management of diesel motive power maintenance and operation is best done through a system of periodical reviews ranging from daily position sheets to quarterly meetings between concerned officials of the railways.

1.4.1 General Manager of the Railway will conduct a quarterly review with the CME and COM which should discuss –

1.4.1.1 Changes of locos ownership type wise & shed wise, which has been planned for the intermediate and long term future. The programme of such changes should be indicated.

1.4.1.2 A broad time bound schedule for development of facilities, location, training and deployment of men for maintenance and operation.

1.4.1.3 Review of pending proposals of HQ and field units with finance, personnel and other departments.

1.4.1.4 An evaluation of the progress in meeting such objectives over the past period.

1.4.2 The CME will conduct a quarterly review with principal HQrs engineers in-charge of maintenance covering the following areas.

1.4.2.1 Personnel

1.4.2.1.1 Availability of trained supervisors, recruitment and conversion programme, refresher courses, promotional courses.

1.4.2.1.2 Availability of trained maintainers, recruitment and conversion programme, refresher courses, promotional courses.

1.4.2.2 Maintenance-Maintenance costs, an ABC analysis thereof, cost control measures.

1.4.2.3 Review of important items such as – ultrasonic examination of axles, testing of pressure vessels, progress of loco alterations, status of power units in regard to wheel profiling, wheel renewals, provision of fire extinguishers in motive power units etc.

1.4.2.4 Progress in development of new facilities, acquisition / commissioning of plant and machinery

1.4.3 The CME will conduct a monthly review with the CWE comprising of:-

1.4.3.1 POH overdues, programme and quality control.

1.4.3.2 Selected statistics of vital repair and return items from shops typically, electrical rotating equipments, trucks, wheels, etc. Such lists will be drawn by the railway to meet their own special requirements.

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1.4.3.3 Special repairs of locos such as: re-power packing, rewiring, rebuilding of accident damaged units.

1.4.4 The CME will conduct a monthly review with the principal HQ engineers in charge of maintenance covering:-

1.4.4.1 Availability of units

1.4.4.2 Compliance of schedules covering time taken, analysis of unscheduled repairs, preventive measures.

1.4.4.3 Casualties of units in traffic, preventive measures.

1.4.4.4 Status of waiting material and heavy repair locos, assistance required from Board, Production units, other Railways and Shops.

1.4.4.5 Availability of spares.

1.4.4.6 Punctuality of diesel hauled passenger services.

1.4.4.7 Consumption of lubricants.

1.4.4.8 Special developments in maintenance techniques for achieving better quality of service and reduction in downtime.

1.4.4.9 Scrutiny of the various outstanding issues listed in the monthly D.O. to be addressed by the engineer in charge of the maintenance sheds to the CME covering the topics listed above.

1.4.5 The meeting described above should include every quarter the Field Executives in charge of the maintenance sheds and back shops covering all the topics listed in the foregoing.

1.4.6 The CME will conduct a review with the Headquarter Engineers in charge of Operations, Fuel and Maintenance covering the following aspects:-

1.4.6.1 Casualties of units in traffic involving crews, progress in monitoring of crews, refresher courses, preventive measures

1.4.6.2 Trends in consumption of Fuels and lubricants – conservation measures.

1.4.6.3 Review performance of fueling points in regards to cleanliness in dispensation of fuels and lubricants, safety and security measures.

1.5 **Inspection:** The CME will have a programme of inspection of diesel motive power unit maintenance facilities and backshops so as to cover all the sheds and backshops in the system atleast once in a year. Similar inspections will be carried out by CMPE/D Dy.CME(D) HQ at a frequency of once in three months. Such inspections should include.

1.5.1 An appreciation of maintenance facilities, plant, equipment and personnel vis-à-vis present, intermediate future and long term requirements - progress of work.

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1.5.2 Evaluation of the progress of the maintenance shed in achieving targets of availability, reduction in downtime, implementation of corrective measures

1.5.3 Review of casualties of diesel units and preventive measures.

1.5.4 Progress of locos alterations

1.5.5 Spot check of quality of work particularly selected from areas where difficulties have been experienced.

1.5.6 Availability of unit exchange spares in good condition.

1.5.7 Lubricant conservation measures.

1.5.8 Inspection of shed premises to see if facilities, plant and equipment, trackage, inspection pits, lighting are maintained functional, clean and ensuring safety.

1.5.9 Functioning of the staff grievance redressal system.

1.5.10 Measures for safety of rolling stock and at workplace, Random checks on vital items such as records of bogie maintenance, wheel profiles, testing of fire extinguishers, etc.

1.5.11 Inspection of locos selected at random to monitor implementation of a particular casualty prevention measure, vital items such as: Speedometer, VCD, brakes etc. or lubricant conservation measures.

1.5.12 Records of load test of units so as to ensure that repairs have been satisfactory.

1.5.13 Inspection of heavy repair/accident damaged units so as to monitor progress.

1.5.14 Review of status of repair of major assemblies and equipment such as power packs, compressors, rotating electrical equipment, major auxiliaries, trucks, etc.

1.5.15 Availability of spares, storage conditions in stock rooms.

1.5.16 Selected shed statistics such as late starts, locos returning late for schedules, loco wise defects register, lube oil change register, spectrograph reports etc

1.5.17 Random checks on quality of repairs such as on reconditioning of cylinder heads, parts cleaning, etc.

1.5.18 Review status of outsourcing activities, maintenance of records related to execution of contracts, timely initiation of new contracts, etc.

1.5.19 Progress of RSP, M&P and Works items

1.5.20 Compliance of various statutory acts laid down by Government of India

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1.6 **Diesel Officers Organization at HQ:** Under overall charge of CME, the diesel organization at HQ, depending on holding of diesel units (including multiple units, counting each Power car as one unit), will be as under:

*Holding of Diesel Units	SAG		JAG		SS		JS	
≤200	CMPE/D	-	Dy.CME/D **P-STC	Dy.CME(O)	EME/D	EME/O	-	-
>200≤400	CMPE/D	CME/O	Dy.CME/D **P-STC	-	2- EME/D	2-EME/O	1-AEME/D	-
> 400	CMPE/D	CME/O	2-Dy.CME/D **P-STC	-	2- EME/D	2-EME/O	2-AEME/D	AEME/O

* For the purpose of deciding organization of Mechanical Officers dealing with operations (O), holding of diesel units higher of two: territorial and based on that Railway, will be considered.

**P-STC- Principal System Training Centre (explained in Ch-6 of this manual)

1.6.1 CMPE/D & CME(O)/Dy.CME(O) along-with their Dy.CMEs/EMEs/AEMEs in their respective fields will be responsible for the effective discharge of the nominated functions and will report directly to the CME.

1.6.1.1 The CMPE/D with Dy.CME(Diesel) with their officers in-charge of maintenance of units.

1.6.1.2 The CME/O/Dy.CME(O) with their officers in-charge of operation of diesel motive power units, fuel and related matters

1.7 **Functions of CMPE/D/Dy.CME(Diesel)-**Intensive utilization of costly diesel motive power units – a prime factor in obtaining the economics inherent in diesel traction, is necessarily based on high standards of maintenance. To achieve this objective, CMPE/D with Dy.CME/D/HQ will on behalf of the CME:

1.7.1 Plan the necessary maintenance facilities in coordination with the planning department of the CME's office to meet the operational needs.

1.7.2 Assist the CME to select, train and deploy experienced engineers to man the diesel maintenance facilities.

1.7.3 Assess requirements of supervisors for the railway system, plan their recruitment, training and deployment between different maintenance sheds.

1.7.4 Assess requirements of artisans and suitably monitor their availability and training.

1.7.5 Coordinate and review the annual requirements of bulk indent items and placement of demands by COS for both stock and non-stock items. As per present policy such requirements are bulked for ALCO designs of locos at DLMW/PTA and for HHP locos at DLW/BSB. Follow up with COS the procurement and availability of spares in the maintenance sheds.

1.7.6 Liaison with COS for procurement with drawings and specifications and technical consultative services

1.7.7 Oversee the spares position in the Diesel sheds with the assistance of EME(D)/HQ and assist with timely liaison with stores to prevent hold ups on shortages of spares.

1.7.8 Technical scrutiny and furnish recommendations to stores in all cases of stores procurement of spares.

1.7.9 Processing maintenance/repair/overhauling proposals of field units on trade, of items which require specialized attention or are beyond the powers of the Division or adequate manpower for the same is not available and cannot therefore be handled at the Diesel sheds.

1.7.10 Coordinate with administrative officers of other disciplines in the Railways, Production Unit, Board, Public sector and Manufacturers in regard to matters of common interests.

1.7.11 Maintain a close day to day scrutiny of availability, casualties and performance of diesel units and arrange assistance to the maintenance sheds from all sources so as to ensure the best quality of service.

1.7.12 Oversee the budget, obtain such analysis as required from Accounts and institute measures for reducing costs.

1.7.13 Liaison with RDSO

1.7.14 Provide technical guidance to the Drawings & Designs organization on the Railways to provide the Maintenance sheds, Backshops, COS with drawings, specifications, maintenance information.

1.7.15 Coordinate, analyze and develop corrective measures on the basis of the data made available to the CME through the Management Information System in vogue on the railways. One of the important functions of the CMPE/D & Dy.CME will be to refine such systems.

1.7.16 Carryout periodic field inspections of the diesel maintenance sheds so as to cover each mega shed at least once in 2 months, major once in 3 months and minor once in 4 months. (Guidance may be sought from Para 1.5.1 through 1.5.18 – a set of selected topics being taken up in each visit). However, this is the suggested periodicity and can be suitably modified according to the local conditions (number and category of sheds, whether operations are also looked after by CMPE/D or not, etc.) on Zonal Railways.

1.7.17 Suitable liaison with back shops, production units and manufactures on the feedback from the maintenance sheds so as to get a better end product and improved services. For this purpose, he will visit back shops. He will exercise technical control over Diesel Back shops.

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1.7.18 Co-ordinate with field units in processing proposals for sanction of items/assemblies/sub-assemblies/alterations in locos/replacement of old items in Rolling Stock Programme and submit to CWE, after HQ finance vetting.

1.7.19 Co-ordinate with field units in processing proposals for sanction of works and M&P required for effective maintenance of diesel units.

1.8 Functions of CME(O)/Dy.CME(O)-

1.8.1 Train Operations:

1.8.1.1 Monitor day-to-day matters pertaining to train operations concerning running staff for smooth and efficient operation of train services.

1.8.1.2 Arrange to prepare Loco links and scrutinize Crew links prepared by divisions and implement them through Power Officers of the division, coordinating with adjacent Railways.

1.8.1.3 Coordinate with the divisions for working out the requirement of running staff at each depot, Loco Pilots working hours, implementing 10-hours rule. All Power Officers in the divisions will assist him.

1.8.2 Human Resource Development:

1.8.2.1 Will be the cadre officer for all the running staff.

1.8.2.2 Oversee the six-monthly reviews made by the divisions about the requirement of running staff and process for recruitment through both lateral-induction and direct-recruitment, keeping close liaison with Personnel branch.

1.8.2.3 Organize training of running staff in initial, promotional and refresher courses, coordinating with Training Schools.

1.8.2.4 Arrange training of supervisors and running staff in Simulator.

1.8.3 HSD Installations:

1.8.3.1 Overall in-charge for maintenance of HSD Installations. Power Officers of the division will assist him.

1.8.3.2 Liaison with Railway Board, Stores branch and Oil Firms for smooth supply of Fuel Oil at every HSD Installation.

1.8.3.3 Monitor proper accountal of fuel oil, safety and security at every HSD installation.

1.8.4 Running Rooms:

1.8.4.1 Overall in-charge for maintenance of running rooms in the Railway.

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1.8.4.2 Plan for capacity expansions, depending upon the necessity.

1.8.4.3 Arrange for proper maintenance and upkeep of running rooms through Power Officers in the divisions.

1.8.5 Diesel Loco Operations:

1.8.5.1 No loco of home or foreign Railway to run overdue.

1.8.5.2 Act as a link between Diesel sheds and Operating department.

1.8.5.3 Arrange to prepare power-plan and distribute locos among diesel sheds, accordingly.

1.8.5.4 Ensure proper utilization of diesel powers to meet the requirement of Operating branch.

1.8.5.5 Ensure targeted daily outage of Diesel Locos from Sheds and their distribution over different divisions and other Railways.

1.8.5.6 Coordinate with other adjoining Railways for Diesel Operation.

1.8.5.7 Monitor daily utilization of locos and reduce detention of locos on line.

1.8.5.8 Arrange for timely servicing and scheduling of locos.

1.8.6 ARTs/ SPARTs/MRVs/SPARMVs/BD cranes:

1.8.6.1 Nodal officer and overall in-charge for maintenance of ARTs/MRVs/SPARTs/SPARMVs and BD Cranes in the Railway, keeping a close liaison with Safety Organization, Mechanical Branch and Divisions.

1.8.6.2 Plan for requirement of tools and other equipment for all the ARTs/MRVs/SPARTs/SPARMVs and BD Cranes and arrange for timely procurement. Coordinate with M&P section of CME's office for getting necessary sanctions under M&P Programme PH-41

1.8.6.3 Arrange for proper upkeep of all the equipment in the ARTs/MRVs/SPARTs/SPARMVs and BD cranes.

1.8.6.4 All the Officers of different disciplines in Mechanical department maintaining ARTs/MRVs/SPARTs/SPARMVs and BD Cranes will assist him in maintenance.

1.8.6.5 Plan for Training of supervisors and staff in maintenance and operation of equipment of ARTs/MRVs/SPARTs/SPARMVs and BD Cranes.

1.9 **Diesel maintenance organization in the CME's office:** The Diesel maintenance organization in the CME's office will basically consist of.

1.9.1 An **Information Acquisition Group (IAG)** normally under the CME(O)/Dy.CME(O) who obtains the information from all over the system and furnishes a daily report to the CME, CMPE/D, CME(O) / Dy.CME(O), Dy.CME (Diesel) listing the availability and performance of diesel units. Staffing and other details about IAG are given in **para 2.6** of Chapter 2 of this manual. While needs vary, a proforma furnished in **Annexure-1.1** will prove useful for listing out the daily position.

1.9.2 A **Technical Services Group (TSG)/(Material & Design)** consisting of an experienced engineer in JAG/SS, suitably assisted by a SS/JS engineer and an adequately staffed team of supervisors and technicians. Depending on multiplicity of diesel units this nucleus group can be suitably expanded to meet diverse needs. Duties of this TSG will cover:-

1.9.2.1 Procurement of spares, consisting of-

a) Scrutiny of all stock/non-stock recoupment memos/stocking & RSP proposals for diesel spares. Provision of drawings, wherever required, and specifications and vendors information to the Stores for aiding procurement. In this regard it is brought out that ideally all the drawings, specifications and vendors of RDSO/PUs should be utilized for procurement of material for use in Diesel units. Hence, normally there should not be any need of issue of local drawings, local specifications and locally approved vendors in Zonal Railways. Such instances should be exceptional and reasons for the same should be furnished by in-charge of TSG and approved by CMPE/D for continuing such procurement.

b) Maintain material history in a systematic manner, consisting of stocking at various field units, changes in specification over a period of time, AAC and consumption at various units, pointing out need of stocking of new items. Review of AAC of each field unit on the basis of past history and consumption in sister units, should be done once in six months, in consultation with officer in-charge of respective field unit and put up to CMPE/D for approval and onwards submission to stores department.

c) Scrutiny of all tender offers and furnishing a technical appreciation to the purchase office.

1.9.2.2 Liaison with maintenance sheds, evaluation of feedback information on performance of new design material and vendors.

1.9.2.3 Liaison with RDSO & PUs for updating information on drawings, specifications and sources of supply. For this purpose, the respective website of the PUs and RDSO should be perused by the designated person in the TSG.

1.9.2.4 Visit of each field unit by at least one supervisor of TSG, once in a month, to monitor the quality of material being supplied by various vendors and its field performance.

1.9.2.5 Carryout investigation of causes of poor performance of specific material/items and defining corrective & preventive measures.

1.9.2.6 Give regular feedback to PUs and RDSO regarding performance of material supplied by various vendors.

1.9.2.7 Keep record and follow up of warranty claims lodged by field units.

1.9.2.8 ABC analysis of costs and follow up on cost control measures.

1.9.2.9 Liaison with field units to frame the bulk indents of the railways.

1.9.2.10 Keep track of various technological developments in loco and assemblies design and maintain proper record of the same.

1.9.2.11 Keep track of various modifications in loco issued by RDSO and PUs, compile them, advised them to field units and monitor their compliance.

1.9.2.12 Process proposals for outsourcing, non-stock procurement, AMC/overhauling, RSP, Miscellaneous, etc. received from sheds.

1.9.2.13 Any other work assigned by CMPE/D.

1.9.2.14 The organization of TSG/(Materials and Designs) will consist of SSEs/JEs and technicians. The technicians will help supervisor in discharge of their duties during visit to field units, for photocopying, binding, maintaining documents, etc. SSE & JE will form a separate cadre, converted from existing drawing cadre. Technicians will come from regular cadre and will go back to parent shed after five years. The staff complement of the TSG, depending upon the holding of diesel units (including multiple units, counting each Power car as one unit) in a Zonal Railway, will be as under:-

Holding of Diesel Units	SSE	JE	Technicians
≤200	6	6	4
>200≤400	8	7	6
> 400	10	8	8

1.9.2.15 The (TSG)/(Material & Design) should be suitably equipped with advanced computer work station having latest design and drawing software, computer operated duplicating machines, photocopying machine, advanced diagnostic tools like: Vibration measuring equipment, decibel meter, infrared thermometers, thermal imaging camera, high definition digital camera, high definition video camera, measurement equipments such as digital micrometers, digital verniers, thread gauges, basic hand tools, filling cabinets and record keeping equipments, drawing storage equipment ,etc.

1.9.3 A **Quality Assurance Group (QAG)** consisting of an experienced engineer in JAG/SS suitably assisted by an experienced inspector assists the Administrative officer to provide the backup support in the following fields:-

1.9.3.1 Maintain various performance statistics related to diesel units: Outage, Ineffective, Reliability, Punctuality, Heavy Schedules, Lube Oil and Fuel Oil consumption, Scrap disposal, etc.

1.9.3.2 Analysis of casualties and follow up on casualty prevention procedures.

1.9.3.3 Co-ordination with field units for sending diesel units to shops for POH timely.

1.9.3.4 Co-ordination with Traction Directorate of Railway Board for submitting various information related to Outage, Reliability, Punctuality, allotment/transfer of locos, condemnation of locos, etc.

1.9.3.5 Carry out checking of diesel units in yard and online for assessing the safety and reliability.

1.9.3.6 Carry out Quality Audit of one major assembly and two ready locos (turned out after schedule) in each shed once in a month.

1.9.3.7 Monitor various drives: Summer, Monsoon, Winter, Special Safety and Reliability Drives.

1.9.3.8 Follow up on modification advices with assistance of TSG (Materials & Designs)

1.9.3.9 Monitor follow up of safety, occupational and environmental management in field units

1.9.3.10 Staffing of maintenance sheds – Planning & coordinating recruitment, training, refresher courses.

1.9.3.11 Dissemination of maintenance instructions, manuals etc with the assistance of TSG/ (Materials & Designs).

1.9.3.12 Any other work assigned by CMPE(D).

1.9.3.13 The organization of QAG will consist of SSEs and technicians. The technicians will help supervisor in discharge of their duties. SSEs and Technicians will be drafted from regular maintenance cadre of sheds and will be rotated after every five years. The staff complement of the QAG, depending upon the holding of diesel units (including multiple units, counting each Power car as one unit) in a Zonal Railway, will be as under:-

Holding of Diesel Units	SSE	Technicians
≤200	4	2
>200≤400	6	4
> 400	8	6

1.10 Field Organization:

1.10.1 The Field Organization on the Railways will consist of:-

1.10.1.1 The Diesel motive power maintenance sheds

1.10.1.2 The outstation fuelling and servicing/ trouble shooting points.

1.10.1.3 Operations of diesel units on the divisions

1.10.1.4 Backshops – not being covered in this manual at present.

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1.10.2 A typical Diesel Motive power maintenance shed holding 100 locos usually maintains Rs. 1200 crores worth of assets, spends annually a maintenance and lubricant budget of Rs. 16 crores and is closely linked with an annual fuel budget of over Rs. 500 crores. Owing to the high level of investment and the high cost repercussion of out of service coupled with the complexity of the equipment, maintenance activities are no longer simple servicing and breakdown repairs. The maintenance management organization in the shed has to provide a comprehensive, well organized and administered engineering service. Various technical studies undertaken by RDSO have established the need for a wider and larger engineering service. Deployment of a larger number of trained engineers with the availability of sophisticated cost and time saving diagnostic techniques is becoming a must. Managerial organization of sheds will be as under:-

1.10.2.1 In view of a large variation in sizes, Diesel Sheds are place in three categories, as under:-

- **Mega Sheds** – Holding >175 to ≤250 locos
- **Major Sheds** – Holding >100 to ≤175 locos
- **Minor Sheds** – Holding ≤100 locos

1.10.2.2 Depending on the loco holding, the following orgainsation structure at diesel shed level is proposed:-

Shed Category	Holding	JA grade officer	SS officer	JS officer	Total
Mega Shed	>175≤250	1+*1	3	6	10+*1
Major Shed	>100≤175	1	2+*1	4	7+*1
Minor Shed	≤100	1	1	2+*1	4+*1

*One Principal DTTC, as explained in Chapter 6 of this manual

1.10.2.3 Beside these officers, the following officers / subordinate staff are also required:-

Shed Type	Holding	Stores	M&C	Personnel	Finance	Engg.
Mega Shed	>175≤250	SMM	CMT	DPO	SAO	DEN
Major Shed	>100≤175	SMM/AMM	CMT/ACMT	APO	AAO	AEN
Minor Shed	≤100	AMM	ACMT	OS (P)	SO	Sup (W)

1.10.3 The diesel sheds will be independent units and will be under direct control of CME/CMPE(D), like workshops are under CME/CWE.

1.10.4 The Engineer-in-Charge of the Diesel Motive Power maintenance shed will be in overall charge of all technical and administrative matters in the shed connected with the maintenance of the stock and facilities. His activities range over "pure maintenance" with its attendant planning, operation of maintenance facilities, supervision to alterations/ modifications, and commissioning new designs and stock. The following list is illustrative:-

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1.10.4.1 Plan preventive maintenance of the stock with judicious use of regular scheduled maintenance, judiciously executed planned re-placement, and as also breakdown maintenance – replace when defective in accordance with various guidelines of RDSO/ manufacturers and the railways experience.

1.10.4.2 Execute the above plan.

1.10.4.3 Design, operate and utilize a suitable management information system (Guide lines are available in the chapter on MIS)

1.10.4.4 Frame a budget and operate within it.

1.10.4.5 Design and oversee a suitable documentation service so that the past guides the future with the help of data on identification of areas and information on the frequency of failures. Mean Time between failure (MTBF), data on rate of wear, etc.

1.10.4.6 Oversees the planning and procurement of material for which he will be assisted by a suitable stores organization under the charge of an officer, the administrative control of the stores organization will rest with the Engineer –in-charge of the shed.

1.10.5 While no single procedure of business can universally apply to all sheds and types of motive power, the following will serve as a useful guideline which may be modified by the Engineer-in-Charge as found necessary to suit local conditions. Details of the documents, proforma etc. are available in the chapter on “MIS”.

1.10.5.1 Short term:-

a) The engineers and senior supervisors of the shed review the progress in the past twenty four hours and plan the work in hand of the next twenty four hours with the help of a ‘Daily Position Sheet’. This is made available at their residences by 06.00 hrs. and has the position current upto 04.00 hrs. This paper provides information on: outage in the last 24 hrs, casualties, outturn of locos from the various repair centers inclusive of the average time taken. For planning the days work the Daily Position Sheet gives the disposition of locos at various repair centers. The early scrutiny of this position sheet permits early planning to get repairs off to a flying start.

b) A “Repair summary” of the locos that have come in the last 24 hrs with remark regarding repairs done and test results is made available a little later in the day. This permits a quick check on the efficacy of the repairs done and permits locos to be recalled or corrective measures instituted on the basis of this data.

c) A “Repeated booking register” maintained loco-wise where dates that a particular item has been booked are posted under the appropriate column is used to keep tab on the general health of the fleet and Monitor a ‘no defect’ programme. Usually 20-25 selected items are nominated for this book. A few of the items are changed from time to time as designs change or maintenance improves and attention is shifted to another area. However, now with advancements in information

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technology such booking of repeated bookings should be done directly by section in-charge through a computer provided to him.

d) The vital parameters like water level & its concentration, lube oil level (taking into account additions, if any), Traction Motor & Traction Generator Gear Case lubricant level, Suspension bearing oil level to be checked for abnormal consumption by checking the record of outgoing and incoming levels. Accordingly, investigation to be done and corrective measures taken

e) "Lube oil consumption" record is checked to identify locos requiring attention

f) "Lube oil control" record is checked for spectrograph result, TBNE, Insolubles, fuel dilution, etc which gives a fair indication of engine condition.

g) The "Loco scheduling" records provide information on planning of schedules, locating overdues and controlling maintenance attention so that optimization is achieved.

h) The "Loco Alterations" records are scrutinized to monitor progress in effecting loco alterations directed from time to time.

i) The "Water treatment" records are scrutinized to monitor that water treatment is being correctly done. Depletion in concentration and reduction in water level are used as an index of water leak and such locos are picked up for a special check.

j) The "Load Test" record of each loco passing through annual schedule is checked over to ensure correct performance.

k) Sample checks are done of the schedule forms.

l) Sample checks are done of the water treatment plants output.

m) Sample checks of fuel records

n) Regular checks of plants and equipment out of commission or awaiting installation.

o) Sample checks of quality of work at various repair centers, inclusive of night inspection

p) Scrutiny of consumption of selected items- high value – with a view to assess judicious utilization

q) Daily scrutiny of the "Casualties" register and follow up on remedial action with weekly meetings on nominated days with the maintenance team with senior supervisors and supervisors of the sections concerned involved in failures.

1.10.6 The functions and procedures for other maintenance engineers/officers of the shed are basically modeled on the lines indicated for the Engineer-in-charge in the proceeding paragraphs except that there is a greater degree of functional specification.

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1.10.7 Organization of the maintenance Sheds- Basically the organization is functional. Arrangements may vary to suit local conditions, but broadly they are grouped as under:-

1.10.7.1 Annual and above schedules

1.10.7.2 Semi-annual schedules

1.10.7.3 Monthly and quarterly schedules

1.10.7.4 Trip Schedules

1.10.7.5 Non-scheduled repair

1.10.7.6 Over hauling sections – divided into several subgroups covering: Controls, Airbrake, Fuel injection equipment, Switch gear, Governor, Auxiliary machines, Traction Generator/Alternator and Traction motors, Compressors, Tool room, Standards room for gauges and their repairs inclusive of calibration of speedometer, etc.

1.10.7.7 Trucks and chassis

1.10.7.8 Millwright (inclusive of electric equipment)

1.10.7.9 Statistics or Repair office organization who does the scheduling and maintain the register

1.10.7.10 Engine alterations

1.10.7.11 Safety and Housekeeping Services

1.10.7.12 Technical Services Group (Materials & Designs) – maintains Technical Specifications, Drawings, Other Technical Information, Updating maintenance instructions, prepare proposals, etc. This Group will maintain close liaisoning with HQ group.

1.10.8 Field Organization for Operations of Diesel Units:

1.10.8.1 The field organization of mechanical officers looking after operation of diesel units at the divisional level will be as under:

Territorial Holding of the Disel units# on the Division	JA grade officer	SS officer	JS officer	Total
>75≤150	1	1	2	4
>25≤75	1		2	3
≤25	1		1	2

#Including Goods and Coaching outage and DEMUs/SPARTs/SPARMVs

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1.10.8.2 **Functions of Sr.DME/O-** will be as under:

a) Diesel loco activities:

i. Monitor diesel operations: punctuality and engine failures
ii. Monitor movement of due/overdue schedule locos
iii. Conducting load trials to fix optimum load to avoid stallings
iv. Fixing trip rations
v. All other matters related to loco operations

b) Running staff matters:

i. Half yearly reviews of requirement of running staff
ii. Ensuring Training & Periodical Medical Examinations of running staff
iii. Filling up of the vacancies of running staff including ensuring placement of indent on RRB
iv. Drawal of crew links
v. Monitor 10 Hrs implementation duty, Computerization of crew booking and other duties connected to Running staff

c) Fuelling Points – Fuel Management:

i. Ensuring proper maintenance of fuelling equipment
ii. Availability of HSD oil, receipt, issues, consumption of HSD oil on day to day basis
iii. Accountal of GTKMs, SFC, Trip rations, fuel budget and all other matters connected to fuel

d) Lobbies

i. Computerisation of crew booking points
ii. Compliance and issue of safety instructions to be followed for running staff, supply of safety bulletins, conducting safety seminars
iii. Other activities connected to crew management like number of hours earned and KMs earned by LPs and ALPs

e) Accident Relief Trains:

i. All matters connected to maintenance and operation of ARTs including MRVs, HREs, HRDs and BD Cranes, etc.
ii. Overall in-charge for relief and restoration at accident site.

f) Running Rooms:

i. Maintenance of Running rooms as per the standards laid down by the Board
ii. The above duties are in addition to the duties on Carriage and Wagon side

Annexure-1.1

Daily Position to be put up to CMPE/D regarding Performance and Availability of Diesel Units

1. **Daily summary position:** containing shed-wise punctuality, failures, outage, both on ownership and territorial, POH summary, overdue schedule locos summary, dead locos summary, new locos, etc.

2. **Daily Punctuality and failure details:** containing details of individual cases of punctuality and failures.

3. **Daily summary of loco movement:** containing individual details of locos going from and to shops, new locos, transfer locos, position of locos in POH, dead loco movements, link casualties, etc.

4. **Daily detail accountal of diesel locos:** containing details of goods locos in passenger service, departmental, shunting and siding, etc.

5. **Daily repair position of locos:** containing status of repair of individual locos in sheds.

6. **Daily Inferior locos position:** containing details of individual inferior service locos.

7. **Daily overdue schedule locos position:** containing details of overdue schedule locos.

8. **Daily FOIS loco position-ownership:** containing summary of shed wise loco position

9. **Daily FOIS loco position-territorial:** containing summary of division wise loco position

10. **Daily position HSD oil in RCDs:** If operations are also being looked after by CMPE/D

11. **Detention of train on crew account;** If operations are also being looked after by CMPE/D

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Chapter 2

Operations Management

2. OPERATIONS MANAGEMENT

2.1 Operations Concept:

2.1.1 Diesel locos are costly assets. Therefore, it calls for a different operational concept for their management to achieve effective utilization and get the best results. An effective operations control management, loco requirement and its monitoring, crew requirement and their training are required for effective utilization of diesel locos. A diesel loco would cater to the power requirement of several divisions and even on the adjoining railways. Therefore, an effective Central Power Control Organization is required at the railway headquarter to monitor and direct the movement of diesel locos between different divisions in accordance with the requirement.

2.2 Organization – Railway Board level

2.2.1 With the increasing traffic requirement, the power requirements for each Railway need a very close scrutiny so that the allotment is made to get the best operational results, keeping in view the maintenance facilities available.

2.2.2 At the same time, as more and more diesel locos are put on the line, the workload of utilizing these costly assets for the optimum return and coordination of diesel operation between different railways would increase. Hence, there is need that Director Mechanical Engineering Traction be assisted by a Joint Director and two Dy. Directors, duly supported by three Assistant Directors. The organization chart is given in **para 1.1** of Chapter 1 of this manual.

2.2.3 This organization will be responsible for the following:

2.2.3.1 **Allotment and distribution:** The requirement of diesel locos of each railway should be examined and the allotment made according to the priorities laid down. Depending upon the traffic needs, it may also sometimes require transfer of diesel locos from one zone to another for making necessary adjustments. Development of the diesel loco maintenance facilities to meet the operational demand is also required to be planned, commensurate with the projected diesel loco holding of the Zonal Railway/Area.

2.2.3.2 **Daily Outage:** Monitor performance of different zonal railways with regard to daily availability of locos, i.e., day to day diesel outage, particularly with regard to locos of one zonal railway working on another railway, in accordance with the directives and the quota fixed from time to time.

2.2.3.3 Ensuring reliable operation of the locos by monitoring day to day punctuality of important mail/express train.

2.2.3.4 Analyzing failure of diesel locos online with regard to the reliability of their performance.

2.2.3.5 Rendering assistance of material from DLW/DLMW and other railways to reduce the ineffective period, where locos are held up for long duration.

2.2.3.6 Coordinating with RDSO/DLW/DLMW for sorting out major design/vendor related issues, affecting reliability of locos.

2.2.3.7 Utilization of locos, i.e., Engine Kms/day/ engine "In use" and ' On Line'

2.2.4 Managing various issues related to Crew / loco Management.

2.2.5 Managing various issues related to Diesel Fuel and Lubricants.

2.3 Daily Outage: The outage of diesel locos for goods traffic would be fixed on the following basis:

2.3.1 Total locos on line = N

2.3.2 Ineffective percentage = 0.10N (0.05N for HHP locos)

2.3.3 Locos in use = 0.90N (0.95N for HHP locos)

2.3.4 Mail/Express/Passenger Link=L

2.3.5 Spares for running maintenance = 10% of (0.90 N-L) (5% for HHP locos)

2.3.6 Outage =0.81N (0.9025 N for HHP locos), if L=Zero, otherwise as per the calculation

2.4 Ineffective Position:

2.4.1 Ineffective position of diesel locos on each railway would also be watched daily to maintain the maximum outage of diesel locos. If any locos are held up for long duration, necessary assistance of material from DLW or other railways would be rendered to reduce the ineffective percentage. The provision of ineffective towards maintenance is 10% for the Alco locos (consisting approx. of 5% for heavy schedules 2% for POH and 3% for corrective maintenance, waiting for material etc.), other than WDP1 & WDP3A for which ineffective prescribed is 12.5%. The same will be 5% for HHP locos (consisting approx. of 3% for heavy schedules 1% for POH and 1% for corrective maintenance, waiting for material etc.).

2.5 Zonal Railways: CME(O)/Dy.CME/O will be responsible for the following aspects of diesel operation:

2.5.1 Planning and utilization of diesel locos to meet with the requirements of passenger, goods and other services on the Railway.

2.5.2 Distribution of diesel locos between different divisions on the railway.

2.5.3 Ensure daily outage target of diesel locos from sheds and their distribution over different divisions and railways.

2.5.4 Co-ordinate with other railways for diesel operations.

2.5.5 Watch daily utilization of diesel locos on each division and other railways.

2.5.6 Reduce detentions to diesel locos on line.

2.5.7 Plan servicing and scheduling facilities for diesel locos keeping in view the operating requirements.

2.5.8 Ensure timely dispatch of locos to base sheds for undergoing prescribed maintenance schedule (locos not to run overdue schedule)

2.5.9 Ensure reliability of diesel locos in operation. Keep a check on daily position of diesel loco failures and its repercussions on punctuality of coaching and goods operation. Analyze cases of loco failures and take remedial measures.

2.5.10 Timely Movement of disabled diesel locos.

2.5.11 Induction/Promotional and Refresher Training of running staff for diesel operation.

2.5.12 Keep a check on crew link for passenger services and 10 hours duty working for goods services.

2.5.13 Provision, maintenance and operation of HSD oil installation for fueling of diesel locos.

2.5.14 Ensuring fuel economy in operation.

2.5.15 Co-ordinate, upkeep and maintenance of all ARTs/SPARTs, ARMVs/SPARMVs and Break Down Cranes available in the Zone.

2.6 Central Power Control Organization: A central Power Control Organization at the Railway Headquarters shall be provided for exercising the necessary control on diesel operation. This will be staffed by a Chief Power Controller, with two Power Controllers in each shift to function round the clock. An assistant (Group C) and a Group D staff shall also be provided in each shift to the shift Power Controllers for maintaining the various records, distributing daily position, various documents, etc. to the HQ officers. However, this scale of organization can be suitably enhanced depending on the local conditions, with the approval of CME. The Central Power Control will be responsible for:

2.6.1 Maintaining close liaison between the shed and division regarding the power distribution.

2.6.2 Monitoring availability of locos from each shed for traffic on 4-hourly basis.

2.6.3 Continuous collection of factual data of loco position on each division on 4- hourly basis.

2.6.4 Monitoring ineffective locos in sheds.

2.6.5 Watching position of locos for schedule attention.

2.6.6 Forecast of locos to be turned out from shed.

2.6.7 Keeping a watch on the movement of disabled, overdue schedule, new and locos from/to POH/Rebuilding shops.

2.6.8 Daily utilization of diesel locos on each division.

2.6.9 Monitoring of VVIP / VIP specials like MR, MOSR, GM, etc. from point of view of arrangement of diesel loco and running staff requirement.

2.6.10 Close monitoring of ART /SPART, ARMV/SPMRT & BD Cranes during accidents.

2.6.11 Monitoring of diverted trains in coordination with Zones & Divisions.

2.7 Facilities: The Central Power Control Organization should be well equipped, to enable it to discharge its function efficiently. It should have suitable and well-furnished accommodation which is free from other disturbances. The key to proper functioning of centralized power control organization is prompt and efficient communication facilities. Central Power Control Organization should be able to contact all diesel sheds, Divisional Control Organization and all the major yards directly, and if possible, simultaneously, so that instructions to all concerned can be conveyed without delay. One P&T Line, three Railway phones with STD, two CUG phones, two computers with FOIS connectivity, two printers and one photocopier should be available to enable Central Power Control to get in touch with Central Control on other Railways, other diesel sheds and individual Officers, LIs/LPs/ALPs, Supervisors, etc., to effectively monitor the loco performance and prepare various types of information required.

2.8 Maintenance Schedules:

2.8.1 Strict enforcement of maintenance schedule is one of the important responsibility of the Central Power Control Organization. If the locos are not attended for schedule maintenance in time, it would not only affect its reliability but would also cause serious setback to the maintenance as well as availability of diesel locos. The uneven flow of locos will result in shed capacity going underutilized during lean period and locos waiting for repairs when there is bunching of locos.

2.8.2 As a rule, the loco should not be booked to work trains after the due date except with the specific permission of the Dy. CME (Diesel) or the Engineer-in-charge of the shed.

2.8.3 The Central Power Control should therefore prepare a list of diesel locos which are due for schedule attention four days in advance and relay these numbers to the divisions on which the locos are working on that day so that they can be booked on trains working towards the home shed and reach in time for undergoing schedule attention.

2.9 Operations

2.9.1 **Passenger services:**

2.9.1.1 Allotment of diesel locos for passenger services is made on the basis of loco links. Loco links for working passenger services should be so framed as to get the maximum advantage of extended runs by providing fuelling facilities and change of crews en-route.

2.9.1.2 **Loco Link:** Loco link is an arrangement of loco for working a set of trains from one station to another for Mail/Express/Passenger trains. Loco link gives the requirement of locos required to run the given number of trains. Loco link is prepared by HQ office in consultation with COM**.** Factors to be considered while preparing a loco link: 1) Availability of the Locos 2) Trip Inspection (Mail/Express /Passenger locos are required to be given trip inspection within the link) 3) Lie over period at destination station: When a loco completes its journey after working a train, this loco is sent to yard, trip shed etc. This loco is again attached to the train as per the link. The period for which it remains idle at destination station (i.e. the time period when loco is detached and again attached to train) is known as lie over period of the loco. This time should be adequate to take care of the types of attention required to be given to loco 4) Total Kms earned during trip should normally not exceed 5000 Kms. 5) Fueling locations.

2.9.1.3 For every 30 locos in link, an additional overlapping loco shall be provided to cater for higher schedules (as per Railway Board's letter no. 2006/TT-IV/9/3 dated 2nd Nov'06).

2.9.2 Goods operation:

2.9.2.1 The allotment of diesel loco for each division is worked out on the basis of number of through goods trains to be run daily on different sections. The number of diesel locos required for working the planned number of trains is arrived at on the basis of target of loco Kms per day per loco in use. Normally, utilization of 500 Km on BG double-line and 400 km on BG single – line per day per loco can be adopted. The actual targets should be fixed by each Railway taking into consideration the operating conditions prevailing on that Railway.

2.9.2.2 To get the best results, all diesel loco operating goods trains should be run on fixed paths. This system is also helpful in forecasting the number of locos which are likely to be available at terminals or the interchange points

2.9.2.3 The movement of each diesel loco in 24 hours should be monitored and plotted on a chart having hourly divisions. Locos working passenger and goods services should be plotted in different colors. The detention to locos in yards can also be shown in a distinct manner for clearly bringing out the utilization of the locos. Similarly, the idle time when a loco is waiting in the yard for load can be shown in a different manner

2.10 Crew Management

2.10.1 Training of Crew:

2.10.1.1 Induction/Promotional training of crews for diesel operation and conducting refresher courses for the running staff should be organized by the Headquarters Office at the various Diesel Technical Training Centers on the Railway. A competency certificate must be issued to the running staff after they have been trained and qualified for operating each type of diesel loco.

2.10.1.2 In addition, special courses for diesel operation shall also be organized for the Trainers and Loco Inspectors.

2.10.1.3 Details of training content and periodicity for promotional and refresher courses for LIs, LPs, Shunters and ALPs prescribed by Railway Board are given at **Annexure-2.1**.

2.10.1.4 After completion of training of particular(s) types of diesel unit(s) by running staff, endorsement of that diesel unit(s) should be made in their competency certificate.

2.10.1.5 After a Loco Pilot/ Shunter/ Assistant Loco Pilot has done the basic course of a diesel electric unit, he can be retrained for Diesel Electric Multiple Unit/ Diesel Hydraulic Multiple Unit with a short 3 week familiarization course. Such courses should include 1 week of handling/on line training with Loco Inspector.

2.10.1.6 In the event of a Loco Pilot / Shunter not having handled a particular type of unit for which he had been trained for a period of more than 6 months, he should be given 3 trips of handling with Loco Inspector. In the event of the period exceeding 18 months, the 3 week familiarization course as mentioned in **para 2.10.1.5** should be repeated.

2.10.1.7 **Road Learning Training**:

(i) Road Learning training is given to running staff to make themselves conversant with signal locations and other operating conditions. This training is essential before a LP or ALP is booked to work the train independently in section. During the Road Learning period, LP/ALPs travel in the section on loco and make themselves aware with the following aspects of train working:

a) Locations of signal at each station of the section.
b) Idea of visibility of signals of each station.
c) Intermediate block signaling in section.
d) Automatic and semi-automatic signals.
e) Location of spring points in section.
f) Approximate idea of gradient of the section and ruling gradient.
g) Siding at various places in section where goods train are placed or removed.
h) Locations of Permanent speed restriction in section.
i) Maximum load allowed in section with single and multiple locos.
j) Banking section where banker is provided to avoid stalling of the train.
k) Maximum permissible and booked speed of the train in section.
l) Idea of capacity of loop lines at various stations.
m) Idea of running time in section.
n) Restriction of not stopping the good trains at certain stations or signals
o) Knowledge of WTT
p) Knowledge of approximate trip rations for different locos and loads.

(ii) Every new LP should be given three trips, including one night trip between 20:00 hrs. to 06:00 hrs. This scale of trips would apply to all systems of working, including sections having one train only system of working. During road learning crew should sign ON & OFF, like working crew.

(iii) After completion of Road Learning, LP/ALP should submit the diary indicating the Road Learning taken by them. During the Road Learning training, they should obtain the signature of the LP of the train by which they traveled during their Road Learning training. In addition to above, the depot in-charge should also interview the crew of his depot, to judge the knowledge gained during Road Learning. If the performance is unsatisfactory, the Road Learning period can be extended suitably with knowledge of branch officer.

(iv) After the road learning training, the candidate should give a declaration as per the format given as under:-

FORMAT

"I hereby declare that I have taken Road Learning in following section.

S.No.	Section	Date of learning	No. of trips	From	To
1.					
2.					
3.					
4.					

Now, I am fully familiar with the requirements for safe and efficient diesel operations in the aforesaid sections.

Signature:________________________

Name:___________________________

Design:___________________________

Date:_____________________________

(v) If the candidate is not confident of Road Learning, in the prescribed period, he may ask for an extension of road learning period to his depot in-charge. On getting such request, Road Learning period shall be suitably extended.

(vi) A register should be maintained at crew booking point indicating the Road Learning validity of LP/ALPs. Before a LP/ ALP is allowed to work the train, a declaration should be obtained that he has taken the Road Learning of the section and he is fully familiar to work the train in the section.

(vii) If a LP/ALP has not operated on a section for over three months, he should be given Road Learning trips as per schedule given below:-

Absence of	Number of Trips
3 to 6 months	One trip
6 months to two years	Two trips
Absence of over 2 years.	Three trips (as given to new entrants)

(viii) More over the depot in-charge should keep watch on the trips performed by a particular crew so that if any crew has not operated in a particular section for about two or two and half months, such crew should be identified immediately and booked to such section. This will avoid expiry of Road Learning of the crew.

2.10.1.8 **Training as Co-LP**:- It is normally a good practice to allow the newly promoted LP to work as Co-LP for a month along with the experienced goods LP. This helps to get the feel of driving and absorbing the driving technique by newly promoted candidate and clarify his doubts. During this period of working as a Co-LP, the nominated loco inspector keeps a watch on the performance of the LP, guides and counsels him suitably.

2.10.2 **System of monitoring and counseling of running staff:-** The working of running staff needs to be continuously monitored to ensure safe train operation. The running staff, i.e., LPs / ALPs belong to a category of staff who are not available at a time on a given workplace. In other types of working, like workshops and sheds, the work place of the staff is definite and therefore, any instruction can be given to the staff in a planned manner. On the contrary, the running staff, moves from one place to another and working is round the clock, with no fixed period of duty and rest. Therefore, giving instructions, counseling and taking the feedback on their working becomes very difficult and cumbersome. Running staff either remains on line or takes rest in running room / at their HQ station. Therefore, they can be counseled / monitored only when they come for duty at the time of sign on and also during their journey by way of foot plate inspection. The system is as under:

2.10.2.1 **Categorization of LPs:** On the basis of monitoring done by LI of their nominated LPs, they will be assigned/reviewed Categories :A, B, C & D, as per Board's guidelines contained in letter no. 97/Safety-I/23/15 dated 29/03/2007.

2.10.2.2 **Monitoring and counseling by Loco Inspector:**

a) Division has certain number of loco inspectors. Each loco inspector should be allotted 15 LPs. These nominated LPs are monitored and counseled by loco inspector during their foot plate inspection and their visit to lobbies. The periodicity of monitoring of the LP as per their category is: 'A' are once in 2 months, 'B' once in a month and 'C' once in a fortnight by their nominated loco inspector. Monitoring should include both up and down directions, all sections, as per crew beat, in night also and for all types of stock.

b) It has become important to formally monitor Shunters and ALPs as they also play an important part in ensuring safe train operations. Hence, one LI should be nominated to monitor 45 shunters or 45 ALPs. These Shunters and ALPs should be monitored, at least once in 3 months. No categorization of Shunters/ALPs is considered necessary.

c) One LI can be assigned mix of LPs/Shunters/ALPs, keeping the overall workload same e.g. 3 Shunters/ALPs can be assigned to a LI, in place of one LP. So, LIs can be assigned: 15 LPs or 45 Shunters or 45 ALPs or 10 LPs + 15 Shunters/ALPs or 10 LPs + 6 Shunters + 9 ALPs, etc.

d) Loco inspector should submit reports to Sr.DME (Power) once in a fortnight. This report would include the performance of their nominated LPs/Shunters/ALPs in respect of technical knowledge, driving techniques (as applicable), safety awareness and traffic rules. The ones found lacking in knowledge during such inspection are to be given special training in his area(s) of weaknesses so that their performance can be brought upto the mark. Such training is imparted in Diesel Technical Training Center (DTTC) of division which is generally headed by a Sr. Loco Inspector (Training). All new Goods LPs should be treated as 'C' category, for first 4 months.

e) On receipt of the report from loco inspector, the frequency of monitoring done by these inspectors are compiled and it is seen whether any LP/Shunter/ALP is overdue for monitoring by loco inspector or not. If any LP/Shunter/ALP is found overdue for monitoring, the nominated inspector is questioned.

2.10.2.3 **Special training to 'C' category and weak LPs (including Shunters and ALPs):** There are some LPs in division who lack in one field or other of train operations and driving techniques. Such LPs should be identified and their weak area like traffic rule knowledge, trouble shooting technique etc. identified with the help of their nominated loco inspector and suitable training of one or two weeks need to be planned to upgrade their knowledge and driving skill. A special watch is required to be kept on the LPs classified as 'C' category.

2.10.2.4 **Watch on the accident prone and alcoholic LPs (including Shunters and ALPs):** (1) List of alcoholic LPs and (2) list of accident prone LPs shall be maintained in each lobby. The LPs are included in this list based on the monitoring reports received from loco inspectors. Accident prone LPs will require frequent monitoring and counseling regarding safety rules and correct method of working in some risky situations. Similarly, more ambush checks are required to be done on alcoholic LPs to find out whether the condition of LP is sober or not.

2.10.2.5 **Visit of running staff to Trip Shed / Diesel Loco Shed:** Loco inspectors should take their nominated LPs, who are found weak in awareness about loco trouble shooting, for training in loco shed or trip shed for practical demonstration of trouble shooting to improve their skill.

2.10.3 Regular issue of Safety Circulars, General Instructions, Safety Camp and Meetings:

2.10.3.1 **Safety Circulars & Technical Instructions:** The safety branch regularly issues the safety circulars indicating the salient features of train operation. This safety circular also highlights the recent unusual/accidents which have taken place due to human failures. Running staff should go through these safety circulars and note the contents of the safety circulars for strict compliance. Similarly, executive branch i.e. mechanical branch, issues the instructions which are mainly technical in nature. This is done to upgrade the knowledge of running staff, make them aware of the recent developments taking place in technical upgradation of loco and rolling stock. These safety circulars and general instructions to running staff are kept in specific folders at crew booking point where the LPs/ALPs sign on and sign off. At the time of signing on, the running

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staff shall go through these important instructions, make themselves aware and acknowledge the same.

2.10.3.2 **Issue of Monthly Bulletin:** Divisions issue monthly bulletins to the LPs. These monthly bulletins highlight the important points of train operation to be followed by running staff. At the same time, case studies of recent failures are also written in simple language with the advice to running staff to follow the correct procedure to avoid recurrence of such mistakes. These monthly bulletins should be circulated to all running staff, even individual copies given to all, if required, duly taking acknowledgement.

2.10.3.3 **Safety Camps:** Safety camps are held at various places in division at an interval of a week's time. These safety camps are organized by safety branch in which experienced safety counselors are associated. In these safety camps, the running staff assemble at a given station and they are counseled on important aspects of train working. These aspects of train working are explained in simple and interesting manner by having man to man contact. Any doubt during such safety camps is clarified and even practical demonstration is arranged. Full use of these safety camps should be ensured for the benefit of the running staff.

2.10.3.4 **Safety Meetings.** It shall be held by lobby in-charge atleast twice a month. In these safety meetings, safety circulars, general instructions, issued during the month are read and the same is explained to each and every staff of the depot.

2.10.4 **Crew Booking Lobby:** The crew change point is provided in the division keeping in view the duty hours of the LPs. There are stations where only goods LPs are changed whereas at some stations coaching as well as goods LPs are also changed. Each crew booking lobby is manned by a Crew Booking Shunter who is a member of running staff. In addition to Crew Booking Shunter, each crew booking lobby can have an indoor and outdoor Shunters depending on the workload. The crew booking points may have a Chief Crew Controller/crew controller in the lobby who is in charge of the crew booking point. Support staff in the lobby for calling the LPs/ALPs, entering CTRs into computer, other data entry, etc. will be provided as per the local conditions and workload. Records to be maintained and information to be displayed at Crew Booking Lobby & its facilities are given at **Annexures 2.2, 2.3 & 2.4**.

2.10.4.1 **Crew Booking Lobby Working System:** The Crew Booking Shunter gets the Train Notice containing the information of expected arrival of train, loco number, and train number. As per the availability of crew, Crew Booking Shunter sends the call to the LP and ALP, about two hours in advance of the time of expected arrival of the train, mentioning the required reporting time. Whenever the LP comes for sign ON or sign OFF, Crew Booking Shunter ensures that the same is done properly. The brief description of duties of the Crew Booking Shunter is given as under :-

a) To maintain the sign ON/OFF register properly.

b) To ensure B.A. (Breath Analyser) test of crew at the time of signing ON / Signing OFF

c) To call the crew for the train as per Train Notice given by traffic department.

d) To maintain the book of availability of LP upto date.

e) To maintain the training particulars (Technical/G&SR), PME & LR particulars of the crew.

f) To have close liaison with the crew controller in control office for balancing the LPs from one depot to another.

g) To ensure timely loading/unloading of LPs' line boxes containing their personal stores.

h) Strive to achieve 104 hrs. of progressive duty in a FN for each LP/ALP, without causing any Breach of his Rest

i) Providing prescribed Periodic Rest every month to running staff

j) Strive for reducing both Pre-Departure Detention and Post Arrival Detention of crew.

2.10.4.2 **Personal Stores of LP and ALP:** LP is the only person available on a train who is technically more competent than the other Railway staff like T.T.E, conductor, guard etc. present on the train. Therefore, LP of the train is provided with certain important tools so that the minor trouble in loco, coaches or wagons can be attended to and section can be cleared without undue detention to the train. Prescribed items of the LPs are given at **Annexure 2.5**. This is given to each LP as personal store. In addition to LP, three items required for train operations are also given to ALP, which is also issued to each ALP as personal store. List of these items is also given at **Annexure 2.5****.**

2.10.4.3 **Method of issue of personal stores to LPs and ALPs:** As soon as the staff is promoted as LP (or inducted as ALP), he is given required training and issued with personal store as mentioned in para 2.10.4.2 above by the depot in-charge. The concerned depot in-charge maintains a register wherein details for issue of personal store to LP/ALP, along with his signature, is recorded. Whenever a LP/ALP is transferred or retires, the personal stores is taken back and kept in store for issue to other LPs/ALPs. Whenever a LP/ALP is on duty, the personal stores shall be kept by the LP/ALP. This personal store of LP is kept in a box called line box, while ALP keeps his stores in his personal bag.

2.10.4.4 **Periodical Medical Examination (PME) of running staff:** Medical examination of running staff is very important for ensuring the safety of train operation. Railway Board vide letter No. 88/H/5/12 dated 24.1.1993 have given the guidelines for medical examination. A thorough and stringent Medical Examination, including X-ray (Chest), ECG, Urine Examination. Blood sugar Estimation, or any other investigation/observation as deemed fit by the medical examiner is to be done keeping in mind the following conditions: Hypertension, Diabetes Ischemic Heart disease, Hearing, Mental condition / Reactions of the candidates, Visual Ability as per instructions laid down in medical manual from time to time. No running staff should remain overdue PME.

2.10.4.5 **Technical and G&SR refresher:** No running staff should remain overdue technical and G&SR refresher course.

2.10.4.6 **Issue of competency certificate to running staff:** Whenever the running staff passes the training course along with necessary handling and Road Learning training, a competency certificate is issued to authorize to carry out the work for which he is trained and found fit after examination by concerned training centre and same to be certified by divisional Power Officer.

2.10.5 **Duty Hours of Running Staff:** It is very essential to know the duty hours of running staff for their efficient management. Similarly, the allowance paid to running staff are different than that of other category of staff. Therefore, it is necessary to understand the type of allowances paid to running staff for better management. The running staff are classified as continuous. The duty hours for running staff is counted from sign ON to sign OFF. The duty hours for the running staff are: Max. Hrs to be utilized = 104 hours in a fortnight. Normally, running staff are not put on duty for more than 10 hrs at a stretch. They can claim rest after performing 12 hours duty provided they have given 2 hours notice.

2.10.5.1 **Rest to Running Staff**

a. **Periodic Rest:** No. of periodic rest in a month = 4 rests of 30 hrs each or 5 rests of 22 hrs each, including a night in bed. This rest should normally be given in a week.

b. **HQ rest:** For duty less than 8 hours = 12 hours rest. For duty more than 8 hours = 16 hours rest.

c. **Outstation rest:** For duty hrs of 8 hrs or more = 8 hrs. rest. For duty hrs. less than 8 hrs. = rest equal to number of hours of duty. However, in this regard it is mentioned that in HOER, there is no mention of outstation rest to be given for duty less than 8 hours. However, for duty hours less than eight, as a convention many Railways are giving rest equal to number of duty hours performed. While giving the HQ or outstation rest as above, 2 hrs call time is also included.

d. **Night Duty:** Running staff should not perform night duty for more than 6 consecutive nights. However, it is preferable if it is restricted to 3 consecutive nights only.

e. **Period outside HQ:** They should not be out of headquarters for more than 72 hours continuously. However, it is preferable if it is restricted to 48 hours only.

2.10.5.2 **Ten-Hours Duty:** Implementation of 10 hour duty of running staff is one of the important functions of Divisional Power Control Organization. A special duty Inspector for the Central Organization and one on each division is required to keep a check on this aspect. Duty hours put in by the running staff should be maintained for each section with complete break-up of pre-departure detention, hours on road, post arrival detention so that the cases of over 10 hours duty could be analyzed and suitable remedial measures taken.

2.10.5.3 **Pre-departure detention of the crew:** The time period from the sign on of crew to actual departure of the train is known as pre-departure detention of the crew. To illustrate this, let us assume that crew of the train has signed on at 8.00 hrs and the actual departure of the train could take place at 10.30 hrs due to line clear etc. therefore in this case pre-departure detention of the crew will be 10.30 – 8.00 = 2'30". PDD should not increase more than 30 minutes by proper coordination between Power and Operating Deptt. It is essential to mention that higher the pre-departure detention, more will be the bursting of ten hours duty cases and requirement of running staff. Therefore, division should make all out efforts to minimize the pre-departure detention of crew.

2.10.5.4 **Post Arrival Detention:** This is the time which the crew takes after arrival of train to sign off at destination/crew change point station. This time is generally 30". However, if the arrival point of goods train is far away from the crew booking lobby, the crew may take more time to come to lobby to sign off.

2.10.5.5 **Time for Crew Change:** LP should be given at least 20" for ensuring proper checking of the loco at crew changing points.

2.10.6 **Running allowances for running staff:** Running staff are paid running allowance instead of TA. Certain percentage of the running allowance is taken into account as pay for fixation of pension, leave salary, etc.

2.11 **Crew Link:** Crew link is prepared for ensuring proper utilization of running staff and for calculating the requirement of LPs/ALPs for running mail/express/passenger trains on a division. Factors to be considered while preparing crew link:

2.11.1 **Running time between two crew change points:** While deciding the crew change point for Mail/Express/Passenger train, it is planned that the running time between two crew change point should not exceed 8 hours, as far as possible. Therefore, while making the crew link, this point should be taken into account and crew change point should be decided accordingly. Provision of running room at crew change point is essential so that LPs signing off at crew change point may take rest properly.

2.11.2 Ensuring prescribed HQ rest, outstation rest and periodic rest.

2.11.3 Excessive detention of LP/ALP in outstation running room should also be avoided.

2.11.4 **Duty hours in a fortnight:** Crew link should be made in such a way that LP/ALP is utilized for not more than 104 hours in a fortnight. Moreover, link should not be slack so that LP/ALP remains underutilized. Therefore, based on the time table timings, efforts should be made to optimize the use of LP/ALP.

2.11.5 **Procedure for making a Crew Link:**

2.11.5.1 Working time table (WTT): First of all, the arrival and departure timing of all the Mail/Express and Passenger trains at crew change points should be noted down for which crew link is to be made.

2.11.5.2 LP signs on about 30” before the arrival / departure of the train to go through SOB and safety literature etc. Similarly, LP takes about 30” to sign off after arrival of the train for completing the work of Handing over the loco and repeating the punctuality position of train, unusual and S&T defects to Power Controller. Therefore, this one hour time should be taken into account while calculating the duty hours of LP.

2.11.6 **Calculation of sanctioned strength of LPs and ALPs** : The procedure of calculation of the sanctioned strength of LPs is as under (Note: Number of ALPs required will be same as LPs, duly adding requirement of shunters):

Average Fortnightly performing hours of Last 6 months (used only for working goods trains) =	A	--
Required Fortnightly working hours per goods LP (104) =	B	
Bare requirement of goods LP =	C1	=A/B
Requirement of LP as per crew link=	C2	
Total requirement of LPs=	C	C1+C2
Additional req. due to traffic fluctuation @ 10%	D	=0.10XC
Revised Bare requirement =	E	=C+D
Leave Reserve @ 30% on bare req. =	F	=0.3XC
Revised bare req. + Leave Reserve =	G	=E+F
Trainee Reserve (TR) @ T% on G =	H	=G*T/100
Total Crew requirement =	I	=G+H

Note: 1. 30% LR and 10% Trainee reserve should be provided for LP(M/E & Pass) in the category of LP (Pass) only.

2. Requirement of LIs should be worked out @ one LI for each 15 LPs, one LI for each 45 shunters and one LI for each 45 ALPs.
3. As per Rly.Board’s letter No.2001/M(L)/467/2 dated 12.11.2012, selection of CCCs & CPRCs is to be done amongst LIs, on tenure basis by a screening process. Hence, this additional requirement of LIs is to be added to the number worked out for monitoring of LPs/Shunters/ALPs.
4. Apart from this requirement of LIs for major activities like Safety Counselors, Fuelling, Lobbies, Running Rooms, Speedometers, Maintenance, etc., as brought out in Rly.Board’s letter No.82/M(L)/467/2 dated 26.09.1991 should also be added to the number worked out for monitoring of LPs/Shunters/ALPs.
5. Requirement of LIs, including 12.5% LR, should be added in the category of LP (Passenger) only.
6. **Calculation of Requirement of Shunters:**
   a. The bare requirement of shunters should be worked out based on the activity-wise workload in 8 hours shift (it should include requirement of shunters in diesel sheds.
   b. 30% LR should be provided on bare requirement.
   c. Detailed justification together with activity-wise, shift-wise calculations should form part of the proposal.
   d. The requirement so worked out should be added to ALP requirement.

2.11.7 **Running Rooms:** It is of utmost importance that train crew get quality rest in running room. So, divisions should ensure that running rooms are maintained as per various guidelines issued by Board. Running Room Committees should regularly visit the running rooms and take corrective measures to put right deficiencies noticed, if any, on priority.

2.12 Diesel Operation Organization on the Divisions:

2.12.1 Every division may not have a diesel shed located in its jurisdiction, but the division is responsible for the operation of diesel locos working under its jurisdiction. On the division, the diesel operation is to be looked after by the Sr.DME(P). Fuelling Installations provided on the divisions for fuelling of locos are also under the charge of Sr.DME(P). Considering the cost of fuel stocks and fuel issues being made by each fuelling point, locally the fuel installations shall be under the charge of a dedicated Supervisor.

2.12.2 **Divisional Power Control Organization:** A Power Control Organization at the Division shall be provided for exercising the necessary control on diesel operation. This will be staffed by a Chief Power Controller, with two Power Controllers in each shift to function round the clock. An assistant (Group C) and a Group D staff shall also be provided in each shift to the shift Power Controllers for maintaining the various records, distributing daily position, various documents, etc. to the divisional officers. However, this scale of organization can be suitably enhanced depending on the local conditions, with the approval of CME. This Cell shall be responsible for the following:

2.12.2.1 **Diesel outage and availability:** It will be the responsibility of the Diesel Power Controller on the division to make diesel locos available in time according to the outage quota and the forecast of goods trains. The daily outage would be worked out by taking the average of the number of locos available on 4 hour basis.

2.12.2.2 **Utilization:** To achieve the optimum utilization, record of every diesel loco in use shall be maintained section wise and its movement plotted on a graph every hour indicating in different columns the hours spent as train engine, yard detentions, light running, etc. These charts would be analyzed daily to work out the:

(a) Section-wise locos on line (*)
(b) Kms per day per loco in use- separately for each class of diesel loco.(**)
(*) The total number of engines on a section will be worked out by dividing the total hours of all locos, including idle hours, by 24.
(**) Total Kms earned by all locos of one class/ Total No. of that class of locos in use.

2.12.2.3 **Crews:** Each division shall have sufficient number of crews trained in diesel operation, posted at crew changing points. Crew should be called according to the forecast of goods trains arranged. Their duty hours should be watched closely and, if necessary, arrangements for their relief made at intermediate stations.

2.12.3 The Divisional Power Control Organization should be well equipped and provided with suitable accommodation to ensure un-disturbed working. There should be effective communication and document preparation facilities: one P&T phone, two Railway phones with STD, two CUG phones, two computers with FOIS connectivity, two printers and one photocopier should be available with the Power Control Organization to conveniently get in touch with each station of the division and other Divisional and Central Power Control office, effectively monitor performance of locos and prepare various information required.

2.12.4 It is necessary to provide adequate strength of Loco Inspectors on divisions to monitor the working of crews on line. The strength should be related to the number of diesel crews operating on the division. A yard stick of one Loco Inspector for every 15 LPs should be observed so that he can:

2.12.4.1 Effectively monitor performance of the crew.

2.12.4.2 Investigate avoidable diesel loco failure due to mismanagement of crews.

2.12.4.3 Educate diesel crews in trouble shooting and fuel economy.

2.12.5 **Supervisor (Running) in Diesel Sheds:** SSE/SE (running) working under Sr.DME (Diesel) in operating division will look after operational aspect of diesel locos in shed. He will be responsible for the following :

2.12.5.1 Maintaining close liaison with the Central and Divisional Power Control Organizations.

2.12.5.2 Maintain 4 hourly position of diesel outage.

2.12.5.3 Maintain minor schedule forecast register: trip, monthly, other higher schedules.

2.12.5.4 Keep record of important features like diesel loco failures, detentions, etc.

2.12.5.5 Check speedometer & VCD records.

2.12.5.6 Monitor issue of Technical Instructions to crew lobbies (called by different names: Shed Notice Book, Shed Order Book, etc.)

2.12.5.7 Trial Loco Register.

2.12.5.8 Supervisor (Running)'s relief Dairy containing important instructions to be followed by the SE/JE (Running) in shift duties

2.13 **Power Plan:** Power plan provides the information for planning the goods train on a division for each section.

2.13.1 **Procedure for issue of a power plan:** Every six months, the running of goods traffic on a Railway is reviewed for each division. Data of actual number of goods trains run are collected. Moreover, the goods train to be run during next six months is assessed. While planning the goods train, availability of goods locos on railway is taken into account.

2.13.2 **Information available in a power plan:** Information in a power plan shall be: a) Number of trains to be run on division section-wise in UP and DN direction. b) Requirement of power for inferior services i.e. shunting work, railway material train, PQRS work of engineering department, etc. c) Outage of the loco on a division (Outage is the average number of locos available for a calendar day of 24 hours) d) Target utilization of the locos, which may vary from one division to another, depending on the operating conditions. e) Net requirement (shortfall/excess) of locos (including the requirement for replacement of overaged locos and requirement for schedule maintenance of extra locos required).

2.13.3 **Shape of a typical power plan:** A typical power plan shall contain columns: S.No., Section, Kms (distance), Average Speed, Average Running time, Average number of trains per day for various types of wagons, Requirement of various types of Locos -SH/DH, Total traffic requirement (outage), No. of SH Trains, No. of DH trains, Total Engine Kms.

2.14 Classification of Loco Failures: Loco is considered to have failed if the Loco is not able to complete its journey with the specified Loco in specified time. Loco failure is classified as under:

2.14.1 **Statistical Loco failure :** If the Loco fails to work its booked train to destination or causes a delay in arrival at destination of 30 minutes or more for mail/express/passenger train and 60 minutes or more for freight trains due to the problems related with loco or enginemanship of crew, is categorized as Statistical Loco failure.

2.14.2 **Non Statistical Loco failure:** Wherever the loco develops some problem during its course of journey but the loss of time is less than 30 minutes in case of mail/express/passenger trains and less than 60 minutes in case of goods train or the loco undergoing repair at the end of its trip and not being available for the return trip, the Loco failure is termed as Non Statistical Loco failure.

2.14.3 **Reasons for Loco failure:** The reason for Loco failure is classified as under by the homing shed:

i. Defective design.

ii. Defective material.

iii. Bad workmanship in shop.

iv. Bad workmanship in shed.

v. Bad workmanship in Production Unit.

vi. Mismanagement by Loco crew.

vii. Miscellaneous

2.14.4 There are certain conditions where failure of a Loco is not to be counted as Statistical failure, even if the conditions mentioned for treating it as Statistical Failure are met. Such failures will be categorized as Non Statistical Loco failures. These conditions are as under:

i. Failure of departmental service Loco.
ii. Failure of shunting service Loco.
iii. Failure of trial Loco (After heavy repair schedule, like Yearly, POH, Engine/Traction motor/Traction Alternator / Turbo Supercharger replacement).
iv. Failure of loco overdue for schedule by more than 24 hours.

2.14.5 Apart from above, failures due to external reasons like: Cattle Run Over, Bad Weather, Bird hit, trailing load being more than permitted, non-compliance of stipulations by traffic department for train running, Stone Pelting, etc. will not be treated as Loco Failure (neither Statistical nor Non Statistical)

2.15 Daily Position: A daily position giving the complete accountal of incidence, loco and Crew Statistics is prepared by Power Controller and Crew Controller for the calendar day and sent to Power/Diesel officials in the morning. Following information is contained in daily position:

2.15.1 **Unusual occurrence of Loco:** This position is prepared covering all the unusuals which have taken place in a calendar day. This position contains following information:

i. Loco No. with base shed to which it belongs
ii. Last schedule date and due inspection date
iii. Name of LP and nominated LI
iv. Train No. and load of the train
v. Section and name of the station or name of two stations between which loco trouble took place.
vi. Description of loco trouble and action taken by Crew and Power Controller or Loco Inspector.
vii. If the loco has failed on Mail/Express/Passenger train or a goods train loco failure has caused repercussions to Mail/Express/Passenger trains, record of time lost and gained of such Mail/Express/Passenger to be mentioned. The taking over and handing over time of Mail/Express/Passenger trains in division is also indicated

2.15.2 **Punctuality position of mail/express/passenger trains:** This position indicates the time lost by passenger carrying trains on division. It has following information as per the format given below:

i. Sr. No.
ii. Train No.
iii. Taken over time in Division/Rly
iv. Handing over time in Division/Rly
v. Details of the time loss or gain by Division/Rly with reasons
vi. The trains losing time on loco account are analysed in detail and remedial action is initiated to avoid its recurrence.

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2.15.3 **Crew unusual:** Some time the trains are detained in division on crew account, as under:

i. The crew may not be available for the train ordered by traffic department.
ii. The crew may arrive late on duty.
iii. The crew may ask for relief due to over hours, sickness or any other reasons.

2.15.3.1 Therefore, all the trains detained on crew account are recorded and sent in daily position consisting of following information:

i. Name of crew
ii. Train No. and load
iii. Station
iv. Detention to train
v. Brief description of the unusual
vi. Reason for the detention and responsibility

2.15.4 **Late start summary of the major yards of division:** Freight trains ordered from the yard suffers late start due to various reasons. These are recorded train wise and summary is prepared as per the following table:

1	2	3	4	5	6	7	8	9
SN	**Loco No**	**Train No**	**Time of Arrival of Train in Yard**	**Name of nominated Outgoing LP**	**Time of Ordering**	**Time EOL**	**Load Ready for departure**	**Reasons for detention**

2.15.4.1 This table indicates delay for each train and reasons also. This helps in taking action for avoiding detention to train in the yard. Regular meetings are also held in yard by senior supervisor and divisional officers of the divisions wherein delay in the yard is discussed to find out the solution.

2.15.5 **Loco link of coaching services:** Based on the current running of mail/express/passenger trains, the locos to be given to various trains for mail/express/passenger services as per the loco link is decided. The detail is also given in daily position. The loco changing required for scheduled/unscheduled repair is decided in consultation with the homing shed or the shed of neighboring division. This position indicates Loco No. nominated for various trains.

2.15.6 **Overdue Schedule Position:** The record of locos overdue for schedule belonging to the homing shed of the division as well as the loco of other division/railway is maintained. This helps in close monitoring of such loco and directing such locos to homing shed for schedule in time. The position is given as per the following format:

a) Overdue Locos of Shed of Own Division, Last Schedule Inspection, Train No. Section & Division/Rly where the loco is working, Overdue days, Remarks (the action taken by Power Controller is indicated in the Remarks Column)

b) Overdue Locos of Shed of Other Divisions/Railways, Last Schedule Inspection, Train No. Section & Division/Rly where the loco is working, Overdue days, Remarks (the action taken by Power Controller is indicated in the Remarks Column)

2.15.7 **Locos running with defect:** This position indicates the loco number with the nature of defect so that watch can be kept on such locos for timely withdrawal of the loco for its attention before it fails. The position is maintained as under : Sr. No., Type of Defect, Action taken. The typical defects with which loco is allowed to run before withdrawing the same at suitable station are: 1. Isolated TMs, 2. Oil throw from turbo chimney, etc. There may be several other types of defect in working loco. The same are to be recorded and action to be taken to withdraw from the service, as soon as possible, for attention to defect to be mentioned.

2.15.8 **Crew Position:** Crew position is to be watched regularly to avoid the shortage of crew for running the trains.

2.15.8.1 Depot wise crew position is given in daily position as under:

a) Name of the depot
b) Sanctioned strength of LP/ALP/Shunter
c) Men on roll
d) Absence of staff from duty due to:
    i) Leave
    ii) Medical examination
    iii) Sickness
    iv) Under training
    v) Under Road Learning
    vi) Under suspension
    vii) Unauthorized absence
e) The staff on line at 00.00 hours.
f) The staff available at 00.00 hours.
g) The staff under Rest at 00.00 hours.
h) Average Head Quarter Rest of LP.
i) Average outstation Rest of LP.
j) LP used on special duty.
k) Higher grade working against casualty

2.15.9 However based on the peculiar working conditions and train operation requirement, more details in daily position can be added by individual Division/Rly.

2.16 Crew Management System: CRIS has developed a Crew Management System (CMS) application for managing its crew for operating trains. It covers all categories of train crew who are required to operate a train.

2.16.1 **Objective:** Following are the main objectives:

2.16.1.1 Optimum and effective utilization of crew through monitoring of mandatory requirements

2.16.1.2 Effective scheduling and assignment of train crew

2.16.1.3 Ensuring schedule rests (12/16) of the crew based on total duty hours completed

2.16.1.4 Paperless Lobby - Calls for booking through SMS, Caution Order, Circular, Sign On/OFF

2.16.1.5 To generate computerized mileage report for direct submission to P Branch for payments.

2.16.2 **Functions:** Main functions envisaged in CMS are:

2.16.2.1 ***Planning and control:***

a) Booking of crew (Coaching, Freight and shunting)
b) Scheduling of mandatory requirements due (Medical, Training, road learning and Loco compatibility)
c) Optimum utilization of Crew
d) Availability of crew position to all concerned "online"

2.16.2.2 ***Safety***

a) Exposure to current circulars
b) Exposure to Caution Orders in force
c) Crew monitoring by Inspectors
d) Grading of Crew
e) Adequate rest

2.16.2.3 ***Analysis:***

a) Crew utilization
b) Longer hours working
c) Overtime working
d) Outstation rest
e) Crew balancing
f) Current crew position to all concerned "online" at any given time.

2.16.2.4 ***Others***

a) Generation of CTRs based on Crew sign ON/OFF.
b) Availability of MIS reports "online".(Bio-data, 10 Hrs reports, PRs, Violation of rules while booking crew, Etc.)
c) Employee's self service.
d) SMS call serve.
e) SMS enquiry of position by crew. Alerts to lobby staff.
f) Alert to LIs.
g) Multilingual operations.
h) Inter lobby communication.

2.16.3 Modules in CMS

a) Freight crew booking.
b) Shunting crew booking.
c) Coaching crew booking.
d) Crew Console (Sign ON/OFF by tough screen Monitor).
e) Caution Order Module.
f) Circulars.
g) SMS.
h) MIS Reports.
i) Crew Monitoring by Inspectors.
j) Employees Self Service.
k) Quiz for evaluation of crew knowledge.
l) Development of Help menu.
m) Bilingual Operation.
n) Password Management.
o) Universal Report Console.
p) Crew Non run.
q) Crew Bio-data.
r) Creation of Coaching links.
s) Creation of Shunter links.
t) System non run

2.16.4 **Implementation of CMS: Implementation of CMS is under way and it is likely that by year 2015 all lobbies will have CMS in place.**

2.17 REMMLOT: RDSO has developed online monitoring system of locos and trains (REMMLOT-**www.loconet.in)**, which makes available real time data from the microprocessor of the loco, including the location of the loco, to authorized personnel. REMMLOT system has already been successfully tested and running on a large number of HHP & ALCO locos. RDSO Report on Remote Monitoring and Management of Locos and Trains (REMMLOT) No. MP. MISC –253 (Rev 00) March -2010 (or latest) has given details of this system. The goal of IR to migrate to predictive maintenance of Rolling stock from preventive maintenance has been brought out in this report. With predictive maintenance not only the cost of maintenance is reduced & availability is increased but also reliability is improved by preventing impending failures. It has also been felt time and again that we are perhaps doing over-maintenance. There has also been a need that monitoring (status and position) of the locos, which is being determined manually, should be replaced with a better system for optimized use of locos, based on the conditions in real time. A large No. of diesel locos have been fitted with microprocessor control system and gradually most of the loco shall be fitted. The MBCS stores operational, health, fault diagnostic, information pack and other vital information of the locos. This has provided an ideal platform for host of new capabilities. Following are the main actions being taken at present with the help of REMMLOT:

2.17.1 Monitoring of loco parameters by the shed to plan schedule / out of course attention to loco at nearest shed.

2.17.2 Advising LP to take timely action to prevent online failure/detention to loco, on the basis of faults noticed on line.

2.18 FOIS: FOIS has been successfully implemented on divisional control and integrated with diesel loco sheds. Full use of FOIS should be made by the Division/Railway for collecting various data pertaining to use of locos.

2.18.1 Division power controller should watch the following parameters to avoid variation between Domain base / Service base outage.

a) Proper Shed in, Shed out for goods /coaching locos in FOIS/COIS

b) Timely change of status of failed locos for goods /coaching locos in FOIS/COIS.

c) Timely change of domain / service of goods on passenger locos in FOIS/COIS.

d) Correct loco attaching /detaching of coaching trains in COIS.

e) Frequent checks at periodic intervals for goods locos status i.e failed (Fd), Dead (D), Under repair (UR), not required for traffic (NRT), in Shed without any reason, in FOIS online by respective division control of the home shed and update it in time, accordingly.

2.19 Safety through Embedded Intelligence on Diesel Locos:

2.19.1 **VCD:** All diesel locos have been provided with VCD. It is an important safety device which helps in keeping the LP&ALP alert. At present there are two types of VCDs: Stand Alone type and inbuilt in Microprocessor Based Control System (MBCS). However, gradually all locos will be retrofitted with inbuilt VCD.

2.19.2 Functioning of VCD takes place as under:

2.19.2.1 VCD operates on a loco after 76 seconds, if LP is lax and had not acknowledged the signals of VCD.

2.19.2.2 VCD operation after 76 seconds, ensure loco penalty brake application and requires LP to reset VCD.

2.19.3 In the VCDs inbuilt in MBCS, the data about VCD activity is recorded by the microprocessor, in the following way :

2.19.3.1 VCD acknowledgement- In case LP/ALP operates VCD button on loco control stand, it shall be recorded as “acknowledged” by LP in one of the computer database field.

2.19.3.2 VCD operation- Diesel loco sheds can analyze the downloaded data to study the incidences of VCD operation on the run from MBCS database. Accordingly, it can inform the respective division to take suitable action against the erring LPs.

2.19.3.3 VCD isolation- If LP/ALP isolates VCD for any reason, it shall be recorded in the database and sheds can inform the concerned division about the specific LP who isolated the VCD.

2.19.4 While analyzing SPAD cases, the embedded intelligence of loco should be made use of. The database of MBCS should be seen for "VCD activity fields". Correlating the time of SPAD cases with "VCD activity" in event recorder of MBCS, shall give information about lax attention of LP. The VCD activity data from different locos, can be used to establish the trend of lax attention of a specific LP, to plan corrective action by Sr DMEs (Power).

2.19.5 **Event Recorder:**
It is provided in Locos which are fitted with Microprocessor Based Control System which gives recording of parameters like brake pipe pressure, brake cylinder pressure, throttle position, reverser position, head light position, distance travelled, etc., recorded during the least count duration, which helps to monitor LP and in investigation of unusuals.

Annexure-2.1

Training of Loco Running Staff

Details of content and duration of training to be imparted to various categories of running staff are as under:

S. No	Course	Content	Duration	Authority
1	ALP Initial course (G&SR+Tech)	a) General Information+ fire fighting + first aid b) Transportation Training c) Basics of Mech. And Elect. Engg+ Coaches + Wagons + Control + Crew lobby d) Loco familiarization and trouble shooting e) Footplate f) Review and Exam.	3 24 14 36 20 6	RB L.No. E(MPP)/2009/3/14, dt:05-06-2009.
		Total	**103**	
2	Conversion Course (ALP/Elec to ALP/Diesel)	a) Loco familiarization and trouble shooting b) Footplate c) Review and Exam.	36 10 2	
		Total	**48**	
3	ALP Refresher course (G&SR+Tech)	a) Loco + G&SR + Signals + Accident + fire fighting b) Trouble shooting on line c) *Simulator training d) Safety Camp e) Viva Voce	15 1 1 3 1	RB L.No. E(MPP)/1998/3/8, dt:09-10-2002.
		Total	**21**	
4	LP (Shunting) Initial course (G&SR+Tech)	Same as LP/Goods	**79**	RB L.No. E(MPP)/2012/3/19, dt:02-04-2013.
5	LP (Shunting) Refresher course(G&SR+Tech)	Same as LP/Goods	**21**	RB L.No. E(MPP)/2012/3/19, dt:02-04-2013.

S. No	Course	Content	Duration	Authority
6	LP Goods Initial Course (G&SR+Tech)	a) Loco + C&W + G&SR + Signals + Shunting + Accident & Disaster Management b) *Simulator training c) Loco handling with LI d) Feedback and discussion	54 6 18 1	RB L.No. E(MPP)/2009/3/36, dt:26-10-2009.
		Total	**79**	
7	LP Refresher course (G&SR+Tech)	a) Loco + G&SR + Signals + Accident + fire fighting b) Trouble shooting on line c) *Simulator training d) Safety Camp e) Viva Voce	12 2 2 3 2	RB L.No. E(MPP)/U998/3/8, dt:09-10-2002.
		Total	**21**	
8	LP Goods to LP Passenger (G&SR+Tech)	a) Loco+ G&SR + Signal + Abnormal working + Shunting + Accident e) *Simulator training f) Loco handling with LI b) Examination and Viva Voce	36 5 5 2	RB L.No. E(MPP)/1998/3/8, dt:20-01-2002.
		Total	**48**	
9	Loco Inspector Induction Course	a) Introduction+ Safety Rules+ Disaster Management+ Inspections+ Establishment+ Manpower Planning+ RCDs+ Driving Skill+ Loco Maintenance Management+ Power & Crew Control Organization+ S&T+ P.Way+ Rolling Stock+ Operational Issues+ Stress Management+ Evaluation and Feedback	**18**	RB L.No. E(MPP)/2009/3/26, dt: 13-07-2009.
10	Loco Inspector Refresher Course	a) Safety Rules+ Disaster Management+ Inspections+ Establishment+ Manpower Planning+ Stress Management+ RCDs+ Loco Maintenance Management+ Operational Issues+ Evaluation and Feedback	**6**	RB L.No. E(MPP)/2009/3/26, dt: 13-07-2009.

*To be substituted by line training with LI in case simulator training facilities are not available.

Annexure-2.2

Records to be Maintained at a Crew Booking Lobby

The following registers are maintained at a crew booking lobby.

1. **Bio-data register of all crew having HQ at that lobby.**

2. **Periodical Medical Examination (PME) Register**: Running staff have to undergo medical examination periodically. Therefore, a register is maintained where the last date of PME is noted and the date of due PME is displayed each month on the board. The staff due for PME are sent for medical examination generally one week in advance. The staff overdue for medical examination cannot be booked to work the train.

3. **Road Learning Register**: Road Learning particulars of all the running staff are recorded in this register.

4. **Progressive hours of working register:** Working hours of the running staff for each fortnight is recorded. This helps in controlling the working hours of the LPs in 2nd week of FN to achieve target of 104 hrs. in a FN.

5. **Periodic Rest register:** Periodic Rest given is recorded for each running staff. It is also ensured that no LP remains without availing proper due periodic rest.

6. **Safety camp/safety meeting register**:- Record for attending or relieving running staff for safety camp is entered in this register.

7. **Personal stores register**: Personal stores issued to **LPs / ALPs** is recorded with the acknowledgement of the concerned.

8. **Sign on register**: This register is available at crew booking point where crew enters the detail at the commencement of the journey.

9. **Sign off register:** This register is available at crew booking point where crew enters the details at the end of the journey.

10. **Track and Signal defects register:** In these registers the defects noticed during the train working is written by LPs for getting urgently attended.

11. **Loco defects Register**: In this register defects noticed in locos during working by LPs are recorded. The important defects should immediately be reported to divisional power controller for advising to respective shed. Also, a monthly summary of defects noticed should be made and sent to Sr.DME(P) for onward submission to respective sheds with copy to CMPE/D, CME(O)/Dy.CME(O) of the respective Railways.

12. **Caution order register:** Contains current caution orders

13. **Loco pilots detail book register**: Availability of crew in HQ and in running room is maintained in this register. Loco pilots are booked with the help of this register.

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Annexure-2.3

Information to be Available/Displayed in the Crew Lobby

Each crew booking point have/display up-to-date information/instructions issued from time to time by the administration. Following information should be available/displayed:

1. Safety Vigil/Bi-monthly Safety bulletin/Fly leaf issued by CSO.
2. Safety circulars issued by divisional safety branch.
3. General Instruction – issued by Sr.DME through SOB.

The above-mentioned information should be got noted by the running staff at the time of sign on in lobby.

4. Safety slogans.
5. LPs passed medical with spectacles – The list of such LPs is displayed in the lobby. Whenever, these LPs sign on, the presence of 2 Nos. spectacles with them should be ensured.
6. List of Senior Goods LPs, screened for working passenger trains.
7. List of Accident prone/Alcoholic LPs.
8. Caution Order Board and Gradient Chart.
9. Flash New Board – For displaying urgent instructions / news concerning LPs/Shunters/ALPs

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Annexure-2.4

Facilities at Crew Booking Lobby

The crew lobby should be equipped with the following facilities:

a. Should be of sufficient area and located at strategic and conspicuous location of the station.

b. Easily identifiable and having access by road and also be within walkable distance.

c. Sound proof arrangement to avoid disturbance.

d. Should have proper arrangement to keep mandatory registers & other related instructions and display of relevant information.

e. Adequate space for furniture and other peripherals like Computers, KIOSKs of CMS, BA equipment, Railway phones, CUG phones, etc.

f. Should have crew counseling room and crew waiting lounge/rest room with required furniture.

g. Purified drinking water facility and toilet arrangements.

h. Vehicles stand for crew with proper safety measures.

Annexure-2.5

Personal Stores of a Loco Pilot and Assistant Loco Pilot

A. Loco Pilot:

1) Tool Box - 1 No.
2) Adjustable spanner - 1 No.
3) Pipe wrench
4) Screwdriver 6" (150 mm) - 1 No.
5) Insulating Plier - 1 No.
6) Hand hammer - 1 No.
7) Chisel - 1 No.
8) Driver's Rule book containing relevant portion of G&SR and Accident Manual
9) Driver's Personal book
10) Working Time Table
11) Troubleshooting guide - 1 No.
12) Driver's Memo Book - 1 No.
13) Walkie-Talkie- 1 No.
14) Red flag – 2 Nos.
15) Green flag – 1 No.
16) Detonator – 10 Nos.
17) Flare Signal – 1 No.
18) Spare Glasses (as applicable)- 1 No.
19) H.S. Lamp Tri colour torch - 1 No.
20) CBC operating handle key

However, this is a tentative list and Railways can modify it depending on their experience and need.

Note: a) Sr. Nos. 2 to 7, as per Rly Bd's letter no. 2002/M(L)/165/5 dated 17.12.2003. As per Rly Bd's letter no. 2002/M(L)/165/5 dated 15.09.2003, tools at Sr. No. 6 & 7 are to be kept in loco in a sealed box for use by the LP.

b) Sr. No. 8 to 19, as per Rly Bd's letter no. 93/M(L)/467/12 dated 20.01.2003

c) Sr. No. 20 as per SR 4.19.1.2 of South Central Railway

B. Assistant Loco Pilot:

1) Working Time Table
2) Red flag – 2 Nos.
3) Green flag – 1 No.
4) H.S. Lamp Tri colour torch - 1 No.

Note: a) The personal stores of ALP is as per SR 4.19.1.2.1 of South Central Railway

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Chapter 3

Infrastructural Facilities for Diesel Loco Shed

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3. INFRASTRUCTURAL FACILITIES FOR DIESEL SHED

3.0 Introduction: Shed layout is a plan of an optimum arrangement of facilities including maintenance bay, operating equipment, storage space, material handling equipment and all other supporting services along with the design of best structure to contain all these facilities. Objectives of shed Layout are: streamline the flow of loco and materials through the shed, facilitate the repairing process, minimize materials handling cost, effective utilization of men, equipment and space, make effective utilization of cubic space, flexibility of servicing operations and arrangements, provide employee convenience, safety and comfort, minimize overall loco schedule time, maintain flexibility of arrangement and operation, facilitate the organizational structure, etc.

3.1 Size and Location of a Maintenance Shed

3.1.1 In the matter of deciding on the location and size of a maintenance shed, operating requirements are the prime consideration. However, due to the flexibility in operation available from diesel locos, it is not essential to have sheds at points coinciding with large traffic yards. It would suffice if a shed is located near to a train examination or crew changing point.

3.1.2 While determining the location of a shed it is important to give due consideration to any possible future changes in the mode of traction, for example, change over from diesel to electric traction. If any change in traction is involved, the requirements of the old and the new type of traction should be studied in an integrated manner, both in regard to location and size of the shed.

3.1.3 The size of a maintenance shed is optimum from the technical angle when the maintenance output is efficient and effective. Experience has shown that for this personalized attention is a pre-requisite. In the homing shed, full history of each loco should be readily available so that locos needing more attention can be selectively nursed even during minor repair schedules.

3.1.4 In the present method of maintenance, the workload of a shed homing 80-100 locos is sufficient to justify installation of all the necessary machines, equipment and instruments.

3.1.5 The maintenance shed should be preferably located at or near an industrially developed town. The sophisticated assemblies used in a diesel loco sometimes require facilities of a kind which may not be readily available in the shed or which may not be possible to provide due to the rare necessity of their use. Facilities available in the industry are very helpful in such cases.

The maintenance shed should be provided with good communication facilities for effective maintenance. Good communication link with large industrial centers help in arranging materials and components at short notice in case of emergencies. From the point of view of efficient maintenance, all repairs schedules M2 (60 days) and above shall invariably be carried out in the homing shed.

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3.2 Basic Features of Shed Layout

3.2.1 Shed Layout should be expandable for homing 250 Locos. (sufficient area should be available for future expansion).

3.2.2 A uni-directional movement of locos in the shed is preferable.

3.2.3 Separate entry and exit points should be provided to avoid bottlenecks.

3.2.4 The layout should permit a loco to skip stage of servicing without hampering the flow of other locos.

3.2.5 The shed should have covered accommodation in its repair area for about 25-30% of the locos homed. The yard of the maintenance shed should be able to hold about 50% of the total holding of the shed at a time.

3.2.6 Each line in the covered repair area of the shed should be able to hold 3 locos at a time.

3.2.7 The layout should provide for the possibility of expansion widthwise i.e. providing more lines side by side. Expansion along the length of the running lines should not be adopted.

3.2.8 The work area in the shed should be divided into two distinct portions, one dealing with servicing and light repairs and the other with heavy repairs. Facilities should be provided in the same sequence in which an incoming loco is to be attended to.

3.2.9 Painting booth: A separate proper paint booth shall be planned.

3.2.10 Now-a-days modern construction techniques are available in which optimum combination of weight, space, cost and aesthetics is ensured. A comparison of prefabricated fabrication technique over conventional one is given at **Annexure-3.1**

3.2.11 RCC buildings should also be constructed utilizing the latest construction techniques.

3.2.12 Use of latest construction materials such as light weight aluminum corrugated sheets, anti skid steel tiles, Translucent Poly carbonate sheets, Epoxy flooring etc. should be made for construction of shed

3.2.13 In designing of shed structure and building the aspect of use of daylight to the maximum possible extent should be kept in view.

3.2.14 For finalizing the shed layout as well as design of shed structure, building, drainage, rain water harvesting, surfaces, etc, consultancy to a reputed architect, who has got experience in designing such building and structures should be awarded. The design should include specifying the latest energy efficient lighting gadgets at various locations of the shed such as: pit, below catwalk, roof, side of shed, buildings, yard, etc.

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3.2.15 A turn table needs to be installed as in coming years speed of mail/express trains is bound to increase for which there will be requirement of running of locos with short hood leading. Other-wise also, for running of mail/express trains, it is desirable to run the trains with short hood leading. Apart from this when making Multiple Units, turn table will be useful in ensuring that they are made with Short Hood leading on both the sides.

3.2.16 With holding of upto 250 locos, movement of locos to and from shed will increase. Hence, the shed should have two entry and two exit lines on each end for unidirectional movement of locos and facility for entry/exit from both the sides to avoid congestion.

3.2.17 With stricter environmental regulations, there is a need that the Diesel Sheds should take energy conservation measures to reduce the carbon foot print. When augmenting infrastructure on large scale, principles of sustainable development need to be kept in view, which will give good returns in the long run.

3.2.18 There should be a two pronged approach for energy conservation – one to reduce the power consumption and other to utilize otherwise wasted power for generating power and shed building should be green building.

3.2.19 The New shed should have environmental conservation measures like Solar distillation plant for batteries, Rain Water harvesting, ETP etc. Apart from this Waste Heat Recovery system (from incinerator) is also a good add-on. Solar paneling of administrative block – solar lighting, and use of Green house principles in construction of new sheds – so that there will be good air circulation as well as good natural lighting will be available.

3.2.20 The shed should have at least 30% Green cover.

3.2.21 Wherever there is potential, wind power can be harnessed to generate power. Indian Railways is already planning Wind Power Plants at some places.

3.2.22 There should be a dedicated over head water storage tank to hold a supply for at least 15 days, depending upon the availability of water supply situation in the area.

3.2.23 The drainage of shed should be well planned, which should have proper sloping, screens, pits. If required intermediate sludge pumps may be provided where sloping is a constraint

3.3 Sequence of Repair Operations:

3.3.1 The recommended sequence of operations for servicing is:

3.3.1.1 Cleaning and washing of under-gearing and body

3.3.1.2 Sanding

3.3.1.3 Fuelling

3.3.1.4 Inspection and topping of lube oil and cooling water

3.3.1.5 Repairs

3.3.1.6 Departure

3.3.2 Lines earmarked for normal servicing attention should be through lines so that minimum time is taken in movement of loco. In the repair areas, separate lines should be earmarked for schedule repairs and for locos needing out-of course repairs.

3.4 Servicing Facilities:

3.4.1 Washing and cleaning:

3.4.1.1 A separate Washing installation should be provided for loco cleaning before entering maintenance areas.

3.4.1.2 A washing apron and pit laid with concrete and provided with good drainage, suitable hydrant points and adequate supply of water, should be located well away from the shed building to clean the under gearing and body of the locos.

3.4.1.3 Automatic washers with mechanized sprays, brushes etc. should be installed to improve the quality of cleaning and minimize manual labour content.

3.4.1.4 Hose and nozzle arrangement for spraying the under-gearing with water under, pressure will ensure proper removal of grease and oil from the chassis. Provision of a boiler to give a steam jet will be an additional help.

3.4.1.5 **Annexure 3.2** shows schematically a washing installation.

3.4.2 Sanding:

3.4.2.1 Sand should be stored under cover to keep it dry. Sand drying arrangements may be necessary in areas having heavy rainfall.

3.4.2.2 Sand should be properly sieved before being filled to prevent the sanding apparatus on the locos getting chocked.

3.4.2.3 Mechanized sanding facilities should be installed to minimize manual labour content and avoid unnecessary spillage of sand.

3.4.2.4 Sanding point should be at an adequate distance away from the fuelling installation and the running shed building.

3.4.3 **Fuel supply installation:** This has been dealt with in Chapter 8 (a).

3.4.4 **Lubricating oil storage and dispensing:** This has been dealt with in Chapter 8 (b).

3.4.5 **Cooling water treatment and dispensing:** Diesel engine water should be treated in accordance with maintenance instructions laid down for different classes of locos as per RDSO MI 15.

3.5 Shed Construction:

3.5.1 Three- level working floor arrangement should be provided. The rail level in the repair area is the same as the general shed floor level. The depressed floor area outside the rails is kept lower than the shed floor level so as to be able to attend effectively to the bogies and under- gear. The pit level between the rails is kept still lower to enable proper examination of under gearing. Above the depressed floor level, platform level is provided, which is at the same height as the loco floor, to attend to all components of the loco above the under frame. Ramps or steps should be provided to conveniently connect the three working levels with the general floor level in the shed. A typical cross section of the three level arrangements is shown in the sample drawing of a typical shed enclosed as **Annexure 3.3.**

3.5.2 Flooring should be easily washable so that spilled oil can be effectively removed. All flooring should be finished with a hard top to withstand abrasion resulting from handling heavy parts and movement of material trollies, etc. Hardonite flooring is acceptable on the ground level in the Running Repair Bay and anti skid steel tiles flooring in Heavy Repair Bay. Epoxy flooring should be used in the Equipment Repair Bay and over Catwalk surfaces of the Running Repair Bay. **Annexure 3.4** shows Hardonite flooring details and Epoxy flooring.

3.5.3 Flooring in the heavy lifting bays of shed should be adequately strengthened. Special reinforcement is required in the location where heavy duty high lift jacks are installed.

3.5.4 To minimize dust nuisance in working area, RCC paved area for at least in 30 meter distance on both sides of shed bays (front and back) should be provided. Also, other paved area, wherever provided, should be RCC.

3.5.5 Roads in shed should be of RCC.

3.5.6 To minimize cracking and to facilitate repairs, flooring should be divided into rectangular panels, with sides not exceeding 2 meters using dividing strips.

3.5.7 The platforms, and ramps as also steps should be protected with steel or cast iron edging of non-skidding type.

3.5.8 Pits should have convex flooring and efficient drainage. Stilt arrangement consisting of steel beam on stub columns should be followed, as far as possible, for supporting track in the pits, since it permits better lighting and ventilation of the pits. See **Annexure 3.4A**.

3.5.9 The edge of the elevated platform should be suitably raised to provide a rim to prevent tools and materials from rolling off. This also reduces the possibility of men slipping at the edge.

3.5.10 To protect personnel working on the elevated platform from falling down when the line is not occupied by a loco, chain guards should be provided. These should be fixed in such a manner near the edge of the platform that they can be removed easily when a loco is placed alongside. Provision of sockets in the platform floor in which steel pipes can be inserted is a convenient method of doing so.

3.5.11 A uniform roof height should be preferably adopted for all bays to enable convenient construction and dispersion of natural light. The minimum height is governed by the requirement of heavy lifting bay.

3.5.12 The roof should be of a construction that caters for maximum natural light in working area. 25% translucent corrugated poly carbonate sheets suitably arranged in a row form **(Annexure 3.5)** is recommended, in preference to north- light glazing.

3.5.13 Now-a-days, still better design of roof which uses minimum height with less clogging by cross members, affording uninterrupted ingress of natural light and an aesthetic view are available, which should be adopted. A typical Rafter roof is shown in **Annexure 3.6.** and **Annexure 3.7**

3.5.14 Rotary turbo ventilators should be provided at suitable locations and in sufficient numbers to remove smoke and fumes (a typical arrangement shown in **Annexure 3.8**).

3.5.15 The repair area in the shed should be made as dust proof as far as possible. All large openings should be provided with rolling or other type of shutters.

3.5.16 Suitable provision should be made while laying out end columns of bays which may require to be extended at a later date, so that minimum alterations are required to the structure and the foundations.

3.5.17 Sufficient welding points should be provided in shed @14m distance in all the repair bays

3.6 Lifting and Material Handling Facilities

3.6.1 Overhead cranes of suitable capacity should be provided to serve repair areas, a part of the machine shop and stores.

3.6.2 Crane capacity should be sufficient to lift the heaviest single repairable component or assembly. Overhead crane is not intended to lift complete loco singly; however, it should be capable of lifting a complete loco from one end so as to enable a bogie to be run out from under it.

3.6.3 Heavy duty high lift electrically operated jacks may be provided at suitable locations in the heavy repair area for lifting the loco. It should be possible to alter spacing of the jacks to suit locos having different spacing of lifting pads.

3.6.4 Tram beam cranes operated from the floor level and hoists should be provided at all suitable work locations. Wherever it is possible to provide these facilities and dispense with overhead cranes, the shed structure can be made lighter.

3.6.5 Fork lift/Platform trucks should be provided in maintenance sheds for movement of components and assemblies.

3.6.6 Movement of material flow should be made smooth. Material flow can be traced onto a plant layout through spaghetti diagram.

3.7 Illumination:

3.7.1 Diesel shed generally remains poorly pit, which is great handicap in ensuring proper and safe maintenance. Hence, it is important to provide good illumination in various areas of the shed.

3.7.2 Three tier metal halide lighting provision should be provided on Roof, Catwalk and pit level

3.7.3 Good illumination is necessary for efficient repair work. In the repair area energy efficient lights giving an even illumination of atleast 500 lux at platform and floor levels should be provided.

3.7.4 Pits should be provided with bulk head fittings for direct lighting of the under-gear of the loco. Here also minimum illumination level of 500 lux is necessary.

3.7.5 At fuelling, sanding and washing points and turn tables etc. illumination level of 300 lux is sufficient.

3.7.6 In open repair sections, illumination level of 600 lux will be required. However, in repair section rooms, illumination level of 700 to 1200 lux may be provided, depending on the type of repair, e.g. in rooms carrying out repair of electronic cards illumination of 1200 lux will be required.

3.7.7 At the area where relief train is stabled, an illumination level of approximately 150 lux should be available. The general level of illumination in the yard in the maintenance shed should also be of the same order.

3.7.8 Two high mast lighting tower for general illumination should be provided.

3.7.9 Low voltage plug points should be provided at all work areas, including the pits, for use of portable and hand lamps with flexible leads.

3.7.10 An Electrical substation with at least two 500kVA transformers (One stand by) or more, depending on capacity of the shed, should be provided.

3.8 **Shed Building :** The shed building, besides providing for the repair area, machine shop, etc should accommodate the following:

a) Battery charging and storage room.
b) Instrument repair and testing room.
c) Fuel injection repair and testing room.
d) Engine governor repair and testing room.
e) Brake testing room.
f) Flaw detector room (magnetic and zyglow, etc.)
g) Filter storage.
h) Tool room.

i) Lockers and washing room.

j) Laboratory.

k) Driver's lobby and lockers.

l) Booking office.

m) Supervisor's office rooms.

n) Shed Officer's rooms.

o) Office room and record room.

p) Library.

q) Lecture or Meeting room.

3.8.1 Details of shed building and bays required in various categories of sheds is given at **Annexure 3.9**.

3.9 **Battery Charging:**

3.9.1 The battery charging room should be located preferably at one end of the shed building, where fumes and gases can be easily exhausted to the atmosphere.

3.9.2 The floors and the walls in the battery room should be of acid resistant construction.

3.9.3 Plug-points for mobile battery charging plant should be provided near the pits to provide direct charging of loco batteries without the necessity of taking them off.

3.9.4 Adequate distilled water should be available for topping up the batteries. Distillation or demineralization plant of adequate capacity should, therefore, be provided.

3.9.5 Adequate number of fire extinguishers and sand filled buckets should be provided in the Battery Charging Room.

3.9.6 Adequate number of exhaust fans should be used in the Battery charging room.

3.10 **Shed Stores:**

3.10.1 The shed stores should have approach by both rail as well as road. The approaches should not interfere with other movements in the maintenance shed. The rail siding should have a clear length of at least 200 meters and access by crane or forklift from both sides of the track.

3.10.2 Maximum use of cubic space should be made for storage of materials. For this purpose, high reach forklift trucks need to be provided in the store.

3.10.3 Proper bins and racks should be provided for storage and handling of components, to avoid damage during handling and in storage.

3.10.4 Adequate lifting facilities should be provided for handling heavy components. Use of fork lift trucks for this purpose is preferable.

3.10.5 Special provision should be made for storage of rubber components since these are subject to deformation, if not properly stacked, and to ageing in the presence of air and due to the effect of temperature.

3.10.6 While designing store building, due regard should be paid to the fire fighting precautions.

3.10.7 To reduce material handling to minimum and save time, small components frequently required should be stocked at platform level near work areas. Heavier components such as brake-shoes etc. can be conveniently stored at the depressed floor level.

3.10.8 A computer with a software shall also be used for effective management of items.

3.11 **Auxiliary Building**:

3.11.1 A small shed should be provided in the vicinity of the main shed building for stabling spare wheels and bogies. A 3-tonne gantry should be provided in this shed.

3.11.2 Under floor type of wheel lathe should be provided in a large maintenance shed for in-situ re-profiling of worn loco wheels. A separate shed for the underfloor wheel lathe is preferable.

3.11.3 A load-box for testing a loco under load should be provided in every diesel shed. It should have facility for entry and exit from both sides. Load box area should have sound proofing and should be for 2 loco length on 2 lines.

3.12 **Compressed Air:**

3.12.1 Air compressor should be installed at a place where minimum disturbance due to vibrations and noise is caused to the surroundings. A separate compressor room is recommended outside the main shed building. However, now-a-days, silent compressors are available which can be installed near/inside the shed at convenient location. Also, good sound proofing enclosures for air compressors are available now-a-days. It will help in reducing unnecessary running of pneumatic pipeline outside the shed.

3.12.2 Compressed air pipe lines should be laid so as to reach all working areas and adequate number of points should be provided to tap the air supply. The layout should permit provision of additional tapping points at a later date. Compressed air is also required for blowing out dirt, to operate hand tools, etc. The pneumatic pipe line should be color coded for distinction.

3.12.3 However, to minimize running of the main compressor to the barest minimum, for energy saving, small air compressors for specific usage should be provided at various places. Also, few portable mobile compressor should be provided which can be moved to any point required. This will save the installation of long compressed air pipe lines and air receivers to safeguard against pressure drop.

3.13 Repair Area:

3.13.1 In the general repair area, separate areas should be demarcated for specialized repair groups such as:

a) Diesel engines

b) Electrical rotating machines

c) Various assemblies of Diesel Engines

d) Cooling equipment and radiators

e) Brake equipment and valves

f) Auxiliaries

g) Under-gearing components

3.13.2 Fitter's benches should be suitably provided in each of the demarcated area.

3.13.3 For ease of handling during repairs suitable hoists and jib cranes, etc. should be provided. Tool Balancers should also be used for various assembly works as these devices reduce fatigue of staff, e.g. these can be effectively used for cam gear assembly.

3.13.4 Special stands and carriers, etc. for different components should be provided in the different repair areas. For example connecting rod and piston assemblies after removal from the engine should be stacked on a rack with the connecting rods suspended from the gudgeon pins. Similarly, special stands for storing / hanging camshafts should be provided. Special holding trays etc. should similarly be provided for bearing shells fuel injection nozzle etc.

3.14 Fuel Injection Room:

3.14.1 A separate room for repair and testing of fuel injection equipment should be provided in every maintenance shed. This room is required to be absolutely dust free. It is preferable to wholly air-condition this area.

3.14.2 Suitable arrangements for expelling fumes from this room should be provided.

3.14.3 Anti-skid oil proof flooring should be provided in the fuel injection room.

3.14.4 The type of testing equipment to be provided in the fuel injection room depends on the make of the diesel engine. However, the minimum repair facilities provided in this room should consist of :

a) Test stands for checking nozzle spray and pressure.

b) Fuel pump calibration stand.

c) Nozzle valve lapping tools and machine.

3.14.5 Spare parts required for repairing injection equipment should be stocked in the injection room itself.

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3.15 Governor, Instruments and Brake Valve Repair Rooms:

3.15.1 Separate rooms should be provided for repair and testing of engine governor, instruments and gauges and brake valves.

3.15.2 All these rooms should be made dust free and have temperature controlled. For this purpose, these rooms should be made Air-conditioned.

3.16 Laboratories:

3.16.1 In every diesel locos maintenance shed, it is essential to have a well equipped laboratory to exercise control on lubricating oil, fuel oil and cooling water. The laboratory is also helpful in NDT of parts during overhauling, carrying out metallurgical and chemical inspection of new parts and supplies received in the shed as well as investigation of failed components. **Annexure 3.10** gives the general equipment that should be available in the shed laboratory.

3.16.2 The essential tests required to be carried out on fuel oil and lubricating oil are described in chapters 8(a) and 8(b), respectively. Some of these tests, including tests on cooling water, are required to be carried out during every trip schedule. For such tests, the laboratory should function round the clock.

3.17 Cleaning and Washing:

3.17.1 Keeping the equipment clean goes a long way in ensuring trouble free operation and long equipment life. Suitable cleaning and washing facilities are, therefore, absolutely necessary in every shed.

3.17.2 Cleaning the components immediately after their disassembly is necessary, before any inspection or repair can be undertaken. Degreasing and cleaning facilities whether of the vapour type or hot bath or spray –jet type are required in every shed. Preferably, mechanized cleaning equipments, to the extent possible, should be provided.

3.17.3 Special cleaning devices with circulating pumps, air stirrers, etc are required for turbocharger after coolers, oil heat exchangers, etc.

3.18 Shed offices:

3.18.1 The offices for Supervisors should be located near their place of work. This ensures effective and constant supervision of the repair work.

3.18.2 The driver's booking office and lobby should be located near the point where the locos are inspected and prepared for dispatch.

3.18.3 The General Administration and other offices should also provide for a meeting room.

3.18.4 **Administrative Building:** It should be close to the work area. It should be suitably sized and architecturally designed.

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3.18.5 A time and security office should be provided close to main entrance. It should be equipped with suitable access control system for all the staff working in the complex.

3.19 Plant and Equipment:

3.19.1 A list of machinery, plants, tools and other items required in maintenance sheds of different sizes is given at **Annexure 3.10** to this Chapter. Suitable adjustments can be made depending upon local need. This list does not include ordinary tools such as spanners, chisel, files, hammers etc.

3.19.2 Every shed should be provided with equipment required for testing and calibrating various tools, machines and fixtures used in repair work.

3.20 Fire Fighting :

3.20.1 Adequate safety measures must be adopted against fire hazards in the shed. Since large volumes of petroleum products are handled, special precautions are necessary.

3.20.2 Firefighting equipment such as hydrants, hoses, extinguishers and fire alarm boxes, etc should be conspicuously visible both at day and at night.

3.21 Diesel Technical Training Centre (DTTC) :

3.21.1 For proper maintenance of the sophisticated equipment on diesel locos the work force has to be adequately trained. Each shed should therefore, include a diesel technical training centre for imparting theoretical and practical training to various categories of staff.

3.21.2 Provision of a hostel attached to the training school is necessary.

3.21.3 The training school should be provided with a library with sufficient books and technical literature and latest audio visual aids for training.

3.21.4 Model room in the training school should display cutaway models and working models of as many components as possible.

3.22 Staff Amenities:

3.22.1 Toilet and washing facilities and water coolers should be available both inside the shed building and for the use of office staff.

3.22.2 Adequate precautions are necessary against dermatitis amongst workers handling fuel oil, lubricants, etc. Suitable cleaning agents and ample washing facilities in the vicinity of areas where these products are handled, are necessary. Use of hand protection cream before starting work and non-irritant cleaning soaps after completion of work should be enforced. Staff locker rooms, and change rooms for gents and ladies should be provided in the shed.

3.22.3 Ample parking shall be provided for cycle, two wheelers and four wheelers close to the shed entry.

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3.23 Fuelling :

3.23.1 Fuelling facilities for at least two locos or on track vehicles at a time (siding to be approx. of 100 meter length) and fuel storage tanks of at least 100 KL capacity should be provided in the shed.

3.23.2 Fuelling arrangement should be such as to prevent any spillage. Still, some spillage invariably takes place, for this arrangements for recovery of spilled fuel should be provided.

3.24 Diesel Loco Service Centre (DLSC):

3.24.1 From operating considerations it becomes necessary to provide DLSCs, where trip schedule attention to the locos can be given. Whereas the homing sheds are provided with all facilities described above, in the DLSC only the minimum facilities enough to ensure satisfactory completion of trip schedule are necessary. Facilities should also be provided for minor repair work.

3.24.2 For infrastructural facilities and other details of DLSC, RDSO report No. MP.Misc.195 September, 2007 may be referred to.

3.25 Power Supply:

3.25.1 Auxiliary substations are planned for catering to the power supply requirement of the whole shed. Details of connected load feeder shall be worked out. Taking diversity factor of 0.5 the maximum demands shall be computed. Two Auxiliary substations are proposed, as the demand by machines in shed area would be very large. The standby power supply is proposed through DG set with AMF panel. The capacity of DG set will be adequate to supply all essential loads without over loading.

3.25.2 Proper grounding, adequate number of earth pits, MCB and Circuit breakers of reputed make, etc. should be provided in wiring. Underground cable laying and cable trench, wherever possible should be preferred.

3.26 Water Supply, Sewerage and Drainage Work:

3.26.1 In house facilities shall be developed for the water supply of the entire shed. Sewerage, pit and storm water drainage shall be given due care while designing the shed for efficient system functioning. The pit drainage and storm/rain water drainage should be separate for facilitating treatment of pit drainage through ETP. Past records of Municipal Corporation shall be used to design the drainage system. Rainwater harvesting would be given due emphasis to charge the underground water reserves.

3.27 **General Layout Drawing**: General layout drawing similar to that of Siliguri Diesel Shed and of Sabarmati Diesel Shed Phase II may be followed as template

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Annexure 3.1

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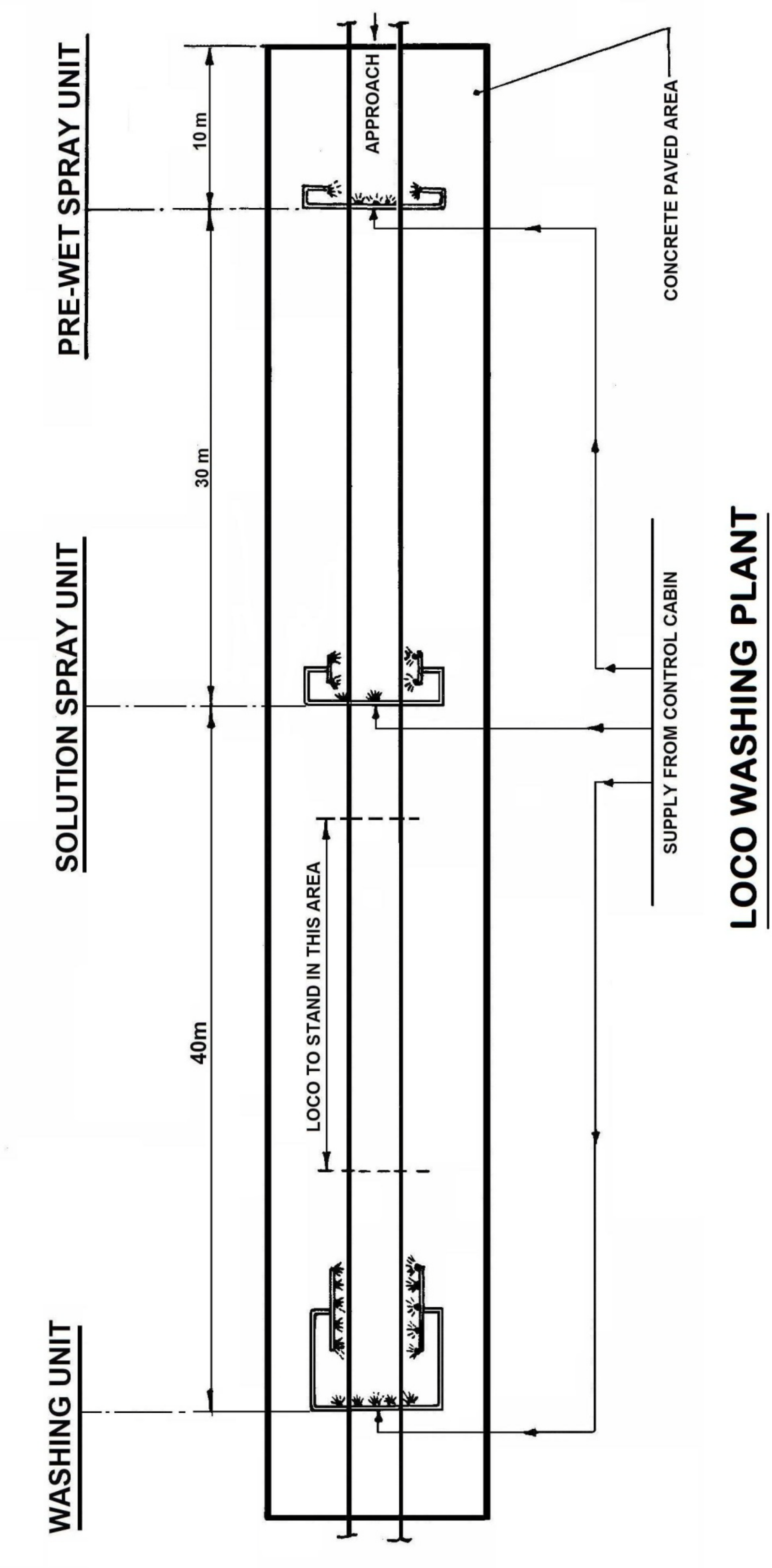
Comparison of pre-engineered and conventional Structural Steel Buildings

Pre Engineered Buildings	Conventional Structural Steel
Design Criteria A.I.S.C. / M.B.M.A. / A.W.S / IS 875	**Design Criteria** IS 800, IS 801 & IS 875 (More conservative)
Design Quick and efficient since standardization of P.E.B has significantly reduced design time. Specialized computer analysis and design programs reduce design time and optimize material required. Drafting is also computerized with minimal manual drawings. Design, detail drawings and erection drawings are supplied free of charge by the manufacturer. Approval drawings may be prepared within 10 days to 3 weeks. Computer-generated building techniques and material designs provide better estimates. Pre-engineered components go together without a problem, preventing expensive construction surprises. Consultant fee/in-house design expenses are avoided.	**Design** Each conventional steel structure is designed from scratch by the consultant, with fewer design aids available to the Engineer. Maximum engineering & detailing required on every project. Generalized computer analysis programs require extensive input/output and design iterations. Drafting is manual or only partially automated. Much consultant time and expense is devoted to design and drafting, as well as co-ordination and review.
Life & Asthetics As the material is bought directly from major steel manufacturers, so quality and life is much longer. The sheeting is of best quality with an expected life of over 30 years. As there is no cumbersome network of trusses and there is a wide variety of colors, so building looks much better from inside and outside	**Life & Asthetics** Normally material is from small mills and of recycled steel so the quality and life are always questionable. Sheeting is of asbestos and is to be replaced at regular intervals of 3-5 years. An ugly looking vast network of trusses which wastes lot of space as well.
Weight About 30% lighter through the efficient use of steel. Primary framing members are designed with tapered built-up plate sections with the most steel in the areas of highest stress, using high strength steel. Frame geometry matches the shape of the internal stress diagram, minimizing material wastage and reducing total weight, Built-up section with large depths in the highest stressed areas. Size of each member is selected on the basis of the max internal stress in the member. Secondary members are light gauge cold formed "Z" or "C" shaped members. Members are roll-formed for minimum weight, time saving and labor cost. Due to less weight, light foundation will be required.	**Weight** Steel member sizes must be selected from standard hot rolled sections, which in many cases are heavier than what is actually required by design. Members are the same cross-section along the entire length, regardless of local stress, magnitude. Hot rolled section has a constant depth; many parts of the member, in areas of low internal stresses, are in excess of design requirements. Secondary members are from standard hot rolled "T"and "C" sections. In many cases members are heavier than required, and therefore are not as economical as cold-formed members. Made out of heavier standard hot rolled "I" & "C" sections, difficult to fit customized requirements, force under or over sizes, leading to requirement adjustments. Due to more weight, extensive heavy foundation will be required.
Base Material Rigid Building P.E.B. System uses almost all steel to meet 50,000 P.S.I. minimum yield including the cladding	**Base Material** In most of the cases (90%) Base Material is 36,000/-P.S.I. minimum yield

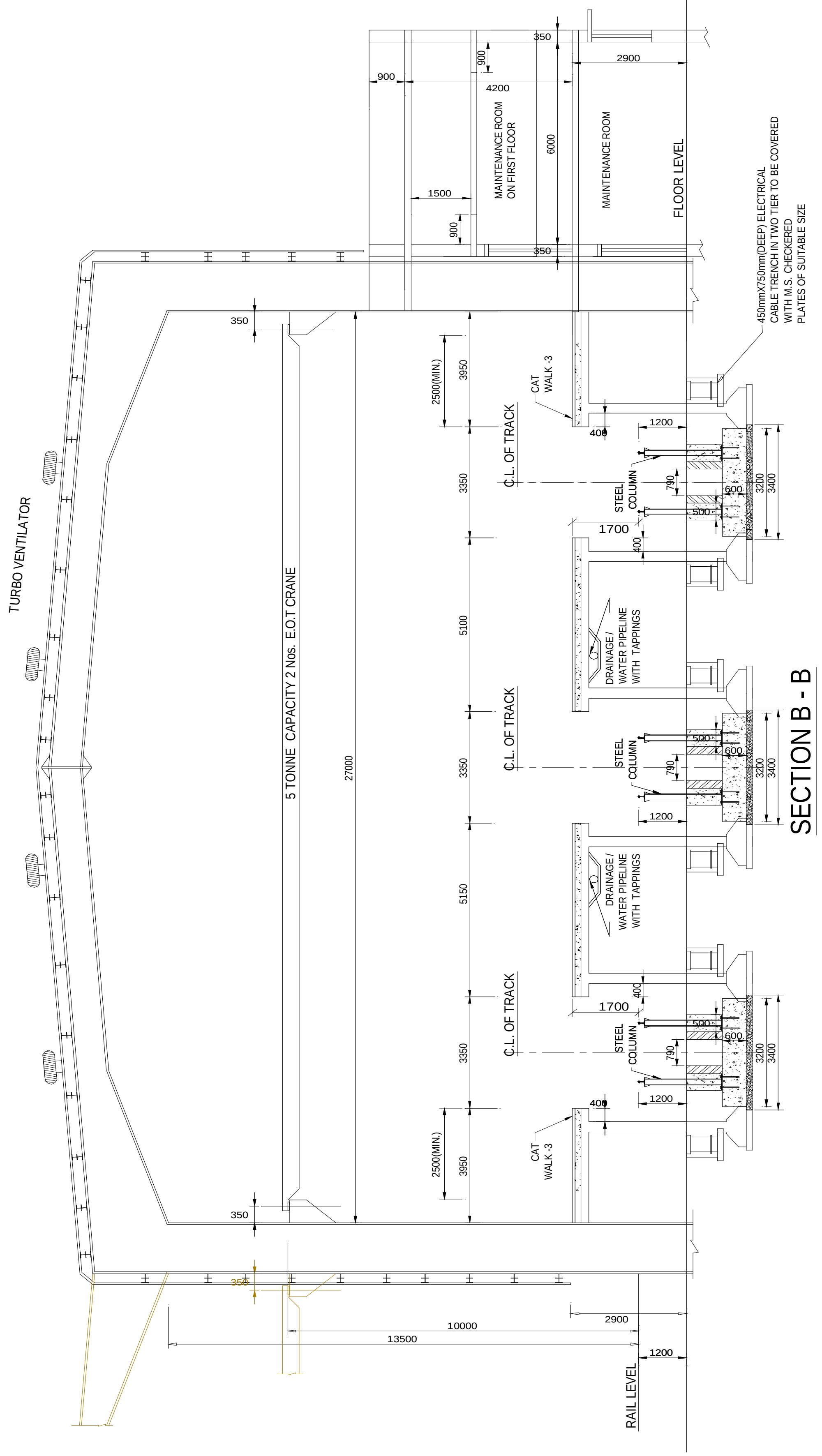
Pre Engineered Buildings	Conventional Structural Steel
Overall Price Price per square meter may be as much as 40% lower than conventional steel.	**Overall Price** High price per square meter.
Sourcing & Co-ordination Building is supplied complete with cladding and all accessories, including erection if required, all from one source of supply.	**Sourcing & Co-ordination** Sourcing of different material has to be done from different sources.
Changes Very flexible, tailor made, accepts changes and revisions easily. One supplier to coordinate changes. Easily accommodated at any stage since this is made up of standard raw materials.	**Changes** Changes, revisions & additions can be difficult due to extensive re-design and co-ordination among suppliers and sub-contractors. Substitutions of hot rolled sections are infrequently rolled, time consuming and also very expensive if it is already shipped for fabrication.
Performance All components have been specified and designed specifically to act together as a system for maximum efficiency, precise fit up, and performance in the field. The experience with similar buildings, in actual field conditions worldwide has resulted in design improvements over time, which allow dependable prediction of performance.	**Performance** Components are designed in general for possible use in many alternative configurations. Design and detailing errors are possible in assembling diverse components into unique buildings. Each building design is unique, so prediction of how components will perform together is uncertain. Materials, which have performed well in some climates, may not in other environments.
Seismic Low-weight flexible frames offer high seismic resistance	**Seismic** Rigid heavy structures do not perform well in seismic zones.
Functional Versatility Larger spans & longer bay spacing. Easily re-locatable & reusable as joints can be dismantled.	**Functional Versatility** Restriction on larger spans & longer bay spacing. Can’t be relocated as all joints are rigid.

Annexure 3.2


PRE-WET SPRAY UNIT
SOLUTION SPRAY UNIT
WASHING UNIT
10 m
30 m
40m
APPROACH
LOCO TO STAND IN THIS AREA
CONCRETE PAVED AREA
SUPPLY FROM CONTROL CABIN
LOCO WASHING PLANT

Annexure 3.3

Sample Drawing of a Three Tier Typical Shed



Annexure 3.4

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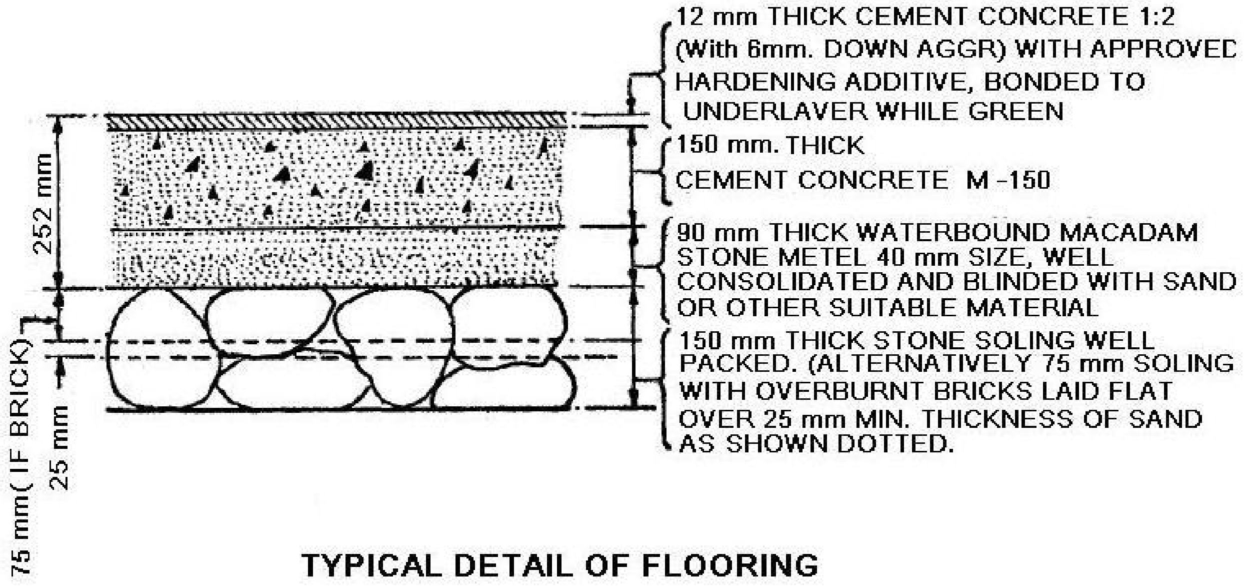
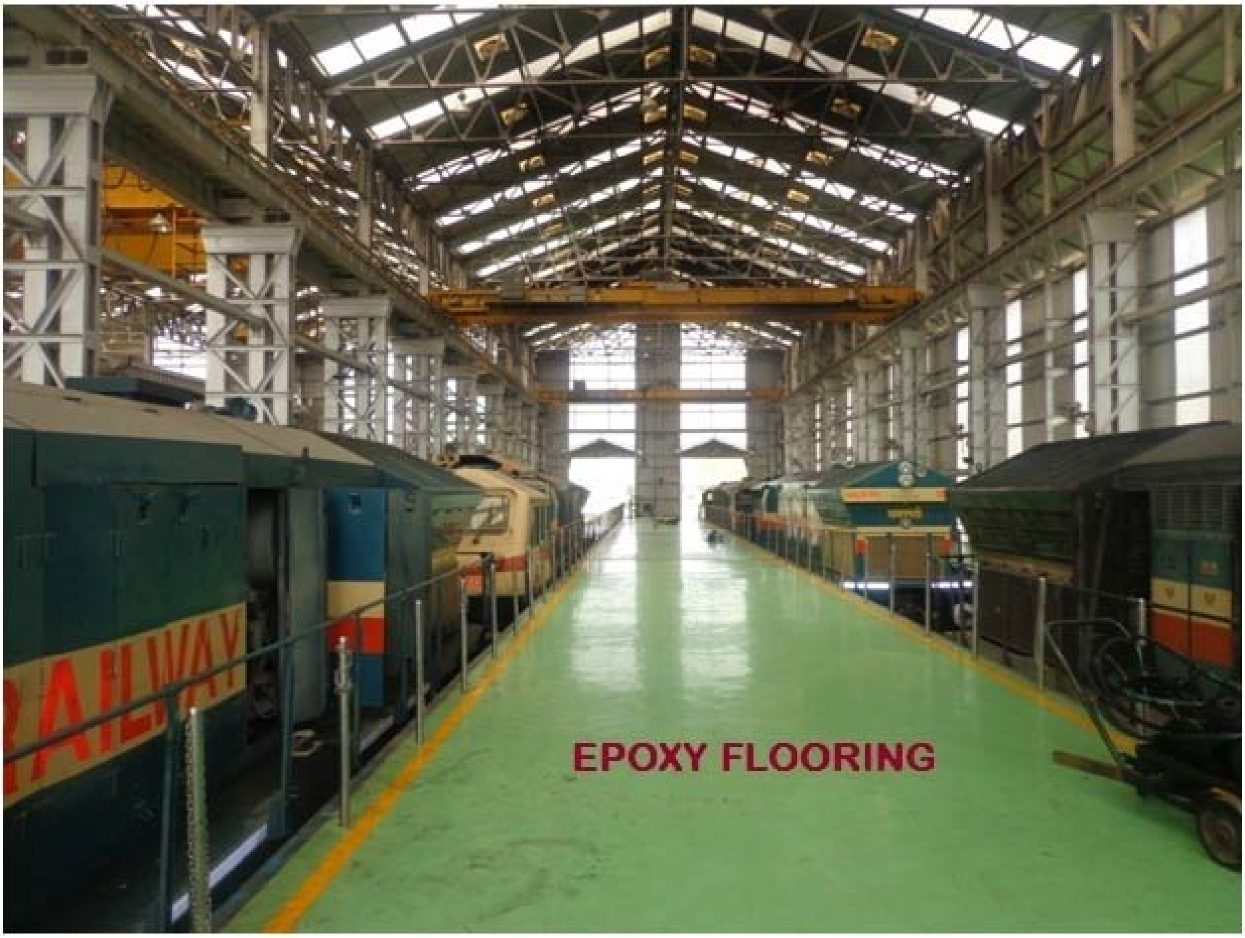


TYPICAL DETAIL OF FLOORING



PHOTOGRAPH OF EPOXY FLOORING

Annexure 3.4A

STILT TYPE ARRANGEMENT OF TRACK IN PITLINE

Annexure 3.5

PHOTOGRAPH OF TYPICAL RAFTER ROOF

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Annexure 3.6

PHOTOGRAPH OF UNDER CONSTRUCTION LATEST DESIGN SHED

Annexure 3.7

PHOTOGRAPH OF ALLUMINIUM & POLY CARBONATE CORRUGATED SHEETS FOR ROOF & SIDE WALLS

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Annexure 3.8

Rotary Turbo Ventilators

Annexure 3.9

Infrastructure Required for Diesel Shed

Note: C- Common for Alco & HHP, A- Only Alco, H- Only HHP

SN	Purpose	C/A/H	Requirement		
			<100	≥100 <175	≥175 <250
A.	**RCC BUILDINGS**				
I	**ADMINISTRATIVE BUILDING**				
1.	Sr.DME and other officers rooms	C	30 x 8	45 x 8	60 x 8
2.	Sr.DME Office	C	20 x 8	30 x 8	40 x 8
3.	Meeting hall	C	30 x 8	40 x 8	50 x 8
4.	Time office	C	20 x 8	25 x 8	30 x 8
5.	Information Cell (MIS)	C	20 x 8	25 x 8	30 x 8
6.	SMM Stores Office	C	20 x 8	25 x 8	30 x 8
7.	NS Stores office	C	20 x 8	25 x 8	30 x 8
8.	Data processing room (Computer cell)	C	20 x 8	25 x 8	30 x 8
II	**SUPERVISORS ROOMS**				
9.	Sr.Section Engineer (Mech)	C	6 X 6	6 X 6	6 X 6

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SN	Purpose	C/A/H	Requirement		
			<100	≥100 <175	≥175 <250
10.	Sr.Section Engineer (Elec)	C	6 x 6	6 X 6	6 X 6
11.	Sr.Section Engineer (HS/Mech)	C	6 x 6	2 x 6 x 6	3 x 6 x 6
12.	Sr.Section Engineer (HS/Elec)	C	6 x 6	2 x 6 x 6	3 x 6 x 6
13.	Sr.Section Engineer (MS/Mech)	C	6 x 6	2 x 6 x 6	3 x 6 x 6
14.	Sr.Section Engineer (MS/Elec)	C	6 X 6	2 x 6 x 6	3 x 6 x 6
15.	Sr.Section Engineer (LS/Mech)	C	6 X 6	2 x 6 x 6	3 x 6 x 6
16.	Sr.Section Engineer (LS/Elec)	C	6 X 6	2 x 6 x 6	3 x 6 x 6
III	**Diesel Technical Training Centre-DTTC (Knowledge Sharing Centre)**				
17.	Principal Room	C	6 x 6	6 x 6	6 x 6
18.	Lecturers Room	C	4 x 6 x 6	5 x 6 x 6	6 x 6 x 6
19.	Trainee Class room	C	3 x 12 x 6	4 x 12 x 6	5 x 12 x 6
20.	Model Room	C	20 x 12	30 x 12	40 x 12
21.	Conference Hall	C	20 x 12	25 x 12	30 x 12
22.	Library	C	15 x 8	25 x 8	30 x 8
23.	Hostel	C	50 beds	100 beds	150 beds
IV	**Mechanical Sub Assemblies maintenance**				
24.	Governor O/H Room	C	10 x 6	15 x 6	20 x 6
25.	FIP O/H Room	C	15 x 6	20 x 6	25 x 6
26.	Air Brake Room	C	15 x 6	20 x 6	25 x 6
27.	Carpenter Room (cab maintenance)	C	10 x 6	15 x 6	20 x 6
28.	Centrifuge Room	A	6 x 6	10 x 6	15 x 6
29.	Dynamic Balancing Machine	A	10 x 6	15 x 6	20 x 6
30.	Clean room for Turbo	H	-	-	40 x 12
31.	Roller Bearing O/H Room	A	10 x 6	15 x 6	20 x 6
V	**Electrical Sub Assemblies maintenance**				
32.	Micro Processor Room	C	10 x 6	15 x 6	20 x 6
33.	Relays maintenance	C	10 x 6	15 x 6	20 x 6
34.	Contactors & Breakers room	C	10 x 6	15 x 6	20 x 6
35.	Speedometer Room	A	10 x 6	15 x 6	20 x 6
36.	Battery Maintenance Room	C	20 x 6	25 x 6	30 x 6
VI	**Supporting Sections**				
37.	Mech. Millwright	C	10 x 6	15 x 6	20 x 6
38.	Elec. Millwright	C	10 x 6	15 x 6	20 x 6
39.	Tool Room	C	15 x 6	20 x 6	25 x 6
40.	DM Plant	C	6 x 6	10 x 6	15 x 6
41.	Generator Room	C	15 x 6	20 x 6	25 x 6
42.	Laboratory	C	15 x 6	20 x 6	25 x 6

SN	Purpose	C/A/H	Requirement		
			<100	≥100 <175	≥175 <250
VII	**Amenities**				
43.	Canteen	C	15 x 10	20 x 6	25 x 6
44.	Staff rest room	C	10 x 6	15 x 6	20 x 6
45.	Ladies Dressing room	C	10 x 6	15 x 6	20 x 6
46.	Washing room for staff	C	10 x 6	15 x 6	20 x 6
47.	Urinals and toilets	C	16 x 6	25 x 6	30 x 6
B.	**Simple Shed without gantry, track and catwalk**		**18 x 160**	**18 x 200**	**18 x 240**
44.	Turbo & After cooler overhauling section	C	9 x 15	9 x 20	9 x 25
45.	Pumps & blowers overhauling section	C	9 x 15	9 x 20	9 x 25
46.	Cylinder head and valve lever overhauling section	C	9 x 15	9 x 20	9 x 25
47.	Compressor overhauling section	C	9 x 15	9 x 20	9 x 25
48.	Engine components	C	9 x 10	9 x 15	9 x 20
49.	Component cleaning shed	C	9 x 15	9 x 20	9 x 25
50.	Small Electrical rotating machines overhauling section.	C	9 x 20	9 x 25	9 x 30
51.	Electronic cabinets and rectifiers	C	9 x 20	9 x 20	9 x 30
52.	Machine shop	C	9 x 25	9 x 30	9 x 35
53.	Sand room	C	9 x 10	9 x 20	9 x 20
54.	N S Stores	C	18 x 30	18 x 35	18 x 40
55.	SMM stores	C	18 x 50	18 x 60	18 x 70
C.	**Simple Shed without gantry but with track**				
56.	Wheel Lathe Shed	C	10 x 40	10 x 40	2x10 x 40
D	**Simple shed without gantry but with track and catwalk**		**7 x 110**	**7 x 220**	**7 x 330**
57.	Loco Washing Shed	C	7 x 50	7 x 100	7 x 150
58.	Loco Paints shed	C	7 x 30	7 x 60	7 x 90
59.	Loco Load testing facility	C	7 x 30	7 x 60	7 x 90
E	**Heavy shed with gantry but without track and catwalk**		**18x50**	**18x70**	**18x85**
60.	Traction Alternator	C	9 x 20	9 x 30	9 x 30
61.	Traction Motor	C	9 x 40	9 x 50	9 x 60
62.	Radiator	C	9 x 20	9 x 30	9 x 40
63.	Engine Block	C	9 x 20	9 x 30	9 x 40
F	**Heavy Shed with Gantry, Track and without Catwalk**		**18x70**	**18x105**	**18x170**
64.	Under Truck overhauling	C	18 x 40	9 x 70	18 x 70

SN	Purpose	C/A/H	Requirement		
			<100	≥100 <175	≥175 <250
65.	Loco lifting	C	18 x 30	18 x 40	18 x 70
66.	Drop pit table	C	--	18 x 30	18 x 30
G	**Heavy Shed with gantry, track and Catwalk**		**18x70x2 (12 berths)**	**18x70x3 (18 berths)**	**18x70x4 (24 berths)**
67.	Light Schedules	C	18 x 70 (6 berths)	18 x 70 (6 berths)	18 x 140 (12 berths)
68.	Medium Schedules and special repairs	C	9 x 70 (3 berths)	18 x 70 (6 berths)	18 x 70 (6 berths)
69.	Heavy Schedules	C	9 x 70 (3 berths)	18 x 70 (6 berths)	18 x 70 (6 berths)

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Annexure – 3.10

List of Machinery & Plant and Tools required for Diesel Sheds

(This is a tentative list, sheds can review (delete/ add) depending on their exact requirements and latest technological advancements)

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
1.	**A. Material Handling / Transportation equipments**				
2.	EOT crane of 50/10 T Cap (with VVF drive)	H	1	2	3
3.	EOT crane of 40/10 T Cap (with VVF drive)	C	1	2	3
4.	EOT crane of 20/5 T Cap (with VVF drive)	C	1	1	2
5.	EOT crane of 10/5 T Cap (with VVF drive)	C	1	1	2
6.	EOT crane of 5 T Cap (with VVF drive)	C	2	3	4
7.	EOT crane of 3 T Cap(with VVF drive)	C	2	3	4
8.	Pillar crane of 0.5 T Cap	C	4	6	8
9.	Pillar crane of 1.5 T Cap	C	4	6	8
10.	Pillar crane of 2.0 T Cap	C	4	6	8
11.	Pillar crane of 3.0 T Cap	C	4	6	8
12.	Tram Beam Crane of 3 T Cap	C	2	3	4
13.	Fork lift truck of 5T Cap	C	2	4	6
14.	Fork lift truck of 3T Cap	C	2	3	5
15.	Battery operated platform truck of 2T Cap	C	3	4	6
16.	Road mobile crane of 10T Cap	C	1	2	3
17.	Synchronized Lifting jacks of 45T cap (in set of five)	H	2	3	4
18.	Synchronized Lifting jacks of 35T cap (in set of five)	C	2	3	4
19.	Lorry of 10T Cap	C	1	2	3
20.	Material handling Van fitted with crane	C	1	2	3
21.	Pickup Van	C	1	2	3
22.	Monorail with hoists for i. Battery Section ii. Cylinder head Section iii. Piston Assembly Section	C	2	3	4
23.	Material stackers	C	1	2	3
24.	Turn Table	C	1	1	1
25.	**B. Special purpose equipments**				
26.	CNC Under floor wheel lathe	C	1	2	3
27.	Drop Pit Table	H	1	1	2
28.	Hydraulic equipment for mounting & dismounting of crab nut and main bearing of HHP Locos	H	1	2	3

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Home

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
29.	Hydraulic equipment for mounting & dismounting of main bearing of ALCO Locos	A	1	2	3
30.	Huck Bolt installation & cutting equipment	H	1	2	3
31.	Traction Motor Pinion extractor for ALCO Locos	A	2	3	4
32.	Traction Motor pinion extractor for HHP Locos	H	2	3	4
33.	Cartridge Tapered Roller Bearing (CTRB) installer/ extracting equipment	H	1	2	3
34.	Surge comparison tester	C	1	2	3
35.	Microprocessor based Soldering/ De-soldering station	C	1	2	3
36.	Water Load box (with computerized recording)	A	1	2	3
37.	Engine Cranking Fixture	H	1	2	3
38.	Engine turning fixture for ALCO locos	A	1	2	3
39.	Engine turning fixture for HHP locos	H	1	2	3
40.	Traction motor cleaning plant (of suitable capacity, commensurate with the shed holding)	C	1	1	1
41.	Dehumidifiers for storage of electronic cards	C	2	3	4
42.	Electronic card reader	C	1	2	3
43.	Valve face grinding machine	C	1	2	3
44.	Valve seat grinding machine	C	1	2	3
45.	Lapping machine	C	1	2	3
46.	Exhaust Gas Analyser	C	1	2	3
47.	Nozzle re-conditioner for HHP Locos	H	1	2	3
48.	Electronic wheel diameter measuring gauge (LHS & RHS)	C	2	3	4
49.	Lapping Machine Injector nozzle seats	A	1	2	3
50.	Buffing Machine (Contact Tips Electrical Switch Gear)	A	1	2	3
51.	Pre Lube Pumping System	A	1	2	3
52.	Insert pressing/ removing fixture for crankcase assembly	H	2	3	4
53.	Lifter for radiator assembly	H	2	3	4
54.	Engine Lift device & hooking position, clamp for lifting idler gear stub shaft in horizontal position for HHP locos Part No. DLW: 15610287 & Drg. No. SK01GM0032	H	2	3	4
55.	Infrared Camera (Thermal Imager) for detecting high temperature spots	C	1	2	3
56.	Digital Storage Oscilloscope	C	1	2	3
57.	**C. General purpose equipments**				
58.	Diesel Generator set of 500 KVA	C	1	2	3
59.	Effluent Treatment Plant (of suitable capacity, commensurate with the shed holding)	C	1	1	1
60.	Incinerator (of suitable capacity, commensurate with the shed holding)	C	1	1	1
61.	Induction heaters for fitment of bearings	C	2	3	4
62.	Battery charger	C	2	3	4
63.	Centre Lathe	C	1	1	1
64.	Shaping machine	C	1	1	1
65.	Radial Drilling Machine	C	1	1	1
66.	Vertical Drilling Machine	C	1	2	3
67.	Magnetic Base Drilling Machine	C	2	3	4
68.	Vertical Surface Grinding Machine	C	1	2	3
69.	Marking Table 2 m X 1.5 m	C	1	2	3
70.	Hydraulic Press of 80T cap	C	1	1	1
71.	Gasket Die Punching Press	A	1	2	3
72.	Hydraulic Pipe Bending Machine	C	1	1	1
73.	Winching Machine	C	2	3	4
74.	Air assisted spray painting equipment	C	2	3	4

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
75.	Air Compressors	C	2	4	6
76.	Shot Blasting Machine	C	1	2	3
77.	Deep Freezer	C	1	2	3
78.	Electric air circulating oven	C	2	3	4
79.	DC welding plant (Inverter based)	C	4	6	8
80.	AC Welding plant (Inverter based)	C	4	6	8
81.	Portable generator cum welding set	C	2	3	4
82.	Power Hack Saw	C	1	1	1
83.	Staff Lockers	C	500	900	1300
84.	Material Storage Rack	C	As per shed requirement		
85.	Slotted Angle Storage Rack	C	As per shed requirement		
86.	Tool Storage Rack	C	As per shed requirement		
87.	Drawing Storage Rack	C	As per shed requirement		
88.	Laser marker for metallic objects	C	2	1	1
89.	Laser marker for non- metallic objects	C	2	1	1
90.	RFID and Bar Coder printer	C	2	1	1
91.	**D. Tools (Special purpose)**				
92.	Kiene Diesel Engine Pressure indicator to Alco cat no: 2478003	A	2	3	4
93.	Grinder, valve seat basic set to Alco Cat no: 2470225	A	2	3	4
94.	Power wrench set (torque Multiplier set) 7:1 to Alco Cat no: 2470195, cylinder head to Alco Cat no: 2470198 (251 in line), cylinder head to Alco Cat no: 2470197 (251 v)	A	2	3	4
95.	Gauge Elongation Con rod to Alco Cat no: 2470043	A	2	3	4
96.	Gauge elongation main Drg to Alco Cat no: 247004	A	2	3	4
97.	Wrench for Inter Main Bearing Bolts to Alco Cat no: 2471101	A	2	3	4
98.	Wrench LH main Drg Belt to Alco Cat no: 2471103	A	2	3	4
99.	Wrench RH main Drg Belt to Alco Cat no: 2471104	A	2	3	4
100.	Portable tachometer frequency indicator (for engine speeds, speed relay calibration) to Alco Cat no: 8943485 G2	C	4	6	8
101.	Electric hand tachometer with adaptors and carrying case Alco Cat no: 8943485 G2	C	8	12	15
102.	Megger hand operated 0 to 2000 megaΩ 100 volts with 12 foot leads (James D Biddle Co. 7680 Testing resistance of insulation) to Alco Cat no: 101X910	A	2	3	4
103.	Hand pyrometer with rigid extension and Prong extension arm and carrying case to Alco Cat no: 582X70	A	2	3	4
104.	Special tools for dismantling compressor valves	C	2	3	4
105.	Pin Insertion / Extraction Tool for square pins in CPC connectors to Part No. 91019-3 of Tyco Electronics or equivalent make.	C	8	12	15
106.	Pin Insertion tool kit consisting of 3 tools in a leather case to Part No. KA-260, A-4598, A-4599 and A-4600 of Jonard or equivalent make.	H	2	4	4
107.	Pin Extraction/Removal tool kit consisting of 3 tools in a leather case to Part No. KA-260, R-4601, R-4602 and R-9461 of Jonard or equivalent make.	H	2	4	4
108.	Crimping tool for governor Amphenol plug AF8 along with gauge and turret Head to Part No. M22520/1-01, M22520/3-1 & TH 185 of AMP or equivalent make.	H	2	4	4
109.	Hand crimping tool for CPC round pin to Part No. 91521-1 of AMP or equivalent	H	2	4	4
110.	Hand crimping tool for EM2000 pin to Part No. 91523-1 of AMP or equivalent	H	2	4	4
111.	Hand crimping tool for EM2000 pins to Part No. 91515-1 of AMP or equivalent make.	H	1	2	2
112.	Micrometer Adjustable Click wrenches ½" drive, range 50 – 250 lb.ft, increment 1lb.ft, length 22½ inches of Sweeney or Precision or equivalent make.	H	4	8	8

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
113.	Engine cylinder compression testing equipment with adaptor to EMD part no 9572281	H	2	4	4
114.	Bearing puller with three legs forged steel of various sizes	H	2	4	4
115.	Hook and clamp for lube oil strainer to DLW part No. 15610238 & Drg No. MT01GM 0041	H	1	2	2
116.	Alignment fixture for water pump to DLW part No. 15630031 & Drg No. MT21GM0031	H	2	4	4
117.	Pressing Tool for valve guide to DLW Part No. 15610500 & Drg No. MT01GM0145	H	8	16	16
118.	Injector pry bar to DLW Part No.15610720 & Drg No. MT01GM0176	H	4	8	8
119.	Head frame seal inserter to DLW Part No.15610792 & Drg No. MT01GM0184	H	4	8	8
120.	Box Socket Wrench – Half moon 5/8” x 3/4” to DLW Part No.15610810 & Drg No. MT01GM0186	H	4	8	8
121.	Wrench for Governor to DLW Part No. 15610706 & Drg No. MT02GM0175	H	2	4	4
122.	Guide-valve bridge snaps ring installing to DLW Part No.15610755 & Drg No. MT05GM0131	H	4	8	8
123.	Installer for Water pump impeller to. DLW Part No. 15610615& Drg No. MT05GM0168	H	4	8	8
124.	Trammel for valve height checking to DLW Part No. 15610652 & Drg No. MT05GM0172	H	4	8	8
125.	Water pump disassembly tool to DLW Part No. 15610822 & Drg No. MT05GM0187	H	4	8	8
126.	Socket for main Rectifier Diode removing to DLW Part No.15620013 & Drg No. MT21GM0191	H	4	8	8
127.	Power Assembly removing tool to DLW Part No. 15610184 & Drg No. MT01GM0097	H	16	20	32
128.	Wire brush for P-pipe cleaning to DLW Part No. 15610536 & Drg No. EQ04G40052	H	4	8	8
129.	Reamer for Cylinder test valve seat to DLW Part No.15610883 & Drg No. MT01GM0194	H	8	10	10
130.	Injector timing gauge to DLW part No. 15610263 and Drg No. MT01GM0083	H	8	16	16
131.	Clamp for back lash checking to DLW Drg No. SK01GM0114	H	2	4	4
132.	Guide pin to line up oil pan to crank case during assembly to DLW Drg No. MT01GM0136	H	1	2	2
133.	Set consists of 1) Installer for Hydraulic lash adjuster to DLW Drg No. MT01GM0171 2) Pressing tool to EMD/DSL/UBL Drg No. TU/206/01	H	4	8	8
134.	Jacking tool for accessory drive to DLW Drg No. MT01GM0111	H	2	4	4
135.	Distance gauge #2 Idler gear stub & L.S. Cam shaft & R.S Cam Shaft to DLW Drg No. GP01GM0009	H	1	1	1
136.	Master for setting gauge to DLW Drg Nos. GP01GM0009 & GP01GM0238	H	1	1	1
137.	Digital Protractor for measuring radar angle to Model no. Angle Star DP45 of make Schaevitz sensors or equivalent	H	4	8	10
138.	LCR meter to Part No. LCR-24 of Chy make or equivalent	H	1	1	1
139.	Digital master clock to RDSO Specification No. RDSO/SPN/TC/ 62/2008	H	1	1	1
140.	Insulation resistance tester 0-5000V & 0-500V to model No MIT 510/2 of Meggar or equivalent	C	8	12	15

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
141.	Digital multi meter 3.5 digits & 4.5 digits to Model No. 1009 of Kyoritsu or equivalent	C	15	20	20
142.	Extracting tool for Pin & Socket of EM2000 to EMD part No. 9576512 or equivalent	H	4	6	6
143.	Automatic wire stripper to EMD Part No 8147749	H	4	6	6
144.	Wire Crimper (width 4AWG) to EMD Part No 8166676	H	2	4	6
145.	Wire Crimper (width 8AWG) to EMD Part No 8159240	H	2	4	6
146.	Pin Extracting tool (8 pin/socket EM2000) to EMD Part No 40060038	H	1	2	4
147.	Extraction tool for interface module contacts to Part No 9081-0-0 of Positronic industries or equivalent	H	1	2	4
148.	ESD work bench	H	1	2	2
149.	Tread wear Gauge	C	8	2	15
150.	Liquid Nitrogen cryocan	C	2	3	4
151.	Lifter 'G' turbocharger to EMD Part No 40053534	H	2	3	4
152.	Holding fixture for crankshaft with crank case	H	2	3	4
153.	Alignment gauge with dial indicator for oil pan to crankcase	H	2	3	4
154.	Accessory housing alignment gauge (oil pump holes)	H	2	3	4
155.	Line up indicators gauge to set up of stub shaft from crankshaft & camshaft.	H	2	3	4
156.	Arrangement for alignment of Left Side water pump in HHP locos	H	2	3	4
157.	Backlash check gauge on starter gear & bracket assembly	H	2	3	4
158.	Lifter for Auxiliary Generator assembly	H	2	3	4
159.	Lifter for bearing caps.	H	2	3	4
160.	Leak test gauge attachment (for HHP Power pack assembly)	H	2	3	4
161.	Lifting arrangement for head frame	H	2	3	4
162.	Clamp for lifting cylinder Head.	H	2	3	4
163.	Try square12"(Std) for counter weight setting accessory End.	H	2	3	4
164.	Steel straight edge 36" for counter setting accessory End.	H	2	3	4
165.	Arrangement for alignment of Right Side water pump in HHP locos.	H	2	3	4
166.	Pointer disc used for timing engine.	H	2	3	4
167.	Gauge with dial indicator for cam shaft drive housing alignment.	H	2	3	4
168.	Counter weight alignment gauge at camshaft drive end.	H	2	3	4
169.	Gauge for injector rack setting	H	2	3	4
170.	Hook for lifting accessory drive housing.	H	2	3	4
171.	Alignment gauge to check lineup of oil pan & crank case on cam shaft drive end	H	2	3	4
172.	Piston holder for power pack drop (lifting device)	H	2	3	4
173.	Reaming fixture for oil pan with starter motor bracket.	H	2	3	4
174.	Reaming fixture & plug to be used to ream stub shaft to crank case plate	H	2	3	4
175.	Assembly fixture for connecting rod carrier & piston pin.	H	2	3	4
176.	Piston ring compressor guide (std)	H	2	3	4
177.	Clamp lifter for cylinder liner assembly.	H	2	3	4
178.	Cleaning tool for water seal counter bore in cylinder liner	H	2	3	4
179.	Wire brush for cleaning of crankcase lube oil manifold	H	2	3	4
180.	Line up tooling for engine to compressor applied to shaft	H	2	3	4
181.	Lifter for cooling fan assembly.	H	2	3	4
182.	HHP loco alternator & engine alignment device	H	2	3	4
183.	Gauge for alignment of driving end auxiliary generator (mount on shaft dia)	H	2	3	4
184.	Mounting arrangement on flange dia of dial gauge for alignment of driving end auxiliary generator.	H	2	3	4
185.	Cradle for four power pack.	H	2	3	4

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
186.	Gauge to check length & twist of connecting rod fork.	H	2	3	4
187.	Gauge to check length & twist of connecting rod blade	H	2	3	4
188.	Spring depressor (cylinder head valve & valve lever)	H	2	3	4
189.	Jacking tool for adjusting & lining up accessory drive housing on Crankcase.	H	2	3	4
190.	Crankcase line up fixture for oil pan assembly.	H	2	3	4
191.	Spanner bar to check flexing of accessory drive gear assembly.	H	2	3	4
192.	Bracket lifter for assembly of camshaft housing.	H	2	3	4
193.	Lifting device for turbo air duct assembly.	H	2	3	4
194.	Locating pad for end crab cylinder head at accessory end.	H	2	3	4
195.	Crankcase line up fixture (small length) for oil pan assembly.	H	2	3	4
196.	Jack for Governor injector linkage.	H	2	3	4
197.	Lifter for After cooler core assembly.	H	2	3	4
198.	Template to check line up of oil pan & crankcase on cam shaft on accessory end.	H	2	3	4
199.	Mandrel for assembly/ disassembly for valve guide (HHP Loco)	H	2	3	4
200.	Doweling fixture for Generator	H	2	3	4
201.	Upper Main bearing shell remover	H	2	3	4
202.	Lash adjuster minimum clearance gauge	H	2	3	4
203.	Wrench for cylinder test valve	H	2	3	4
204.	Gauge block for lash adjuster test stand	H	2	3	4
205.	Eye bolt for lifting piston	H	2	3	4
206.	Cylinder liner lifter (Style-II)	H	2	3	4
207.	Wrench basket Bolt & Nut	H	2	3	4
208.	Lead wire holder	H	2	3	4
209.	Rod for TDC checking	H	2	3	4
210.	Gauge Block 1"	H	2	3	4
211.	Wrench injector assembly.	H	2	3	4
212.	Pin vice for pin 0.0" - 0.40" dia	H	2	3	4
213.	Cooling System Test Kit	H	2	3	4
214.	Pneumatic Torque Kit for Cylinder	H	2	3	4
215.	Manual Cylinder Crab Nut Torque Kit	H	2	3	4
216.	Universal Piston and Rod Retainer	H	2	3	4
217.	Inertial Filter Lifter	H	2	3	4
218.	Water Pump Lifter	H	2	3	4
219.	Fork Rod Support	H	2	3	4
220.	Compression Release Adapter	H	2	3	4
221.	Brake Valve Lifter	H	2	3	4
222.	EMD Starter Motor Lifter	H	2	3	4
223.	Cantilever Lifters for Various Loco Component Handling	H	2	3	4
224.	Radiator Cap Tester	H	2	3	4
225.	Main Alternator Lifter	H	2	3	4
226.	Traction Motor Axle Cap Torque Kit	H	2	3	4
227.	AR10 Alternator Bearing Housing Puller with 115V Electric Pump	H	2	3	4
228.	Power Assembly Lifter	H	2	3	4
229.	Exhaust Stack Wrench	H	2	3	4
230.	Turbocharger Screen Lifter	H	2	3	4
231.	Roots Blower Lifter	H	2	3	4
232.	Forklift “C” Frame Lifter	H	2	3	4
233.	Lapping Machine for Cylinder head face.	A	1	2	3
234.	Lapping Machine for HP Tube	A	1	2	3
235.	ECC Slip Ring Puller	A	1	2	3

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
236.	Special type puller for removing of ECC bearing	A	1	2	3
237.	Traction Alternator slip ring machining arrangement	A	1	2	3
238.	Boroscope	C	1	2	3
239.	**E. Tools (General purpose)**				
240.	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 spanners	A	400	700	1000
241.	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 spanners	H	200	350	500
242.	William/ ALCO spanners	A	5	6	8
243.	Half moon spanners	A	5	6	8
244.	Adjustable spanners	C	5	10	15
245.	Socketry (in sets)	C	8	12	15
246.	T handles	C	8	12	15
247.	Hex. Allen key (in sets)	C	4	6	8
248.	Sq. allen keys (in sets)	C	4	6	8
249.	Pipe wrenches	C	4	6	8
250.	Hammers	C	4	6	8
251.	Chisels	C	8	12	15
252.	Punches	C	8	12	15
253.	Non contact type thermometer	C	8	12	15
254.	Industrial vacuum cleaner	C	4	6	8
255.	Hydraulic jacks with pump of various capacities	C	4	6	8
256.	Hydraulic crimping tool	C	4	6	8
257.	Hand Crimping tool	C	8	12	15
258.	Hydraulic Cable cutter	C	4	6	8
259.	Hand Cable cutter	C	4	6	8
260.	Pneumatic angle die grinder	C	4	6	8
261.	Pneumatic Impact wrench	C	8	12	15
262.	Electrical impact wrench	C	8	12	15
263.	Angle grinder	C	4	6	8
264.	Drilling machine	C	8	12	15
265.	Cordless drilling machine	C	8	12	15
266.	Orbital Sander	C	4	6	8
267.	Chop saw	C	4	6	8
268.	Snap gauge	C	8	12	15
269.	Dial bore gauge	C	8	12	15
270.	Digital Bore gauge	C	8	12	15
271.	Air bore gauge	C	8	12	15
272.	Cable stripper	C	4	6	8
273.	Lux meter	C	4	6	8
274.	Digital Megger	C	8	12	15
275.	Leakage current tester	C	4	6	8
276.	Electronic Stethoscope	C	4	6	8
277.	Nozzle centering tool	C	4	6	8
278.	True running gauge	C	4	6	8
279.	Air plasma cutting machine	C	4	6	8
280.	Gas welding set	C	4	6	8

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			<100	≥100 <175	≥175 <250
281.	Machine lamps	C	25	30	40
282.	Electrode oven	C	4	6	8
283.	Pedestal grinder	C	3	4	5
284.	Tool grinder	C	4	6	8
285.	Micro meters inside and outside of various sizes	A	2	2	2
286.	Swivel handle	C	8	12	15
287.	Distance piece	C	5	8	10
288.	Cutting plier	C	10	12	15
289.	Screw driver	C	10	12	15
290.	Philips screw driver	C	10	12	15
291.	Drill bit (in sets)	C	8	12	15
292.	Hand taps (in sets)	C	8	12	15
293.	Screw extractor (in sets)	C	8	12	15
294.	Files	C	8	12	15
295.	Chain pulley	C	2	4	6
296.	Outside caliper	C	4	6	8
297.	Inside caliper	C	4	6	8
298.	Digital Vernier Calipers of size 0-150 mm & 0-200 mm	H	4	6	8
299.	Vernier caliper (with digital display and printout facility)	C	8	12	15
300.	Micrometer (with digital display and printout facility)	C	8	12	15
301.	Pitch gauge	C	8	12	15
302.	Dial gauge (with digital display and printout facility)	C	8	12	15
303.	U tube manometer	C	2	3	4
304.	Bench vice	C	8	12	15
305.	Tri square	C	4	6	8
306.	Surface plate	C	2	3	4
307.	Grease gun	C	8	12	15
308.	Applicator gun for sealant	C	8	12	15
309.	Feeler gauge (in set)	C	25	40	60
310.	Feeler gauge of range 0.03-0.50 mm to Model No. 184-302 of Mitutoyo or equivalent make.	H	8	12	15
311.	Simpson Multimeter	C	8	12	15
312.	Multi meter with probe to measure high voltage up to 6000 volts	C	2	4	6
313.	Clamp on meter for measuring AC/DC voltage and current	C	8	12	15
314.	Volt Meter 0-1500	C	2	4	6
315.	Hydrometer for checking specific gravity	C	10	15	20
316.	Depth gauge	A	2	4	6
317.	Pitch Gauge of range 0.4 to 7 mm to Model No. 188-122 of Mitutoyo or equivalent make.	H	4	6	8
318.	Screw Pitch Gauge of range 4 - 42 TPI to Model No. 188-111 of Mitutoyo or equivalent make.	H	4	6	8
319.	Heat gun of temperature range 50 – 600° C to Model No: D 26414 of DEWALT or equivalent make.	C	4	6	8
320.	Tool kit consisting of sockets and ratchet to Model No. 3261-01 of Force or equivalent make	H	8	10	12
321.	4 ½ Digit Digital Micro ohmmeter with measuring range 1 micro ohm to 20 kilo ohm in 07 ranges	H	4	6	8
322.	Digital clamp meter with accessories to Model No. 2003A of Kyoritsu or equivalent make.	H	8	12	15
323.	Tool kit consisting of sockets and ratchet and screw driver to Model 4246 of Force or equivalent make.	H	8	12	15

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			<100	≥100 <175	≥175 <250
324.	Back Plunger Type dial Gauge (0.001 inch to 0.1 inch) to Model F-52 of Baker or equivalent make.	H	4	6	8
325.	Digital External Micrometer (0 to 25 mm) to Model No. DMIC25-1 of Baker or equivalent make.	H	4	6	8
326.	Milliohm meter to Model No GOM-802 of GW Instek or equivalent make.	H	4	6	8
327.	Hand Crimping Tool for size 10-22 AWG to Part No. 59824-1 TETRA-Crimp Hand Tool of Tyco Electronics or equivalent make.	H	2	4	4
328.	Hand crimping tool for terminal wire (size 4-8 AWG) to Part No. 600850-1 of TYCO or equivalent make.	H	2	4	4
329.	Crimping tool big square contacts to Part No. 90382-2 of TYCO or equivalent make.	H	2	4	6
330.	Engraving Machine	C	8	12	15
331.	Digital Laser Alignment Tool	C	4	4	8
332.	Oil bath Chamber for heating of different types Ball/Roller Bearing	C	1	2	3
333.	**F. Testing equipment (Mechanical)**				
334.	FIP test stand	A	1	2	3
335.	Woodward Governor test stand	C	1	2	3
336.	Injector test stand for HHP Locos	H	1	2	3
337.	MUI injector test stand for HHP Locos	H	1	2	3
338.	OSTA test stand	A	1	2	3
339.	Main bearing elongation test stand	A	1	2	3
340.	Bearing Health Analyser	C	1	2	3
341.	Spring testing machine	C	1	2	3
342.	Dynamic Balancing machine	A	1	2	3
343.	Air compressor test stand	C	1	2	3
344.	Bogie running and checking test stand	C	1	2	3
345.	Engine compression testing equipment	C	5	5	7
346.	Engine blow-by testing equipment	A	2	3	4
347.	Cylinder Head test stand	C	1	2	3
348.	Hydraulic Shock Absorber test stand	C	1	2	3
349.	Air Brake test stand (for conventional Brakes- IRAB1)	A	1	2	3
350.	Air brake test stand for various valves of CCB (in set)	A/ H	1	2	3
351.	Air Drier test stand	C	1	2	3
352.	Lash Adjuster test stand	H	1	2	3
353.	EPD test stand	H	1	2	3
354.	Torque Calibrator	C	1	2	3
355.	Pneumatic Gauge Calibrator	C	1	2	3
356.	Computerized SFC Recorder	A/ H	1	2	3
357.	Fuel/Lube oil systems valves test rig	A	1	2	3
358.	Test rig for pressure and temperature gauges	A	1	2	3
359.	Hydraulic pump for testing of radiator	C	2	4	6
360.	Explosion Door testing apparatus	A	1	2	3
361.	Small Bearing lateral play checking gadget	C	2	3	4
362.	Cylinder head spring test stand	A	2	3	4
363.	Fuel oil T-Jumper Testing Gadget	A	2	3	4
364.	Test Bench for Dynamic testing of RTTM Blower	A	1	2	3
365.	Test Bench for checking LWS operation	A	2	3	4
366.	Test Bench for calibration of fuel oil relief, regulating valve pressure & orifice test	A	2	3	4
367.	Fuel injection high pressure tube profile measuring gadget	A	2	3	4

S N	Description	C/ A/ H	Shed Holding (Locos) <100	≥100 <175	≥175 <250
368.	Testing gadget of After Cooler	A	2	3	4
369.	Test bench to test the performance and functionality of the sanding gear, magnet valves, sanding jet, conveyor etc	A	2	3	4
370.	Calibration stands for temperature and pressure transducers	C	1	2	3
371.	**G. Testing equipment (Electrical)**				
372.	AC fuel pump motor test stand	C	1	2	3
373.	5 KV Digital Analog insulation tester	C	1	2	3
374.	Traction motor trial run equipment for ALCO locos	A	1	2	3
375.	Traction motor trial run equipment for HHP locos	H	1	2	3
376.	Battery conductance analyser	C	2	3	4
377.	819 LCR Bench meter	C	1	2	3
378.	Radiator fan (AC) trial run equipment	H	1	2	3
379.	Speed Sensor calibrator	C	1	2	3
380.	Temperature Sensor calibrator	C	1	2	3
381.	IC testing equipment	C	1	2	3
382.	Breakers & Relays test stand	C	1	2	3
383.	Speedometer test stand	A	1	2	3
384.	High Potential Test Set	C	2	3	4
385.	Gadget for checking spring tension of Hydraulic Governor	A	1	2	3
386.	Test bench for oil leakage from Hydraulic Governor pump & pipe	A	1	2	3
387.	Test bench for Illumination intensity of Twin beam head light	A	2	3	4
388.	Circuit breaker test stand	A	2	3	4
389.	Test stand for Auto Flasher Light	A	2	3	4
390.	Test bench for calibration of Load Meter	A	1	2	3
391.	Sensor testing unit Equipment	A	1	2	3
392.	Traction Motor carbon brush holder spring tension checking test bench	A	1	2	3
393.	Inter lock Over Travel Test Stand	A	2	3	4
394.	BKT & Reverser Test Bench	A	1	2	3
395.	Dynamic Brake controller test stand	H	1	2	2
396.	DCL motor test stand	H	1	2	2
397.	Contactor & Relay Test Stand	H	1	2	2
398.	Meter calibration test stand	H	1	2	2
399.	SCR bridge test stand	H	1	2	2
400.	MU signal test box	H	1	2	2
401.	Temperature sensor calibration stand	H	1	1	2
402.	Clip Station for testing of electronic cards	C	1	2	3
403.	**H. Cleaning Equipments**				
404.	High pressure jet cleaning plant	C	2	4	6
405.	Diesel Engine Component cleaning plant	C	1	2	3
406.	Ultra sonic nozzle cleaning plant	C	1	2	3
407.	Radiator Internal Cleaning Plant	A/ H	1	2	3
408.	Radiator External Cleaning Gadget	A/ H	1	2	3
409.	Oil fired Boiler	C	1	2	3
410.	Bosch Tank for cylinder head cleaning (having provision of internal circulation and stirring)	C	1	2	3
411.	Bosch tank for bogie frame cleaning	C	1	2	3
412.	Cylinder head valve cleaning plant				
413.	Car body cleaning plant	A	1	2	3
414.	Mechanized Loco Washing and Cleaning Equipment	C	1	2	3
415.	Piston Cleaning Equipment	C	1	2	3

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
416.	Floor scrubber	C	6	8	10
417.	In-situ Plate Type Lube Oil Cooler cleaning gadget	A	1	2	3
418.	**I. Canteen Equipments**				
419.	Cooking Utensils	C	As per shed requirement		
420.	Eating and Serving utensils	C	As per shed requirement		
421.	LPG gas	C	As per shed requirement		
422.	Hot Case	C	As per shed requirement		
423.	Hot and cold water dispensing unit with filtration plant of adequate capacity	C	As per shed requirement		
424.	Microwave	C	As per shed requirement		
425.	Tea & Coffee dispensing unit	C	As per shed requirement		
426.	Seating and serving infrastructure	C	As per shed requirement		
427.	Audio Video Display unit	C	As per shed requirement		
428.	Dishwasher	C	As per shed requirement		
429.	Automatic Chapatti maker	C	As per shed requirement		
430.	Grinders	C	As per shed requirement		
431.	Deep freezer	C	As per shed requirement		
432.	Refrigerator	C	As per shed requirement		
433.	Air cooling system	C	As per shed requirement		
434.	**J. Training School Equipments**				
435.	Pick up van for trainees	C	1	2	2
436.	Simulator (of suitable capacity, commensurate with the shed holding)	A	1	1	1
437.	Simulator (of suitable capacity, commensurate with the shed holding)	H	1	1	1
438.	Digital Writing Boards	C	3	4	5
439.	Multimedia projector	C	3	2	1
440.	Slide Projector	C	3	2	1
441.	DVD player	C	3	2	1
442.	Overhead Projector	C	3	2	1
443.	Epidiascope	C	3	2	1
444.	Handycams	C	3	2	1
445.	Digital Camera	C	3	2	1
446.	Computer	C	5	4	3
447.	Notebook Computer	C	3	2	1
448.	Printers	C	5	4	3
449.	Scanners	C	3	2	1
450.	Photocopier	C	3	2	1
451.	Lamination Machine	C	3	2	1
452.	Paper cutting machine	C	3	2	1
453.	Spiral binding machine	C	3	2	1
454.	Cut Away Models of various parts of locos, both Alco and HHP	C	As per requirement		
455.	Working Models of various parts of locos, both Alco and HHP	C	As per requirement		
456.	**K. Other items**				
457.	Automatic Fire Alarm System	C	As per shed layout		
458.	Garbage Compactor	C	1	2	3
459.	Hazardous waste compactor (stainless steel)	C	1	2	3
460.	Steel Turning Compactor (boiler)	C	1	2	3
461.	CCTV camera	C	As per shed layout		
462.	Air Curtains	C	As per shed layout		
463.	Centralized Greasing system	C	As per shed layout		

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
464.	Lube oil dispensing system	C	As per shed layout		
465.	Mobile dispensing unit for Suspension Bearing oil				
466.	Pneumatic dispensing unit for cardium compound				
467.	Oil centrifuging and filtering plant (of capacity suitable to shed holding)	C	1	1	1
468.	Electronic meters for remote relaying of data for lube oil, fuel oil, water & oil/greasing compound for Traction Motor gear case	C	As per shed layout		
469.	Compactor optimizer for storage of files	C	As per shed layout		
470.	Vehicle for shed in-charge	C	1	1	1
471.	Vehicles for officers for inspection purpose	C	2	3	4
472.	RTE based communication system	C	As per shed layout		
473.	Computers (having LAN connection)	C	30	40	50
474.	Online printers	C	2	3	4
475.	Xerox machine cum printer A3 size	C	2	3	4
476.	Printers (of various capacities, mono/multicolor)	C	10	15	20
477.	A0 size scanner, plotter cum copier	C	1	2	2
478.	Fax machine	C	4	6	8
479.	Intercom facility (With electronic exchange of 100 lines or more, as per shed holding)	C	1	1	1
480.	V.H.F. SETS (Walkie-Talkie)	C	15	20	25
481.	Video surveillance system for monitoring of shed activities (as per shed size and holding)	C	1	1	1
482.	Wheel set trolley/towing equipment for Diesel Locos	C	1	2	2
483.	**L. Laboratory Equipment**				
484.	**Equipment for testing lubricating oils**				
485.	**For viscosity determination**				
486.	Constant temperature water bath for kinematic viscosity as per IS -1448 Part–I, P25-1960	C	2	3	4
487.	Cannon-Fe Kinetic Viscometer tubes calibrated No. 350	C	6	8	10
488.	Thermometer ASTM 28 F and 46 F	C	6	8	10
489.	Stop watches	C	4	6	8
490.	Rubber solution bulbs (in sets)	C	1	2	3
491.	**For fuel dilution de-termination**				
492.	Pensky Martens open Flash Tester with thermometers I.P. 15F and IP 16 F	C	1	2	3
493.	Cleveland open cup ASTM-D.92	C	1	2	3
494.	Small petrol gas generator	C	1	2	3
495.	**For water contamination test**				
496.	Hot plate with variable temperature control 2000 watts.	C	4	6	8
497.	Porcelain crucibles about 40 mm dia. (in sets)	C	1	2	3
498.	Pair of tongs in different sizes (in sets)	C	4	6	8
499.	Dean and stark water determination apparatus with ground glass joints 500cc flask 2 cc receiver and a suitable electric heater.	C	1	2	3
500.	**For ash content test.**				
501.	Muffle furnace with calibrated pyrometer max temperature range up to 1000°C	C	1	2	3
502.	Silica of Porcelain crucibles	C	1	2	3
503.	Desiccators	C	1	2	3
504.	Balance Analytical (preferably Chainmatic)	C	1	2	3
505.	Balance Physical capable of reading up to 10mg	C	2	3	4
506.	**For sediment content test.**				
507.	Variable speed centrifuge (as per ASTM D-893)	C	1	2	3
508.	Centrifuge tubes cone shaped (as per ASTM D-893)	C	1	2	3

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
509.	**For Neutralisation value test.**				
510.	Apparatus for Neutralization value determination by potentiometer titration – as per ASTM D-664.	C	2	3	4
511.	Alkali resistant conical flasks capacity 250cc	C	4	6	8
512.	Microburette	C	8	12	15
513.	**Blotter test**				
514.	Whatman No1 or any good quality analytical filter paper to be used.	C	As per shed requirement		
515.	**Miscellaneous Equipment**				
516.	Air oven Range up to 150°C	C	1	2	3
517.	Lubricating oil sampling gun.	C	4	6	8
518.	Dark field microscope for determining qualitatively the condition of additives in lubricating oil	C	1	2	3
519.	Chemicals and reagents for qualitative analysis of metals and quantitative analysis of water	C	As per shed requirement		
520.	Miscellaneous glass apparatus like test tubes breakers , flasks etc.	C	As per shed requirement		
521.	**Equipment for Testing Greases**				
522.	Penetrometer with accessories including ‘grease worker’ as per I P 50/48 or ASTM D-217	C	1	2	3
523.	Drop point apparatus as per ASTM D-566	C	1	2	3
524.	**Equipment for Testing Diesel fuels :**				
525.	**Density/ Specific gravity test:**				
526.	(i) Graduated hydrometer of floating type – Range 0.500 to 1.000	C	6	8	10
527.	(ii) Thermometer – Range 0 to 110°C	C	2	4	6
528.	Viscosity – Cannon Fenske viscometer tubes no. 100	C	2	4	6
529.	Flash point- Pensky- Martens and closed flash point apparatus with suitable thermometer –IS-1448 pt. I.P.21-1960	C	1	2	3
530.	Total Sulphur – Bomb calorimeter with accessories	C	1	2	3
531.	Carbon residue -	C			
532.	Rems bottom carbon residue apparatus including calibrated pyrometer	C	1	2	3
533.	Cocking bulbs- Pyrex type (for the replenished as per use)	C	2	3	4
534.	Distillation apparatus as per ASTM D-158 with 6 Nos of distillation flasks	C	1	2	3
535.	Thermometer ASTM 8 F	C	**4**	6	8
536.	Apparatus for determination of Existent Gum content in fuels as per ASTM D-381	C	**1**	2	3
537.	**Equipment for Engine Cooling Water Test :**				
538.	Chloride test :				
539.	Porcelain (China) dish 80mm dia	C	2	4	6
540.	Burettes 50 ml capacity graduated	C	4	6	8
541.	Pocket Refractometer to determine the oil content to the emulsion	C	3	4	5
542.	**Equipment for Testing Metallic Wear**				
543.	Spectrograph	C	1	2	3
544.	**Rubber Testing** :				
545.	Durometer – Shore– A Hardness Tester	C	1	2	3
546.	Electric Oven – for ageing characteristics, temperature range up to 250 °C	C	2	3	4
547.	Swelling Test apparatus Pyrex Beakers – 4 Branded mineral oils of known characteristics.	C	1	2	3
548.	Soxhlet Apparatus - for extraction.	C	1	2	3
549.	Rubber Tensile Testing Machine with Dumbbelt cutters to prepare test specimens capacity 250 to 500 kg max.	C	1	2	3

S N	Description	C/ A/ H	Shed Holding (Locos)		
			<100	≥100 <175	≥175 <250
550.	**Metal Hardness tester :**				
551.	Portable Surface hardness tester	C	2	3	4
552.	Ultrasonic Hardness Tester	C	4	6	8
553.	Horizontal Tensile Testing Machine (40 T)	C	1	2	3
554.	**Miscellaneous Equipments**				
555.	DM/RO Plant for maintenance purpose (of suitable capacity, commensurate with the shed holding)	C	1	1	1
556.	Distilled water plant	C	1	1	1
557.	RO Plants of 500 litres capacity (for shed staff)	C	4	6	8
558.	Ultrasonic flaw detector	C	2	3	4
559.	Zyglow testing machine	C	1	2	3
560.	Magnetic particle testing machine	C	1	2	3
561.	Fume Chamber	C	1	2	3
562.	Grease debris analyzer	C	1	2	3
563.	Electrolysis apparatus	C	1	2	3
564.	Portable gloss-meter	C	1	2	3
565.	Metallographs	C	1	1	1
566.	Magna flux testing equipment	C	1	2	3
567.	Magnifying glass	C	4	6	8
568.	Dye Penetration Testing Equipment	A	1	2	3

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Chapter 4

System of Maintenance

4. SYSTEM OF MAINTENANCE

4.1 Objective: Indian Railways (IR) follows the system of preventive maintenance for its Rolling Stock so as to achieve the maximum possible availability and reliability in service. The system of preventive maintenance envisages a schedule for maintenance attention at regular specified intervals including replacement of components. It aims to replace the components before they actually fail in service due to ageing, wear and tear, while also endeavoring to obtain maximum life possible for the components. The system also aims at synchronization of attention to all related components so that the manpower and engine-days lost on account of the examination is minimized.

However, IR needs to introduce the concept of predictive maintenance to bring down both cost and as well as down time for maintenance. To achieve this, it is necessary to lay down a list of parameters which are required to be monitored remotely and also during the last shed attention paid to arrive at the decision about next schedule to be given to the loco. Remote monitoring is an essential requirement in achieving this objective. It is recommended that, few locos should be put on trial on the system of predictive maintenance.

4.2 Basis of Maintenance : The system of preventive maintenance has evolved on one of the following criterion:

i. Time;
ii. KM;
iii. Engine hours

Time basis is used for scheduling the preventive maintenance of diesel locos due to its simplicity. Time involved between schedules being adjusted according to the utilization of the locos. However, for POH of Alco locos, both time and Km basis is presently specified i.e. 10 lac Km or 8 years, whichever is earlier.

4.2.1 **Frequency of Maintenance Schedule:** Periodicity of various maintenance schedules of Alco Locos have been enhanced substantially since the introduction of WDM2 locos. The schedule and periodicity of various maintenance schedules of Alco and HHP locos are presently prescribed in the following documents of RDSO:-

4.2.1.1 MP-MISC.-140 (Rev.1) of Sept’06- Schedule of Standard Examinations of Alco Locos of 2600 & 3100 HP with plain suspension bearings

4.2.1.2 MP-MISC.-141(Rev.1) of Sept’06- Schedule of Standard Examinations of Alco Locos of 3100 & 3300 HP with roller suspension bearings

4.2.1.3 MP-MISC.-212 of May’08 and Railway Board’s letter dated 2003/M(L)/466/20 dated 27th June’08 for enhancing trip schedule periodicity of 3100 & 3300 HP Alco locos to 30 days

4.2.1.4 MP-MISC.-236(Rev.0) of July'09 and Railway Board's letter 2003/M(L)/466/20 dated 13th May'10 for enhancing trip schedule periodicity of 3100 & 3300 HP Alco locos to 40 days

4.2.1.5 MP-MISC.-285 of Aug'12- Schedule of Standard Examinations of HHP Locos of 4000 & 4500 HP

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4.2.1.6 MP-MISC.-285 of Aug'12- Schedule of Standard Examinations of HHP Locos of 5500 HP

4.2.1.7 Apart from the above-mentioned Schedules of Standard Examination, RDSO regularly issues Instruction Bulletins (IBs), Modification Sheets (MOD Sheets), Investigation Reports (INV), Maintenance Guides (Guide), Diagram Books (D-Book), Minutes of Diesel Maintenance Group (DMG) Meetings, Miscellaneous Reports (MISC), Indian Railway Standard (IRS) Specifications of various items, Specifications of various items (Spec), Project Reports (PROJ), Test Procedures (TPs) and Drawings of items. All these are hosted on a website called IR Diesel Power (www.irdieselpower.in) for online reference. These should be regularly taken into cognizance by the sheds for the purpose of maintenance and procurement of material and for building up infrastructure.

4.2.1.8 DLW also issues a periodical Technical Publication called "Soochna" which contains latest developments made in manufacturing of locos, Design Bulletins, Failure Investigations, Important Change Notices, Important Corrective and Preventive Action (CAPA) and Trial Items fitment details. This technical publication is available on official website of DLW 'www.dlw.indianrailways.gov.in'. It should be referred regularly by the sheds for making themselves aware of the latest developments and for purpose of maintenance and monitoring performance of materials supplied by new vendors/new design products.

4.2.1.9 Schedule periodicity of Alco locos is as under:-

S. No.	**Schedules**	**Original Periodicity**	**Current Schedules for Alco Locos**	
			Name of Sch	**Periodicity**
1	Trip or Weekly	Max. 7 days	T1*	15, 20, 30 & 40 days
2	Fortnightly	15 days	T2*	15, 20, 30 & 40 days
3	Monthly	30 days	M-2	60 days
4	Quarterly	90 days	M-4	120 days
5	Half Yearly	180 days	M-12	12 Months
6	Yearly	1 year	M-24	24 Months
7	2 yearly	2 years	-	-
8	3 Yearly	3 years	M-48	48 Months
9	POH	6 years	M-96	96 Months

*Periodicity of:

-15 days for WDM2, WDM3A & WDG3A with plain suspension bearing. In these types of locos T2(T-30) contains all items of T-15 + some additional items like fuel oil filter change, compressor discharge valves cleaning, alternator/generator cleaning , rectifier cleaning and suspension bearing examination.

-20 days for Roller Suspension Bearing locos including WDM3D locos. In these types of locos T2(T-40) contains all items of T-20 + some additional items like compressor

discharge valves cleaning, alternator cleaning , rectifier cleaning and roller suspension bearing examination.
-30 days for Locos fitted with Microprocessor Based Control System (MBCS) and Pure Air Brake (applicable to locos having 20 days trip schedule)
-40 days for locos fitted additionally with REMMLOT, Small Auxiliaries motors (CCE, FPM, DEBM) in AC variant, MCBG & Upgraded Compressor (applicable to locos having 30 days trip schedule). In these types of locos monthly will be done after 80 days, Quarterly after 160 days and Half Yearly after 400 days

4.2.1.10 The schedule periodicity of HHP locos is as under (as given in RDSO report no. MP.Misc-285 of Aug'12) :

S.No.	Schedules	Periodicity
1	Trip/Monthly	Trip/30 days
2	90/180 days	90/180 days
3	Yearly	1 year
4	2 yearly	2 years
5	3- Yearly	3 years
6	6-Yearly	6 years
7	POH	18 years

4.3 Maintenance Schedule: The schedule of attention to various items in the loco and the frequency of attention shall be as indicated in the Schedule of Standard Examination, issued by RDSO from time to time. The current schedules issued are mentioned in **para 4.2.1**.

Any changes warranted to the above schedules shall be authorized only by CME and such changes shall be discussed in the ensuing DMG meeting for final adoption, if considered necessary.

4.4 Maintenance Methods: Maintenance methods followed shall be in conformity with the DMI(s) issued from RDSO or OEM's instructions, if in case RDSO has not issued DMI(s) on the subject. The number of copies of DMI(s) distributed to each Shed shall be adequate to cater to all the officers and senior supervisors of the Shed. After attending to the Schedule, the same shall be certified in the relevant cards/registers maintained for the purpose. All DMI(s) and OEM's instructions should also be available in soft copies on a central server with each section which should have a dedicated computer through which these DMI(s) and OEM's instructions can be accessed. This system can also be used for conveying important instructions issued by HQ, Sr.DME and various other information relevant to maintenance, reliability, safety at work place, environment management, etc.

4.5 Use of Advance/Diagnostic Methods for increasing the effectiveness of Preventive Maintenance:

4.5.1 Present practice of diesel loco maintenance is based upon preventive maintenance schedules. Preventive maintenance schedules entails planned replacement / checking of diesel loco components on pre-defined maintenance periodicity. Currently diesel sheds are replacing most of the items during M24 / M48 and very few items during M12 / M4 schedules. Though this system has served IR very well, but sometimes components do not follow predefined maintenance frequency. Certain components have a tendency to fail prematurely; before planned replacement cycle.

4.5.2 Predictive maintenance technique tries to plug the loophole of preventive maintenance by incorporating condition monitoring of component parameters. These parameters are mostly temperature, vibration, Insulation Resistance, current, run down time, energy consumed, rpm, drop in level, concentration, condition of lube oil & fuel oil. etc.

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4.5.3 At present, the only diagnostic method being used to carry out predictive maintenance is testing of the lube oil in which presence of various elements is ascertained and if found beyond a limit, the causes for the same are looked for. Also, to some extent Fuel Oil Pressure (FOP), Lube Oil Pressure (LOP) and Booster Air Pressure (BAP) readings recorded by Loco Pilots during running of the locos are analyzed to see if there is any need to undertake investigation of a particular assembly/area. However, now-a-days technology has become advanced and there are many advanced diagnostic methods available for increasing effectiveness of maintenance. Some of them are mentioned hereunder:

4.5.3.1 **Trend analysis of loco parameters:** Logging of various performance parameters of Loco like current in individual traction motors, Insulation Resistance, turbo run down time, logging of transient faults, FOP, LOP, BAP, etc. By analysis of these parameters, it can be seen whether there is any trend which indicates problem in a particular component or area and accordingly timely preventive action can be taken. This can also be remotely monitored by using REMMLOT and thus be quite effective in improving online reliability of locos.

4.5.3.2 **Vibration Measurement and Vibration Analysis:** Use of vibration level of loco and engine at various places to pinpoint deficiency in the fitment/defect in a component. A single low cost hand held vibration meter or shock pulse meter can give advance indication about the health of the loco components. Condition of the component can be judged by either of the following two methods:

a) Rise in vibration reading from previous reading of same loco in identical condition and location

b) Variation in vibration reading of same component from other locos. Reading should be taken at identical locations. Any change in type and increase in intensity of sound is a cause of alarm. Engineer's stethoscope can also be used for listening sound. However, it is a qualitative technique.

4.5.3.3 **Ferrography:** Use of ferrography to determine ferrous content in grease of traction motors and axle box bearings gives an indication of signs of incipient failures, which if taken care of in time, can prevent potential failures.

4.5.3.4 **Thermography & Temperature measurement:** It is a very simple technique. Measurement is made by using a low cost laser based temperature gun. Properly interpreting the data and observing the temperature rise trend, health of loco components can be predicted. It is based on the premise that efficient/well maintained assembly will consume least amount of energy and will have a minimum heat loss. Higher heat loss indicates deterioration in performance and leads to a temperature rise. Thermal imaging devices can also be used for monitoring and recording temperature rise data.

4.5.3.5 **Average consumption:** If consumption of lubricant /coolant / consumables e.g. RR 606, coolant water, suspension bearing oil, battery water, gear case oil, compressor lube oil, carbon brush & governor oil is found to be more than previous trip or average consumption, then that component is showing signs of leakage or deterioration. No topping up of oil / coolant / water should be done till reasons for excessive consumption are identified and remedial action taken. Routine filling without necessary repair is a primary cause of subsequent loco failure. Shed should chalk out permissible day/ monthly consumption limit of various lubricants and coolants.

4.6 Unit Exchange: Unit exchange method of overhauling/repairs shall be followed in the Diesel Sheds, as explained below:-

Subject unit/assembly/sub-assembly is removed from the loco and replaced by a Unit/ Assembly/Sub assembly duly overhauled/in good order, kept ready in respective ready spare pool. The removed unit is then overhauled/ repaired, tested and made part of ready spare pool. List of items to be kept as unit exchange spares, along-with yardsticks, for both Alco and HHP locos is shown at **Annexures-4.1 (a) and 4.1(b), respectively.**

4.7 Home Sheds and Trouble Shooting Points: Since diesel locos are costly assets and also lend themselves to extensive operation with a fairly large amount of flexibility, they cannot always be brought back, nor insisted upon to be brought back, to the home shed very frequently for attention. The maintenance work may, therefore, be decentralized to a certain extent to meet the requirements of operation in each area. The decentralization shall be on the following lines:-

4.7.1 Trouble shooting/outstation points: With the increase in periodicity of maintenance schedule of locos, it has become imperative to carry out close monitoring of locos on line. Hence, the trouble shooting/outstation points need to be proliferated. These may be located at selected Marshalling Yards/Fuelling points or crew changing points. They shall be suitably manned and supervised by a competent supervisor and will attend to any minor repairs that might develop in between schedules. This will avoid working the locos dead all the way to home shed for attention.

4.7.1.1 Staff provided at such trouble shooting points shall comprise of a Section Engineer/Junior Engineer along-with the diesel and electrical technicians and khalasis in each shift. Strength of staff may, however, be increased or decreased, if local conditions so warrant.

4.7.2 **Diesel Loco Service Centre (DLSC):** Operation of Diesel Loco Service Centre shall be done as per instructions issued vide Rly.Bd’s letter no. 2003/M(L)/466/20 dated 01.07.2010.

4.7.3 Home Sheds: All schedule maintenance, except trip for Alco and 30/60 days for HHP locos, will be undertaken at home sheds, barring POH. The facilities, spares and staff required shall be as indicated at **paras 4.8.2, 4.8.3 & 4.8.4**.

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4.8 Organized Preventive Maintenance:

4.8.1 Comprises of:

4.8.1.1 Provision of requisite maintenance facilities

4.8.1.2 Provision of requisite spares, oils, lubricants other miscellaneous items.

4.8.1.3 Provision of requisite staff and organization

4.8.1.4 Availability of necessary technical documentation issued by OEMs, PUs, RDSO and other Railway Units

4.8.2 **Maintenance facilities:** Comprises of providing a shed with proper layout, various general purpose and special tools, machinery & plant.

4.8.2.1 Shed lay-out is dealt with separately in Chapter-3.

4.8.2.2 Machinery & Plant: Minimum amount of machinery & plant to be provided in each Diesel Shed is listed at **Annexure 3.10 of Chapter 3**.

4.8.2.3 **General purpose tools:** Adequate number of single-ended, double-ended ring and box spanners of various sizes, adjustable spanners, pliers, wrenches, Allen keys, Nylon hammers, digital micro-meters and other precision measuring instruments, having facility of downloading of measurement on to a computer, etc. shall be provided in each shed. Latest technology tools with established reliability should generally be procured. The list of such tools is given in **Annexure 3.10 of Chapter 3**.

4.8.2.4 **Special tools:** Special tools shall essentially be provided in all Diesel Sheds. The list of such tools is given in **Annexure 3.10 of Chapter 3**.

4.8.2.5 DLW should issue list of additional M & P, Testing Equipments and Tools required for maintenance of new types of locos, as and when introduced.

4.8.3 **Spares procurement:** For satisfactory maintenance of Diesel locos, adequate supply of requisite spares is very essential. At the same time, care should be exercised against over-stocking of items.

4.8.3.1 The following principle shall be followed for the procurement of spares:

a. For BIM items of long lead: 18/24 months stock to be maintained with recoupment done every year.

b. For indigenously available items: 12/24 months stock to be maintained with recoupment/balance returns done every year.

c. Items such as Filters, Gaskets, Carbon Brushes, Brake-blocks and hardware should be procured on the basis of a running contract entered into annually with established manufacturers of proven reliability with reference to both quality and capacity for supplies, keeping adequate buffer stock.

d. Lubricants: As at (c) above.

4.8.3.2 **Codal life of Components:** Codal life of various components of diesel loco has been specified in para 219 of Indian Railway Finance Code Vol-I(advance correction slip no. 62 issued along with RB letter no. 2002/AC-II/1/10 dated 24.05.06 and advance correction slip no. 65 issued along with RB letter no. 2002/AC-II/1/10 dated 12.10.07). It should be duly taken into account while deciding rejection of respective component. However, even after revision vide advance correction slip no. 65, this list given in the finance code is not exhaustive and needs to be augmented to cover all major components of diesel loco, both Alco & HHP. Further, periodic revision of this list should be done.

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4.8.3.3 **Must Change Items during POH:** RDSO vide its report no. MISC-254 has specified the items to be changed compulsorily in various schedules. It needs to be complied with strictly.

4.8.3.4 **Traceability of components:** Traceability of all components should be maintained. For ensuring this, all components should have etching/embossing of Manufacturer's initials/ Manufacturing details. Preferably, such marking should be done by using laser marked strip which can be fitted/pasted on to the component. Small components on which etching/embossing is not possible should be supplied in individual packing having the Manufacturer's initials/ Manufacturing details. High strength paper (laserable) duly marked by laser can also be used for this purpose. The details of the components shall be an input in computer software developed for failure analysis.

4.8.4 Staff:

4.8.4.1 **Yard-stick:** Staff shall normally be provided in the Diesel Sheds as per yard stick given below:-

Staff Category/ Shed Category	**Alco Loco**			**HHP Loco**		
	Minor	**Major**	**Mega**	**Minor**	**Major**	**Mega**
Group C- Supervisors (Service Engineers)	0.80	0.80	0.80	0.70	0.70	0.70
Group C-Technicians	4.00	4.00	4.00	2.50	2.50	2.50
Group D	1.40	1.40	1.40	0.50	0.50	0.50
Total	**6.20**	**6.20**	**6.20**	**3.70**	**3.70**	**3.70**

Note: With the introduction of advanced technology in locos, requiring higher educational and intelligence level, job profiles of supervisors has been changed. Now, they have to work like a service engineer, who carries out maintenance and troubleshooting largely by himself. Hence, there is a need to change the designation of supervisor to service engineer, as is being done in private firms and western countries. Role of technicians will be limited to carrying out some hard work like removing assemblies, disassembly, assembly, etc. under the guidance of a service engineer. Therefore, the proportion of service engineers has been substantially increased and that of technicians decreased.

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4.8.4.2 Staff requirement for other activities being carried out in the shed shall be as under:-

S. No.	Staff Category	Alco/HHP		
		Minor	Major	Mega
i)	**Laboratory Staff:**			
a)	Lab Supervisors	8	14	18
b)	Lab Group D staff	8	14	18
ii)	**Loco Inspectors**	4	6	8
iii)	**Fuel Inspectors**	2	4	6
iv)	**Shunters**	8	12	16
v)	**Staff for Control Office and Shunting**			
a)	Shunting Supervisors	3	5	8
b)	Control Office Staff (Technicians)	5	8	12
c)	Pointsman	5	10	14
vi)	**Staff for Millwright and electric supply distribution & maintenance**			
a)	Supervisor	1	2	3
b)	Technicians	6	10	14
c)	Group D staff	4	6	8
vii)	**Group D Staff for handling lubricants, spares and tools**	10	14	18
viii)	**Staff for Office Work**			
a)	Supervisor	8	12	16
b)	Technicians	12	16	20
ix)	**MIS Cell**			
a)	Supervisors	2	4	6
b)	Technicians	4	6	8
x)	**Staff for Miscellaneous Activities**			
(i)	**Housekeeping (including horticulture and scrap disposal)**			
a)	Supervisors	1	2	3
b)	Technicians	2	4	6
(ii)	**Canteen Management**			
a)	Supervisors	1	2	3
(iii)	**Contract Cell (for processing of outsourcing activities)**			
a)	Supervisors	2	4	6
b)	Technicians	3	6	9
xi)	**Staff for Training School**			
(i)	**STC**			
a)	Supervisors	3	4	5
b)	Technicians	2	3	4
(ii)	**DTTC**			
a)	Supervisors	4	5	6
b)	Technicians	4	6	8

4.8.4.3 Staff requirement of DLSCs and Trouble Shooting/Outstation points will be as under:-

Sr. No.	Staff Category	Staff Category		
		Supervisor	Technicians	Group D
i)	**For each DLSC**	5	16	12
ii)	For *each Outstation/ Trouble Shooting Point	2	8	4

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* Minor Sheds will normally require at least one, Major at least two and Mega at least 3 outstation/trouble shooting points. However, requirement may be more, depending on the local conditions.

4.8.4.4 Others:

(a) Yardstick mentioned at **para 4.8.4.1** are sacrosanct and proposal for creation of staff as per these yardsticks will need to be agreed to by finance for reliable and safe operation of locos. Man Power Ratio (MPR) published by E&R directorate of Railway Board will not be taken into account while working out staff requirement based on these yardsticks. Any changes in these yardsticks, if warranted due to change in maintenance practices, technology, etc. shall be authorized by Mechanical Directorate of Railway Board only.

(b) Ancillary Supervisors, Technicians & Group D staff: Shall be provided within the yardstick mentioned at **para 4.8.4.1**. Individual sheds can distribute the overall sanction of the supervisors, technicians and Group D staff between direct and ancillary staff, depending upon local conditions.

(c) Distribution of staff between Mechanical and Electrical streams shall be made according to local conditions.

(d) Yardstick mentioned at **para 4.8.4.1** is subject to complete outsourcing of activities mentioned in chapter 10. In case any activity is not outsourced, equivalent creation of posts would be required.

(e) Yardstick mentioned at **para 4.8.4.1** does not include staff requirement for – Railway Consumer Depot (RCD) & Accident Relief Train (ART). Staff requirement for RCD has been specified in Chapter 8(a) of this manual. For ART, staff requirement has been specified separately by Rly. Board vide letter no. 81.1(M&P)/7/8 dated 07/01/86.

(f) Yardstick mentioned at **para 4.8.4.1** does not include staff requirement for – DLSCs, Outstation/trouble shooting points. It shall be adopted as per **para 4.8.4.3**.

(g) **Laboratory Staff:** Every diesel shed shall have a full fledged laboratory attached to it. It should carry out regular testing of lubricating oil, fuel oil, coolant water of all incoming locos, operation of DM/RO water plants, Non Destructive Testing of various components of locos as per prescribed schedule, testing of new material, as sent by shed stores officer or shed in-charge, failure investigation of failed components, etc. The staff requirement of laboratory is mentioned at **para 4.8.4.2**.

(h) **Operating & Control Office Staff:** There will be requirement in the shed for coordinating with Power Controller for receipt and dispatch of locos, calculating outage, communicating with HQ Power Controller, carrying out shunting of locos inside the shed, joint checking of locos with shunter during handing over and taking over of locos, removal and placement of loco equipment, noting down repairs logged in by LPs, preparing record of incoming and outgoing locos, schedule planning and forecasting, etc.

Requirement of staff for these activities is not included in the yardsticks mentioned at **para 4.8.4.1**, and instead has been given in **para 4.8.4.2**. Cadre of Pointsman will be maintained and filled up by diesel shed themselves by calling for options from Group D staff and providing them mandatory training in Zonal Traffic Training School.

(i) Yardsticks for Shunters required for carrying out shunting inside the shed is given in **para 4.8.4.2**. However, these posts will continue to be filled up by the open line (as being done at present)

(j) **Inspectorial Staff:** Every diesel shed will have Loco Inspectors and Fuel Inspectors. With the increase in the periodicity of maintenance of the locos, it has become important to monitor on line performance of locos. For this purpose, shed is required to have sufficient number of Loco Inspectors. Also, for looking after the RCD, maintenance of fuel statistics in shed and outside the shed in Home Railway and Foreign Railways where fuelling of shed locos take place, monitoring fuel efficiency of locos on line, etc., there is requirement of Fuel Inspectors. The number of Loco and Fuel Inspectors required by sheds is given in **para 4.8.4.2**. These posts will be filled up by division by holding selection from the willing running staff.

(k) **Millwright and Electric Power Supply maintenance staff:** Diesel sheds shall have their own organization for maintenance of machinery and plant and electric power supply arrangement (excluding the feeding sub-stations) inside the diesel shed. Such staff shall be placed under one supervisor for their respective work. Staff requirement for this purpose is given at **para 4.8.4.2**.

(l) **Staff for handling Lubricants, Spares, Tools, etc: Stores Issuers, Tool Checkers**- shall be provided for handling lubricants, spares and tools round the clock, as per yardstick in **para 4.8.4.2**.

(m) **Staff for Office Work**: Adequate staff shall be provided in the offices of Shed-in-charge, SSE/General, Fuel and Store for execution of various function of the respective offices, as detailed hereunder-

i. Office of the shed in-charge shall have an office In-charge with adequate staff for PCDO, Budget, Establishment, D&AR , Machinery & Plant program, Works Program, Technical correspondence, Staff grievances & welfare, Receipt and Dispatch, store work, Stationary, Computer, etc.

ii. Office of SSE/General shall have staff to look after Establishment, Pass/PTO, Time keeping & salary bill preparation, D&AR, etc.

iii. Fuel & statistics office shall have staff for Fuel accountal, Fuel & Operating statistics, Fuel Economy, etc.

The number of staff to be provided for this purpose is mentioned in **para 4.8.4.2** above. Most of the office work in shed is of technical nature. Hence, these posts will be filled up by calling options from the technical staff, they will work for five years, extendable upto eight years provided Shed-in-Charge is satisfied with their working. Satisfactory working has to be certified every additional year beyond five years. However, in case their working is found unsatisfactory by Shed-in-Charge, they can be repatriated to their original assigned work, anytime. Computerized programs/kiosks for applying and preparing/printing Privilege Pass/PTO, salary, leaves should be provided in all sheds in a time bound manner to reduce manual work, to the extent possible.

(n) **Management Information System Cell (MIS)**: Every shed will have one Management Information System Cell which will maintain computerized record of all technical information related to locos e.g. schedules, defects, failure analysis, record of assemblies, etc. The number of staff to be provided for this purpose is mentioned in **para 4.8.4.2**. These posts will be filled up by calling for options from the technical staff, they will work for five years, extendable upto eight years provided Engineer-in-Charge of the shed is satisfied with their working. Satisfactory working has to be certified every additional year beyond five years. However, in case their working is found unsatisfactory by Shed-in-Charge, they can be repatriated to their original assigned work, anytime.

(o) **Staff for Miscellaneous Activities:** Every shed shall have a contract cell for processing various outsourcing activities. Also, staff will be required for staff canteen management and supervision of housekeeping work. Requirement of staff for these activities is given in **para 4.8.4.2**.

(p) **Staff for Training School:** There will be requirement of Instructors and technicians (who will be required to maintain and operate models, help in explanation of working to trainees, etc.) in training schools, both in STC and DTTCs, as brought out in Chapter 6 of this manual. Requirement of staff for this purpose is given in **para 4.8.4.2**.

(q) Number of posts mentioned at v to xi) of **para 4.8.4.2** will be added to the staff requirement worked out on the basis of yardsticks mentioned at **para 4.8.4.1**, as these posts will be filled up from amongst the technical staff only.

4.8.4.5 **Distribution of the staff**- shall be as under:-

Staff Category						
Group C- Supervisors (Service Engineer)	SSE/SE-		50%	JE		50%
Group C-Technicians	Sr. Tech + Tech-I	8% + 41%	Tech-II	26%	Tech-III	25%
Group D	Khalasi Helper		87%	Khalasi		13%

4.8.4.6 **Duties & Responsibilities:** Duties and responsibilities of Senior Supervisors of the Diesel Sheds are indicated at **Annexure-4.2.** These are the indicative list of duties and these can be modified by CMPE/D or even by Shed in-charges.

4.8.4.7 **Recruitment:** With a view to ensure requisite standards staff for satisfactory maintenance of sophisticated and complex equipment in a Diesel Loco, and also to provide for fair chance of promotion for existing staff, following procedure for recruitment shall be adopted:-

a) **Technicians:** In view of drastic reduction in sanction of Group D staff, direct recruitment (DR) of Technicians Grade-III will be done to the extent of 80% of the total posts and 20% by promotion on seniority basis amongst the eligible Group D staff. While sending indents for Technicians to RRB for recruitment against DR quota, required ITI trades for 50% of the indented posts, as per the situation prevailing, will have to be specifically indicated, in accordance with the relevant guidelines issued by Railway Board for this purpose. Shortfalls, if any, in 20% posts to be filled up from Group D staff shall be made good by direct recruitment. (at present the DR quota for Technicians is 60%, 20% from Khalasi Helper on Seniority basis and 20% from Khalasi Helper by LDCE, as specified in Indian Railway Establishment Manual, till such time this para is modified the revised quota for technicians mentioned in this para will not come into force)

b) **Supervisors:** Direct Recruitment (DR) of Junior Engineer shall be done upto 60% of the total posts. Out of the remaining, 20% will be filled up by selection on basis of seniority and 20% through limited departmental competitive examination. Shortfalls, if any, shall be made good by direct recruitment.

c) **Supervisor-Senior Section Engineer:** 20% of the posts of Senior Section Engineering shall be filled up through direct recruitment of engineering graduates. Remaining 80% will be filled up through promotion from Junior Engineer. Shortfalls, if any, shall be made good by direct recruitment.

4.8.4.8 **Promotion**:

(a) **For promotion from unskilled to skilled grade:**
Eligibility: Minimum 3 years service in un-skilled in Diesel Shed and successful completion of the prescribed training course.

Test: The promotion will be based on a written test as per syllabus indicated at **Annexure-4.3.**

(b) **From Technicians Gr. III to Technician Gr. II:**
Eligibility: Minimum 2 years service

Mode of Promotion: based on trade test and ACRs.

(c) **From Technicians Gr. II to Technician Gr. I/Sr. Technician:**
Eligibility: Minimum 2 years service

Mode of Promotion: based on ACRs and Service Record.

(d) **For promotion from Skilled to Junior Engineer- 20% LDCE**
Eligibility: Minimum 3 years service in skilled grade and age below 45 years

Test: Promotion will be based on a written test as per syllabus indicated at **Annexure – 4.4.**

(e) **For promotion from Skilled to Junior Engineer- 20% Seniority**

Test: Promotion will be based on a written test as per syllabus indicated at **Annexure – 4.4.**

(f) **For promotion from Junior Engineer to Senior Section Engineer-80% quota**

Mode of Promotion: based on ACRs and Service Record

(g) **Modifications in the Syllabus:** The syllabus mentioned in the Annexures is an indicative one and will need modification with time and also with different local conditions prevailing in each area. Hence, this syllabus can be modified by CMPE/D, as and when required.

(h) **Modifications in Rules for Promotions:** However, above-mentioned provisions for promotion keep on getting modified from time to time by Railway Board. Hence, latest instructions issued by Board prevailing at the time of notification for promotions will be applicable.

4.8.5 **Technical Documentation:** For carrying out maintenance of locos successfully it is important to have all necessary technical documentation (DMIs, IBs, Mod Sheets, etc.) and other information issued by OEMs, PUs, RDSO and other Railway Units. For this purpose PUs and RDSO should create an online portal, to be easily accessed by users, for posting all necessary technical documentation issued from time to time.

4.9 Record keeping : Data Analysis

4.9.1 For evolving an efficient system of maintenance a comprehensive “Record Keeping” is essential so that failures could be analyzed and schedules revised on the basis of findings, for the cause of failures. Life of components could be established with a certain amount of reliability and schedule replacements effected on this basis. Trends of consumption of spares/lubricants could be watched and expenditure controlled. For this purpose software should be developed as mentioned in Chapter 5 of this manual.

4.9.1.1 The following reports shall be maintained:

a) Loco Master Defect report
b) Component Defect report
c) Analysis Defect report

4.9.2 **Other Shed records to be maintained:** SSE/General shall maintain the following registers in the shed :

a) Schedule Forecast Register as per specimen at **Annexure-4.5**
b) Engine Repair Book as per specimen at **Annexure-4.6**. This book shall always go with the loco and is meant for the Loco pilot to book such repairs as they consider necessary.
c) Repeated Booking Register: As per **Annexure-4.7**.
d) O. K. Register – As per **Annexure –4.8**.

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4.9.3 However, now-a-days with widespread use of computers, every shed should have computerized generation of various reports, as mentioned above. This has been further discussed in Chapter-5.

4.9.4 **Modifications in the Record Keeping formats:** The formats for record keeping given in the Annexures and indicative and can be modified by CMPE/D or even by Shed in-charge, depending on the local conditions.

4.9.5 Monthly Bulletins by HQ: A Monthly bulletin should be issued by Zonal Railway HQ. This bulletin should contain recent failures, accidents, modifications, incidences of crew mismanagement and new technology introduced in diesel locos. This will help in dissemination of information for taking requisite action by sheds for improving reliability and safety of locos.

4.9.6 Certification of Locos: The locos must be certified, before being turned out for traffic use, for "all schedule items and booked repairs as necessary have been attended to and that the loco is in a fit and road-worthy condition" by the shift supervisor.

ANNEXURE-4.1 (a)

REQUIREMENT OF UNIT EXCHANGE SPARES

ALCO LOCOS:

S. No	Description	Requirement of items		
		<100	≥100 & <175	≥175 & ≤250
1.	Diesel engine power pack complete with generator and turbo super charger.	3	4	6
2.	Truck assembly complete with wheels bearing springs, traction motors etc.	6	8	10
3.	Turbo supercharger	5	8	12
4.	Compressor	4	6	8
5.	Radiator set	4	6	8
6.	Lube oil cooler	4	6	8
7.	Radiator fan drive with eddy current clutch with complete gear box	4	6	8
8.	Engine Crank shaft	2	4	6
9.	Camshafts (FE) in loco set	6	8	10
10.	Camshafts (SUCS) in loco set	8	12	16
11.	Fuel injection pumps (loco set)	4	6	8
12.	Fuel injector nozzle with holder complete (loco set)	4	6	8
13.	Fuel pump supports (loco set)	4	6	8
14.	Cylinder heads (loco set)	5	7	9
15.	After cooler	5	7	9
16.	Water pump	5	7	9
17.	Lube oil pump	5	7	9
18.	RTTM blower	5	7	9
19.	Air filter cyclonic	1	4	6
20.	Pistons with connecting Rods and caps (loco set)	5	7	9
21.	Traction Alternator/ Generator (apart from those with the power pack)	4	6	8
22.	Air brake valves (loco set)	4	6	8
23.	Traction motors (apart from those with the trucks)	24	36	48
24.	Aux. generator	4	6	8
25.	Exciter alternator	4	6	8
26.	Dynamic brake blower motor	4	6	8
27.	Fuel pump motor	4	6	8
28.	Crank case exhauster motors	4	6	8
29.	BKT 1 & 2	4	6	8
30.	Reverser 1 & 2	4	6	8
31.	Power contractors	4	6	8
32.	FS contractors	4	6	8
33.	Exciter panel	1	2	3
34.	Voltage regulator	2	4	5
35.	FS resistance	4	6	8
36.	Dynamic brake gird resistance	4	6	8
37.	Governor Wood word/MCBG	4	6	8
38.	Tacho Generator	4	6	8
39.	Axle alternators	4	6	8
40.	All safety relays	4	6	8
41.	Batteries	4	6	8
42.	Fuel pump	4	6	8
43.	Governor oil pump	4	6	8

ANNEXURE-4.1 (b)

REQUIREMENT OF UNIT EXCHANGE SPARES FOR HHP LOCOS

Sl. No.	Description	Requirement of items		
		<100	≥100 & <175	≥175 & ≤250
1.	Power pack complete (with Generator and Turbo-supercharger)	2	3	4
2.	Power Assembly (Fork Rod)	16	32	32
3.	Power Assembly (Blade Rod)	16	32	32
4.	Turbo supercharger	5	8	10
5.	Turbo clutch assembly	4	5	6
6.	Turbo soak back pump and motor assembly	2	4	4
7.	Piston cooling and pressure pump	2	4	4
8.	Air filter cyclonic	1	1	2
9.	After cooler Assembly	5	6	6
10.	Unit fuel injectors	192	192	192
11.	Fuel pump motor	4	8	10
12.	Lube oil cooler	4	7	9
13.	Lube oil scavenging pump	2	4	4
14.	Engine Crank shaft	1	2	3
15.	Camshaft in loco set	6	8	10
16.	Cylinder heads	16	32	48
17.	Water pump	4	8	12
18.	Radiator fan with Motor	6	10	12
19.	Radiator set	4	8	10
20.	Starter motor	4	8	8
21.	Governor assembly	3	3	3
22.	Air dryer	5	8	8
23.	Air brake pneumatic valves and CRU Cards	1	3	3
24.	Air Compressor	4	5	5
25.	Truck assembly complete with wheels bearing springs, traction motors etc. P4	2	4	5
26.	Truck assembly complete with wheels bearing springs, traction motors etc. G4	2	4	5
27.	Wheel set Assembly without traction motor G4 & P4	12	24	30
28.	Traction Alternator assembly (apart from those with the power pack)	3	4	5
29.	Auxiliary Alternator	3	4	5
30.	Traction motors P4 (apart from those with the trucks)	18	36	42
31.	Traction motors G4 (apart from those with the trucks)	18	36	42
32.	Dynamic brake grid with motor	3	5	5
33.	EM 2000 with Modules Chassis assembly etc	1	3	3
34.	DC Link Switch gear	1	3	3
35.	TCC Electronic Blower with motor	1	3	3
36.	Dust bin Blower with Motor	1	3	3
37.	Traction Motor Blower with Motor	2	3	3
38.	DB Hatch assembly	1	1	2
39.	Detector assembly EPD	4	8	8
40.	Radar assembly	2	4	6
41.	Dynamic brake controller	5	8	8
42.	GP relay- 2 NO, 2 NC	8	12	12
43.	GP relay- 3 NO, 3 NC	20	40	40
44.	GP relay – 4 NO, 4 NC	10	20	20
45.	Ground relay	5	8	8
46.	Generator field contactor	3	6	6
47.	Starting contactor	3	6	6
48.	Starting auxiliary contactor	3	6	6
49.	GFD contactor	3	6	6
50.	DB contactor	8	12	12
51.	Module motor	3	6	6

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ANNEXURE 4.2

Duties and Responsibilities of Supervisors

A. Senior Section Engineer (Diesel) (In-Charge)

1. General Supervision over maintenance of locos in shed
2. General establishment and administrative matters.
3. Supervision over receipt, issue and accountal of fuel oil.
4. Investigation of failures and defects and submission of reports, coordinating with SSE(Electrical), whenever necessary
5. Shed housekeeping and cleanliness, loco cleaning, improvements in the shed
6. Conducting supervisors meeting
7. Maintenance of M&P in the Diesel shed, along with procurement plan, under M&P.
8. Maintenance of loco history and all the loco data through MIS
9. Surprise inspection and sample checks on locos during day and night.
10. Implementation of all RDSO modifications issued from time to time.
11. Ensuring nomination of locos for link and goods.
12. Ensuring placement planning of locos according to next day's program.
13. Ensuring relieving of sub ordinate supervisors and staff for nominated training courses in time.
14. Any other duty assigned by shed in-charge.

B. Senior Section Engineer/Diesel (Stores)

1. Responsible for inspection and certification of stores received (indigenous and imported) and related correspondence.
2. Scrutiny and certification of drawings and obtaining specifications of materials. Processing of stocking applications, follow up of indigenous developments and trials.
3. Supervision over demands, supply and consumption of lubricants and stores and review of estimated annual requirements.
4. Keeping track of supply and chasing of vital items from stores, shops and trade.
5. Surprise inspection and sample checks on locos during day and night.

6. Accountal and Disposal of Ferrous and Non Ferrous scrap as per extant procedures.

7. Responsible for execution of transport contract, allotment of Drivers to vehicles and ensuring their driving licenses are updated.

8. Ensuring updated fit certificates of departmental lorry.

9. Ensuring correctness of Vehicle driver log books i.e. KMS v/s Fuel consumed.

10. Any other duty assigned by shed in-charge

C. Senior Section Engineer (Diesel) (Maintenance)

1. Independent inspection of locos on quality of schedules and load box tests of heavy schedules locos.

2. Drawing up of maintenance schedules (programming & planning)

3. Wheel change programme.

4. Maintenance of records and statistics assisted by Junior Engineer.

5. Inspection of accident locos and submission of special report and evaluation of cost of damages and repairs.

6. Examination of locos nominated for VIP specials and accompanying, if necessary.

7. Ensuring that the repair method instructions received are passed on to the supervisors, demonstrated to the staff, and ensuring that these instructions are followed.

8. Supervision over the heavy schedules and ensuring the prescribed outturn.

9. Analysis of loco failures and taking remedial actions to avoid recurrences.

10. Any other duty assigned by shed in-charge.

D. Senior Section Engineer (Electrical) (General) In-charges

1. General administration with regard to staff, correspondence with HQ and preparation of statements.

2. Responsible for the maintenance schedules with regard to their correct implementation.

3. Responsible for the maintenance of all electrical installations in Diesel shed.

4. Supervision over demands, supply and consumption of all stores, spare parts for all electrical items.

5. Finalization of failure reports.
6. Responsible for turnout of locos.
7. Implementation of RDSO and other modifications issued from time to time.

E. Senior Section Engineer (Electrical) (Maintenance)

1. Responsible for the maintenance schedules with regard to revision of schedules and maintenance practice, as necessary, for the electrical equipment of the diesel locos.
2. Follow up modifications and trials including trials of indigenous components on the electrical side and submission of reports thereon (assisted by Junior Engineer).
3. Responsible for turnout of heavy schedule locos assisted by Junior Engineer.
4. Planning of material requirements, preparation of stocking application and follow up action (assisted by Junior Engineer)
5. Scrutiny of drawings, specifications, etc (assisted by (Junior Engineer)
6. Inspection of samples and supplies (assisted by Junior Engineer).
7. Load Box testing.
8. Maintaining all maintenance statistics (assisted by Junior Engineer).
9. To look after the current duties of Senior Section Engineer (Elect) (General) whenever he is away from headquarters.
10. Analysis of loco failures and taking remedial actions to avoid recurrences.

ANNEXURE 4.3

A. Syllabus for the Written test for the Post of Technicians Gr-III from Unskilled- Diesel

1. Knowledge of diesel engines and its working components – Principles and their functions.
2. Knowledge of various precision instruments and tools such as micrometer, Vernier caliper, dial gauge, Hydraulic Torque Wrenches, Wheel Gauge & special tools, etc .
3. Knowledge of overhauling diesel components such as Turbo, Fuel injection pump, water-pump, lube oil pump, Traction Motor Blower, Cylinder head, compressor etc.
4. Capacity to take sizes during schedule examination of Piston, Cylinder liner etc.
5. Trouble shooting and ability to locate defects and rectify.

6. Knowledge of various preventive maintenance schedules of ALCO and HHP Locomotives / DEMUs.

7. Knowledge of various brands of lubricants used in ALCO and HHP diesel locomotives/DEMUs.

8. Knowledge of various systems such as lubricating oil, fuel oil, coolant water and Air brake systems of ALCO and HHP Locos / DEMUs.

9. Knowledge of conducting water load box testing on locomotives / DEMUs

B. Syllabus for the Written test for the Post of Technicians Gr-III from Unskilled-Electrical

1. Knowledge of electrical circuits – Ohms law, kerchief law.

2. Knowledge of various precision electrical measuring and testing equipments like meggar, multi meter, milli-volt meter, milli-ammeter, DC clip on meter, bearing health analyzers, micro ohm meter, etc.

3. Knowledge of various precision instruments and tools such as micrometer, Vernier caliper, dial gauge, etc .

4. Knowledge of overhauling of electrical rotating machines like, fuel pump motor, CCE motor, Auxiliary Motor, Exciter, Traction Motors, Traction Alternator and other rotating machines.

5. Knowledge of overhauling of electrical contractor, electro-pneumatic contactors, relays, electro-pneumatic switches, micro switches, etc.

6. Capacity to measure important electrical readings during schedule examination.

7. Trouble shooting and ability to locate defects and procedure for rectification.

8. Knowledge of various preventive maintenance schedules of ALCO and HHP locos/DEMUs.

9. Knowledge of conducting water load box as well as self load box testing on locomotives/DEMUs.

<u>ANNEXURE 4.4</u>

A. Syllabus for the Written Test for the Post of Junior Engineer (Mechanical)

1. Knowledge of basic principles and working of Alco and HHP diesel engines.

2. Difference between ALCO and HHP locos.

3. Knowledge of functioning of maintenance and test of the engine power pack assemblies: turbo supercharger, power assemblies, auxiliaries, lube oil pump, water pump, air cooler, lube oil cooler, blower, radiator, radiator fan, etc.

4. Knowledge of fuel system, lube oil system, cooling water system, air brake system, trouble shooting and maintenance.

5. Knowledge of functioning and maintenance of air brake system, including vigilance control device and Automatic Emergency Brakes.

6. Knowledge of functioning and maintenance of compressors.

7. Knowledge of inspection and attention to under truck and loco chassis.

8. Knowledge of working and attention of Wood Ward Governors.

9. Knowledge of periodic tests carried out in the Diesel laboratory on lube oil, fuel oil, cooling water and control over their quality.

10. Knowledge of overhauling and testing of fuel injection equipment.

11. Knowledge of load testing and remedial measures to be taken based on observation.

12. Knowledge of Multiple Unit operations and their testing.

13. Knowledge of various safety items and safety devices located in the locos.

B. Syllabus for the Written Test for the Post of Junior Engineer (Electrical)

1. Types of Diesel locos in use and their general working principles.
2. Principles of different types of excitation systems and principles of governing engine in Alco and HHP locos.
3. Knowledge of Micro Processor Controller Based governor and its function.
4. Application of semi-conductors to Diesel Electrical Locos Comparative advantage – principles of working transistor circuits.
5. Sound knowledge of safety devices and their function.
6. Trouble shooting-ability to locate defects and rectify.
7. Dynamic braking principles – calibration and re-calibration of circuits.
8. Load testing, objective of load testing and remedial measures to be taken based on observation.
9. Knowledge of Indian Electrical Act and rules.
10. Knowledge of various warning systems
11. Knowledge of various electrical circuits in the ALCO and HHP locos.
12. Knowledge of Microprocessor Based Excitation Control System Schedule attentions as per extant versions.

ANNEXURE 4.5

Schedule forecast Register for ALCO Locos

Initial Arrival Particulars
Arrived from DLW
Arrived from DLMW
Date of Comm.:

Page No.	
Loco No.	
Type	

POH/RB Particulars:

Shed Left	Shop Arrival	Shop Left	Shed Arrival
RB Particulars			
POH Particulars			

T1 Schedule Dates		
T2 Schedule Dates		

Major Sch. Particulars (M24/48/72)			
S.No.	Type of Sch.	Date Stopped	Date Released
Medium Schedule Particulars (M4, M8, M12, M16, M20)			
S.No.	Type of Sch.	Date Stopped	Date Released

M2 Schedule Dates		
General Check (NS) Dates		

ANNEXURE 4.6

-------------RAILWAY

Engine Repair Book

LP Name __ T. No.__ Train no.___ Loco no. ___ ALP Name__ T. No.__ From_____ To____ LP home shed__ Load as per Guard's journal __ Type of schedule attended at home shed /Satellite shed date Actual Dep. Time ____ Date _____ Actual Arr. Time _____ Date _____ Type of Schedule ____ due and date Kilometers earned during the trip ____ Fuel oil consumption ____ Litres	(Items to be handed over and taken over by drivers.) 1. M.U. Jumper cable 2. V.R.R. Spare fuse (for E type locos). 3. Ground relay cut-out switch seal. 4. Fire extinguisher 5. RTTM blower bolts. 6. Emergency telephone key and seal 7. One spare transition screw coupling. 8. Spare BP & FP hose
LP bookings ____ Shift JE/outstation Technician remarks. Signature of Shift JE/outstation Technician	Signature of LP Handing over Name Designation Home shed Date Signature of LP taken over Name Designation Name shed Date

Levels to be measured

1. Lube oil sump level ---- added ----- litres 2. Compressor sump level --- added --- litres 3. Generator gear case level ----added ----- litres	4. Governor oil level -----------added ------- litres. 5. Expansion tank water level -----added --- litres. 6. Air maze oil bath filter level -----added ----- ltrs.

REGARDING : To be recorded every half an hours.

1. Time 2. Booster pressure 3. Fuel oil pressure. 4. Lube oil pressure 5. Load ammeter readings 6. Battery charging ammeter reading.	7. Water temperature 8. Compressor oil pressure 9. Speed 10. Gradient. 11. Notch 12. Position of Dynamic Brake selector handle. 13. Motoring (M) or Dyn. Braking (B)

ANNEXURE 4.7

------------ RAILWAY

DIESEL SHED ------------- LOCO TYPE ------------

REPEATED BOOKING REGISTER ----------- NUMBER ------ MONTH-------

Dates 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30 31 Remarks	
1 Throttle not responding	
2 Loadmeter not responding	
3 Engine hunting	
4 Low booster pressure	
5 Compressor throwing oil	
6 Power ground	

Dates 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30 31 Remarks	
7 Power brakes not re-leasing	
8 Power contactor fluttering during transition.	
9 Low lube oil pressure	
10 Fuel oil pressure dropping on higher notches	
11 Vent pipe leaking or cracking	
12 Battery charging rate on high side beyond 20 amps.	
13 Wheels slip indication	
14 Fuel Pump circuit breaker tripping	
15 Experiencing jerks while handling	
16 Transition not picking up properly	
17 OSTA tripping and unable to recrank	
18 Fuel Pump Motor not Working	
19 Experiencing wheel slip and unable to haul the load	
20 HP Tube breakages	
21 Fuel banjo bolt leaking fuel oil.	
22 Water level reducing	
23 Water leaking through fuel leak off	
24 Oil carrying	
25 Cam roller splitting	
26 Engine side buffers crack	
27 Engine side buffers disc rotating	
28 Fuel jumper bolt breakages	
29 Horizontal shaft wobbling	
30 Radiator core tubes leaking water	
31 Water leaking from water pump tell tale pipe	
32 Unusual sound from RTTM blower	

ANNEXURE 4.8

------------- RAILWAY

O. K. REGISTER

Date	Loco no	Train no	Shed dep	VCD condition	VCD COC	HB-5 COC	H-5 COC	Brake cyl-COC	28VB COC	Condition of CCB
1	2	3	4	5	6	7	8	9	10	
	Y									

Fire Ex.		MR QA		Sanders	Wipers
ER	Cab	Cut in	Cut out		
14	15	16	17	18	19

Speedometer		Check sealing of Gear no. case bolt & suspension on bearing		Driver's name	Signature
Recorder Roll	Indicator & clock	Cap	Bolts		
21	**22**	**23**	**24**	**25**	**26**

Hand brake working order	Fire extinguishers condition & Nos. available	VCD working order	PT Phone Sl.No.	Dynamic brake in conjunction of Loco brakes	Spare BP/FP Pipe available or not	No. of Wheel skids	Classification lamps working order	Flasher lights working order	Head lights working order	Sign. of shift JE/Elec. & Mech

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Chapter 5

Management Information System

5 MANAGEMENT INFORMATION SYSTEM

Requirements and recommended architecture for MIS of Diesel Operation & Maintenance

5.1 Introduction

IT leveraged management information system is expected to be a key infrastructure for command, communication, control and feedback for all working units of the diesel operations and maintenance organization.

The MIS setup is expected to create one common information sharing and communication infrastructure that enables all maintenance sheds and the operations personnel to interact seamlessly.

Due to rapid growth and development of information technology, it is not possible to make a rigid architecture for the MIS; therefore the following sections provide guidelines for development of the system based on the user expectations. These guidelines are abstracted expectations and therefore need to be expanded to suit the specific objectives at the time of development of the MIS.

5.2 Overall objectives

The MIS shall be designed meeting the following overall objectives:

5.2.1 Single window

The MIS shall be the single window to view and manage operations, maintenance and supporting activities related to diesel units.

The MIS shall be such that all diesel maintenance and operations teams shall be able to share all required information in real-time without resorting to any other means.

5.2.2 Collection and presentation of information in real-time

Real time collection of information and its presentation shall be a core design requirement of the MIS.

5.2.3 Authentication & authorization

Robust authentication and authorization mechanisms shall be mandatory for any interaction with the MIS.

5.2.4 Automation of routine tasks

Routine tasks should be automated. Wherever possible, the system should provide features for creation of new modules for handling routine tasks (similar to development of macros on productivity applications).

5.2.5 Remove or reduce paper

The system shall either remove paper completely or reduce it to bare minimum. Technologies like scanning and OCR, automated ID systems (like barcodes/RFID) shall be deployed extensively towards this aim.

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5.2.6 Connections to other applications

The MIS system shall be capable of connecting to various other applications on the Indian Railways or elsewhere and shall have capabilities for presentation and management of information on these applications as required for operations and maintenance management of diesel units.

As on date the following applications are in existence.

1. FOIS (Freight Operations Information System)
2. COA (Control Office Applications)
3. REMMLOT (Remote Monitoring and Management of Locos & Trains)
4. MMIS (Material Management Information System)
5. AFRES (Advance Finance and Railway Expenditure Information Management System)
6. PRIME (Payroll & Inter-Related Modules)
7. Wayside detection systems (WILD, Acoustic Bearing Defect Detector etc.)

5.2.7 Knowledge management and learning

The MIS shall provide knowledge management and on-line training (virtual classroom) features.

5.2.8 Virtual meeting place of all O&M teams

The IT setup shall provide a virtual interactive infrastructure for all personnel associated with the operation and maintenance of diesel units on the Indian Railways. This requirement shall include features like, bulletin boards, instant messaging, VoIP calling, video conferencing etc. for all users of the portal.

5.2.9 Robust connectivity

Robust and secure network connectivity shall be ensured for all entities.

5.3 IT Architecture

The IT enabled umbrella described in this para is planned to be set up using the concept of Service Oriented Architecture (SOA) to deploy web based services hosted on a central IT infrastructure. This architecture allows for easy deployment of services for the end user without requiring specialist IT resources like servers and its administrators at remote locations, thereby reducing costs and associated complexity.

The central IT infrastructure shall host all applications / databases and present the same in the form of a Diesel Operations and Maintenance Portal. This portal shall be accessible from the user end using simple clients running on the web browsers on PCs / PDAs / Smartphones, etc. The remote IT infrastructure shall be limited to providing connectivity to the central IT setup. Servers, if any, required for enabling good quality of connectivity e.g. caching, NAT services may be hosted at the remote sites.

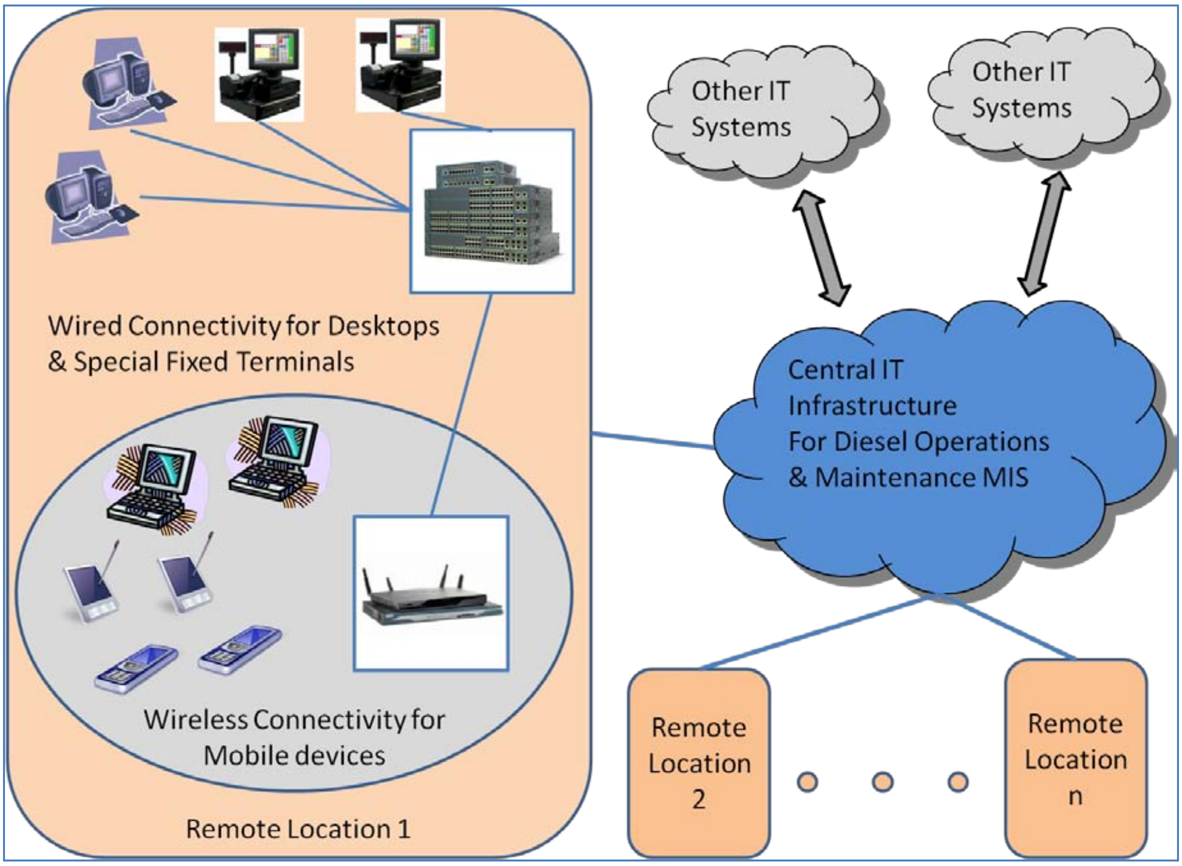

Figure 1: Overview of the Diesel Operations and Maintenance MIS

The figure above provides an overview of the Diesel Operations and Maintenance Management Information System (DOMMIS).

Some of important requirements of the system components are detailed in the following paragraphs.

5.3.1 Central IT Infrastructure

The central IT infrastructure can be setup, maintained and operated in-house or may be setup under agreement for outsourcing. The decision can be taken at the time of implementation.

The central IT infrastructure shall be TIA 942 Tier 4 compliant.

The following standards / certifications shall be used as guidelines for setting up the central system:

1. ISO 15288 (Systems and software engineering — System life cycle processes)
2. Software Engineering Institute CMMI Level 3 or better
3. ISO 27000 family of standard for Information Security Management Systems

5.3.2 Application Performance Management

The MIS system shall deploy application performance management technologies and fix objective benchmarks for user experience indices.

This is essential for ensuring effectiveness of the MIS and more so when the IT infrastructure is outsourced.

5.3.3 Remote Location IT setup

Remote locations comprise of the units like: diesel sheds, fuelling installations, crew management centres, power control cells, etc.

These remote locations shall have robust connectivity to the central system. The clients at the remote locations are not specified due to varying requirements and need to be determined at the time of implementation. As depicted in the figure, the clients shall comprise of fixed network devices like desktop computers and special terminals for attendance, tools & spares issues, and mobile clients like notebooks, PDA and smart phones.

It shall be ensured that each value adding station is equipped with adequate numbers of equipment with required redundancy for continuing operations. Care shall be taken to avoid single point failure deployments.

Deployment of servers and other equipment, requiring specialist IT support, should be avoided at remote locations. However where unavoidable, care shall be taken to ensure proper preventive maintenance.

The software clients shall be web browsers or downloadable applications. Use of dedicated clients requiring installation and configuration should be avoided, unless essential.

5.3.4 Design of applications

The applications shall be designed to be run through applets on the central web portal. These applets shall be deployed for work flow in both pre-defined and ad-hoc modes. It shall be possible for the users (with proper authorization) to define and store new work flows on the system.

Each system user shall be presented with a configurable dashboard indicating the features that can be operated. The design of the dashboard shall be intuitive and standard.

5.4 Authentication

All users of the portal shall have individual access. Depending on the level of authorization granted to the users, suitable authentication mechanism shall be deployed to prevent any repudiation of actions taken on the portal. As a general guide, the following authentication levels shall be deployed:

1. One factor (password based) for portal access: All portal access shall be possible only after password verification.
2. Two factor authentications shall be used for permitting changes to operating and maintenance data.
3. For extremely critical activities three factor authentication mechanisms shall be deployed.

5.5 Model for MIS data management and presentation

This section describes the generic model for collection, processing and presentation of data that is expected to be processed by the MIS.

5.5.1 Adoption of process approach

The MIS shall be designed around the concept of processes as described in the ISO 9001 standard. The system shall be capable of capturing / presenting the following for each defined process. The figure below illustrates the process approach:-

1. Process inputs
2. Work in progress details
3. Process outputs
4. Computing and presenting process parameters and flagging exceptions.

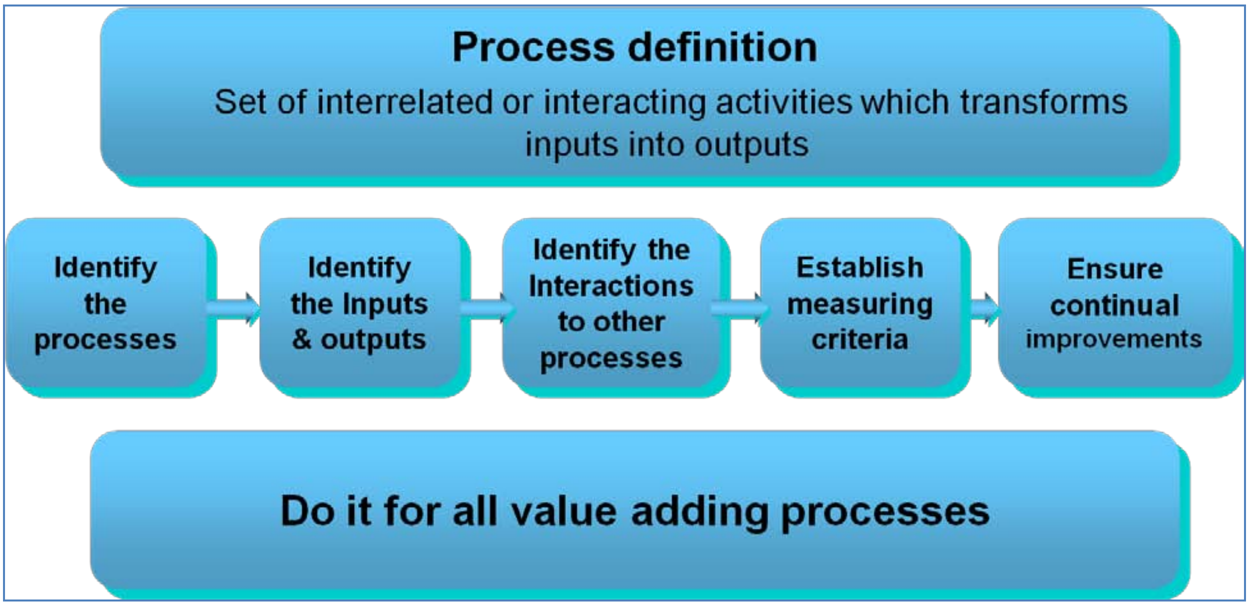

Figure 2: Process Approach

The process approach requires that simplest processes are described first and the more complex processes defined as being built on interactions of these simple processes. This concept shall be used to design and build the information capture forms and reports. This architecture shall enable drill-downs to the most basic levels, as and when required by the portal users.

The MIS system shall be designed to capture and present details of all inputs, outputs of the process and provide functions/ tools for management of the process as described in the following paragraphs.

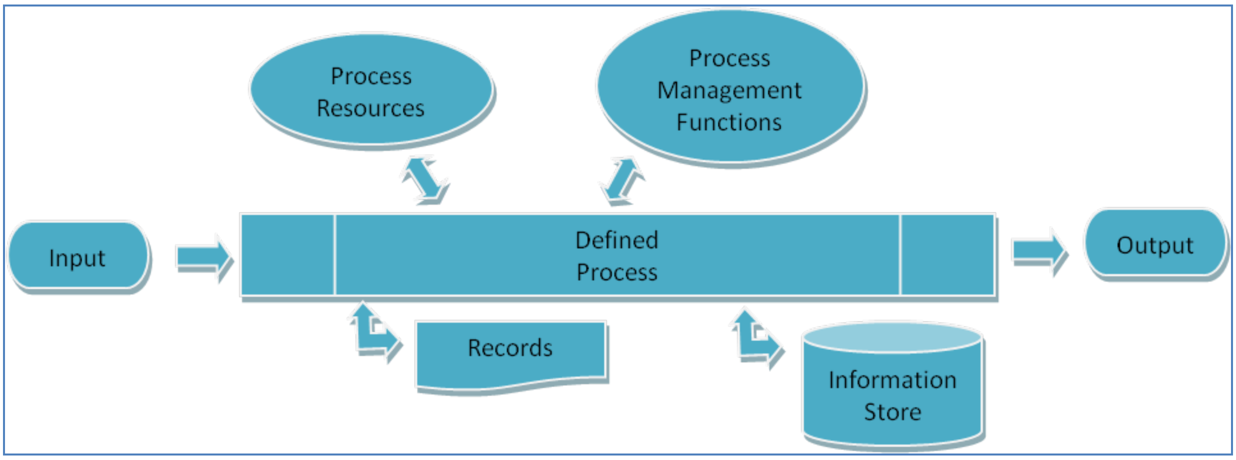

Figure 3: Generic view of a process

5.5.2 Process Inputs

Process inputs are primarily of two categories i.e.

1. Resources
2. Object(s) to be processed. These could be a tangible item or a service request.

   The objects to be processed are dependent on the specific process however the resource inputs to the process can be generically defined as follows:

5.5.2.1 Manpower

The process manpower modules shall provide features for

1. Attendance management
2. Leave management
3. Work allocation and management
4. Training management
5. Individual bio-data management
6. Other features, as required, for a given process shall be defined at the time of implementation

5.5.2.2 Machinery Plant & Infrastructure

The process machinery plant and infrastructure includes the civil, electrical, machinery & plant, and tools & plant resources. The MIS modules shall provide features for:

1. Monitoring status of each of the infrastructure items
2. Monitoring and maintenance of preventive maintenance information
3. Complaints management for breakdown repairs
4. Management of calibration of indication measuring and test equipments.
5. Other features, as required, for a given process shall be defined at the time of implementation

5.5.2.3 Method

The method input for a process includes the documentation for running the process and the records generated as a result of the activities. The MIS module shall provide features for:

1. Management of all process documentation i.e. maintenance / work instructions, check sheets, record formats, etc.
2. Features for filling of records on-line
3. Features for management of stored records
4. Other features, as required, for a given process shall be defined at the time of implementation

5.5.2.4 Material

The material management module for the process shall provide features for

1. Listing and management of all material requirements for a given process.

2. Management of indents for stock / non-stock / consumable items
3. Management of imprest purchase
4. Other features, as required, for a given process shall be defined at the time of implementation

5.5.2.5 Money

The process money module of the MIS shall provide features for

1. Management of budget
2. Tracking of expenditure
3. Management of liability and throw forwards
4. Other features, as required, for a given process shall be defined at the time of implementation

5.5.3 Process outputs

The process outputs are generally in the form of a serviced / new product or a service. The MIS process module for outputs shall provide features for

1. Listing and management of all process output for a given period
2. Management of records of the process output allowing the MIS user to view and manage the following information about the process output in form of a process log
   a. Unique ID for every single product / service processed in a process. Wherever possible, use of automated ID systems like barcodes / RFID shall be used to reduce manual inputs and the associated errors.
   b. Product / service delivered date / time
   c. Details of work done covering questions of who, why, where, when, what & how
3. Other features, as required, for a given process shall be defined at the time of implementation.

5.5.4 Process work in progress

The process WIP module of the MIS shall provide the following functions.

1. Listing and management of all work in progress
2. Flag exceptions and assistance required

5.5.5 Process monitoring indices

The process monitoring indices are expected to be specific to a process and shall be defined specifically for each process at the time of implementation.

The following requirements are applicable in general to all processes. Thus the process indices monitoring module shall provide the following functions

1. Average processing time
2. Low / high limit of processing time
3. Flagging of exceptions falling out of low / high limits on processing time

4. Normal / exceptional / alarming levels of in queue of items / requests
5. Normal / exceptional / alarming levels of out queue of items / compliance
6. Other indices, as required, for a given process shall be defined at the time of implementation

5.6 Broad Features of MIS of Diesel Operation & Maintenance

5.6.1 A web enabled package for capturing loco maintenance and operation related data e.g. loco history, loco failure data, component master, etc., and report generation be part of MIS.

5.6.2 Web enabled package should process various information captured and help in taking decision.

5.6.3 Web enabled package shall also cover material planning, issue and other stores related activities.

5.7 Centralized Organization for handling of MIS of Diesel O & M:

In view of the importance of operation and maintenance of MIS in diesel sheds, which has got interface with Railway Board, RDSO, PUs and Zonal Railway HQ, a central organization need to be there. It will go a long way in effective functioning of MIS and thereby reduce communication gap between central and field units. This organization shall consist of following officers:

Grade	Nos.
HAG	1
SAG	2
JAG	3
SS	4
JS	5
Supervisors (SSE/JE)	10

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Chapter 6

Human Resource Development

6. HUMAN RESOURCE DEVELOPMENT

6.1 Importance: Diesel motive power units are capable of giving long and uninterrupted service at low maintenance costs provided they are maintained with adequate know-how. Experience in other developing countries as well as in India has repeatedly brought out the necessity of training maintainers at all levels, initially, followed by refresher courses as well as familiarization courses to cater for changes of design and equipment. The training organization plays a vital role in enabling the railways to achieve smooth and economical transition from the older form of diesel traction to the modern economical diesel Traction.

6.2 Agencies, Scope and Aim of Training

6.2.1 The training shall be imparted to the different level of Officers and Supervisors by the Central Training Institutes such as IRIM&EE/National Academy of Indian Railways (NAIR)/Vadodara, Zonal Training Centres, System Training Centres (STCs) and Diesel Technical Training Centres (DTTCs).

6.2.1.1 The Probationary IRSME officers will be provided training of 1-1/2 years duration. This will cover technical training at IRIMEE, general and management training at NAIR/Vadodara. During this period, training at manufacturers' works, back-shops, motive power maintenance sheds/depots and RDSO is also included.

6.2.1.2 Apart from probation period, various in-service technical and management courses are to be imparted from time to time to IRSME officers at various stages at IRIMEE, NAIR/Vadodara and at other institutions of repute.

6.2.2 Refresher courses/ seminars on subjects of topical interest at IRIM&EE, RDSO, NAIR, CAMTECH, Manufacturers' Works for Engineers/ Officers engaged in design/ manufacture/ maintenance of diesel units shall also be organized.

6.2.3 Group "B" officers will undergo an integrated course of 8 weeks at IRIMEE/JMP and foundation course of 4 weeks at NAIR/Vadodara.

6.2.4 Various courses at the System Training Center (STC) of the Railways will be organized for supervisors. These training establishments should be at close proximity to Diesel back-shops or maintenance depots. This is vital for the training to be meaningful.

6.2.4.1 Stage-wise training schedule for supervisors of sheds, shops as well as new trainee supervisors for handling maintenance and overhaul of locos & DEMUs is given at **Annexure - 6.1**.

6.2.5 Various courses at the Diesel Technical Training Centres (DTTCs) of the Railways will be organized for technicians and group D staff, apart from running staff.

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6.3 Infrastructure and other requirements of Knowledge Sharing Centre (Training School)

6.3.1 Each Zonal Railway should have one STC and each Diesel Shed should have a DTTC.

6.3.2 Large class rooms with adequate space for models, cut away sections, wired panels, control stands, brake systems are required in the centre. It is essential that the lectures proceed in the immediate proximity of the equipment so that the various instructions can be suitably demonstrated and illustrated. Class rooms should be well equipped with large charts, drawings and a profusion of components so that the trainee is given maximum possible exposure to the equipment. Trainees must be constantly encouraged and urged to handle them.

6.3.3 It is better to develop one class room which should be fully equipped and self contained for a particular system to teach major aspects of that system. For example, one class room may be developed for power pack, another for transmission, a third for controls, a fourth for brake equipments, etc.

6.3.4 One Model Room containing following items should be available in each Centre:

6.3.4.1 Real size working models

6.3.4.2 Cut away models to show constructional details of that component.

6.3.4.3 Circuit diagrams, sectioning diagrams, etc. illuminated and arranged to show the sequence of operations.

6.3.4.4 Special tools and instruments used in diesel loco maintenance.

6.3.4.5 Samples of damaged equipments with tablets explaining the nature and cause of failure and preventive checks.

6.3.4.6 Display Boards with slogans and illustrations, emphasizing safe methods of working

6.3.4.7 Display Boards illustrating ‘Do's' and "'Don'ts'

6.3.4.8 Computerized learning kiosks, etc., containing questionnaire on various technical subjects

6.3.5 One Conference Hall of seating capacity of 50 to 100 persons provided with good quality PA address system, furniture, etc., should be available in each Centre.

6.3.6 Each centre should have a well equipped library with latest relevant literature.

6.3.7 Adequate accommodation for Principal and lecturers should be available in the Centre.

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6.3.8 All the classrooms should have "Digital writing boards". This permits diagrams to be projected and one can also write down important data or illustrate connections directly on the projected drawing on the Digital writing boards.

6.3.9 Classrooms should have Multimedia projector, Slide projector, Epidiascope, Overhead Projector, DVD player, etc.

6.3.10 Adequate numbers of DVDs/CDs/Pen drives are extremely useful for delivering a standard lecture while the instructor suitably supplements it with explanations and illustrations.

6.3.11 Each centre should be liberally provided with Handy Cams, Digital Cameras, Computers, Printers, UPS, Scanners, Lamination machine, Spiral binding machine, Paper cutting machine, Duplicating and Photo copying machine so that training instructions, diagrams etc., can be given to the trainees freely.

6.3.12 Each STC should be headed by an experienced Mechanical officer of JAG rank and each DTTC by JAG/SS/JS rank officer, as mentioned in Chapter-1 of this manual.

6.3.13 The number of trainees in the classroom should be limited to a maximum of 15 per instructor to facilitate proper individual attention being given.

6.3.14 In the maintenance depots or on the loco, wherever practical demonstrations are being given, maximum 5 trainees should be assigned per instructor.

6.3.15 Examination should consist of written paper, practical and interview. Supervisors, running staff and artisans should preferably be given objective type questions, which should cover more ground and should be better suited to test the trainee's grasp, rather than his power of expression.

6.3.16 Finally, the necessity of selecting the best and most experienced men for the training centre is emphasized. The functioning of this organization makes or mars the entire maintenance performance.

6.3.17 Details of civil infrastructure and equipments required for the centre are given in Para A-III of **Annexure 3.9** and para J of **Annexure 3.10** of Chapter 3.

6.4 Planning of Training in Advance

As soon as the Diesel traction is commissioned on any section, adequate strength of well-trained operating, maintenance and running staff should be kept ready for manning the services. Planning the recruitment and training of such staff well in advance is one of the most important tasks of the open line administration. It is also necessary to establish sufficiently in advance suitable training schools with the facilities for imparting the training by qualified instructors.

6.5 Staff Categories to be trained: Following categories of staff are required to be given initial and refresher training:

6.5.1 Degree and Diploma holders recruited directly as Supervisors (SSE & JE)

6.5.2 Technicians selected as Supervisors (JE)

6.5.3 Technicians (Skilled artisans)- directly recruited and promoted

6.5.4 Group D staff

6.5.5 Supervisors and Technicians to also undergo Refresher Course.

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6.6 Initial Training

6.6.1 Supervisors:

6.6.1.1 Initial training period prescribed at present for the supervisors is as under [Railway Board's letter no. E(MPP)2009/3/10 dated 03.06.2011]:

SN	Category	Training Period (in weeks)
1	Senior Section Engineer- Directly Recruited	52
2	Senior Section Engineer- Promoted	Nil
3	Junior Engineer- Directly Recruited	52
4	Junior Engineer- Promoted through Seniority	26
	Junior Engineer- Promoted through LDCE	52

6.6.2 Technicians:

6.6.2.1 Initial training period prescribed at present for the technicians (skilled artisans) is as under [Railway Board's letter no. E(MPP)2004/3/08 dated 24.11.2010]:

(i)	Course completed Act Apprentices trained in Railway Establishments	NIL
(ii)	Course completed Act Apprentices trained in non- Railway Establishments	6 Months
(iii)	Diploma Holder	6 Months
(iv)	ITI Passed candidates	6 Months
(v)	Matriculate or any non- technical Higher qualification	3 Years
(vi)	Degree holder in their relevant fields	6 Months

Note: The Compassionate Ground Appointees (CGA) holding degree/diploma/ITI qualification in the relevant railway related trade, if he/she gets appointed as Skilled Artisan in the trade in which he/she has acquired his/her degree/diploma/ITI they will undergo training for 6 months. In case of CGA degree/diploma/ITI appointed as Skilled Artisan in a trade different than that acquired by them, will have to undergo 3 years training. Practical training should be undertaken in shop floor and not in classrooms."

6.6.2.2 In addition to theoretical training, the trainees should receive thorough practical training on the work they will have to perform on completion of training. In all cases, during training, they should have a period as under-study to senior and experienced staff in actual execution of the type of work they have to perform.

6.6.2.3 For artisan staff, the practical training should be so oriented as to enable them to understand and carry out independently skilled work of the type covered by 'Inspection books', 'Inspection charts', 'trouble- shooting charts' and 'technical charts'. Courses of training for each wing viz. Engine wing and Transmission & Control wing should be carefully planned and implemented for each category of staff.

6.6.2.4 The curriculum of the training of technicians mentioned above can be made by respective Railways, depending on their specific needs.

6.6.3 Group “D” staff

6.6.3.1 At present no training is prescribed for Group D staff. However, it is necessary to provide initial training to Group D staff also as now-a-days they start working technical work from the beginning itself, as most of the non-technical work (housekeeping, cleaning of locos and components, etc.) has been outsourced.

6.6.3.2 Hence, all Group D staff should be given initial training of 3 months duration. It should cover general information about Railways, general information about various types of diesel locos, various maintenance schedules of locos, system of shed working, safety at work place, etc. After training, on the basis of their aptitude and educational qualification, they should be inducted as Diesel-mechanic khalasi helper or Diesel-electric khalasi helper.

6.6.3.3 This training should be imparted in DTTC or in shed (if no nearby DTTC is there).

6.6.3.4 Curriculum of the training of Group D staff can be made by respective Railways, depending on their specific needs.

6.7 Promotional Courses

6.7.1 Before an employee can be promoted, he should, logically, receive training to enable him to discharge his responsibilities in the higher post e.g., a semi-skilled fitter on promotion as a skilled fitter. However, at present promotion training is prescribed only for promotion as Technicians Grade-III or as Junior Engineer. For other promotions like: Technicians Grade-III to Grade-II/Grade-I/ Sr. Technicians or Junior Engineer to Senior Section Engineer no training is training is prescribed after promotion.

6.7.2 But, considering the varieties of locos having technologically complex systems being introduced, it is important not only to impart training on promotion but also to organize specialized courses in between promotions to empower the staff to carry out maintenance of locos efficiently.

6.7.3 Hence, Railways should plan to impart training to such categories of staff for whom no training on promotion is prescribed, depending on the need of the responsibilities to be performed in the promoted post. Such training can also precede the departmental tests which determine suitability for promotion. The training should be generally on the same lines as initial training, but the period may be curtailed since the employee would already have a certain amount of background knowledge on account of his experience.

6.7.4 Specialized course for improving the skill level of staff should also be organized form time to time, on need basis. This will help them efficiently tackle maintenance of locos having technologically complex systems being introduced.

6.7.5 Curriculum and duration of the training on promotion and for specialized courses to various categories of staff, other than those for which it is already prescribed by Railway Board, can be decided by Zonal Railways depending upon the local conditions.

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6.8 Refresher Courses

6.8.1 At present, Refresher courses are prescribed only for Supervisors (SSE and JE). Railway Board has issued in March'07 Module No. ME06 (for SSE) & ME07 (for JE) with duration of 18 days and periodicity of five years. Detailed syllabus is given at **Annexure 6.2.**

6.8.2 However, considering the constantly changing scenario of technology of locos, it is desirable that other categories of staff are also imparted refresher courses.

6.8.3 The categories of staff for whom refresher courses are to be arranged can be decided by the General Manager in accordance with para 117(a) of the Indian Railway Establishment Manual. The duration of such refresher courses can be decided by CME to suit local conditions.

6.8.4 For categories of staff liable for inter-divisional transfers, programming of refresher courses should be done by the Zonal headquarters office. For staff confined to a particular division, the programming should be done at the divisional level.

6.8.5 The critical instructions/points/rules/regulations/etc. should be repeated several times to trainees so as to make a lasting impression and not to be forgotten easily. Trouble shooting should also be given special emphasis during such refresher courses.

6.8.6 During refresher courses, it will be very useful to arrange group discussions amongst the trainees on specific problems encountered during the course of work. This will be a very good forum for exchange of information gained by various trainees during working.

6.9 Training in General and Subsidiary Rules

Maintenance Supervisors, when required, should receive initial training as well as refresher courses in General and Subsidiary Rules normally in the Zonal Transportation Schools, which usually have model rooms to facilitate the proper understanding of the rules and systems of working. In exceptional cases when such training cannot be arranged conveniently in the Zonal Schools, CME may authorize the training in G&SRs to be included in the syllabus for training in Diesel Technical Training Centres (DTTCs). Separate Instructors well versed in the subject should, however, be deputed for imparting the training.

6.10 Responsibility of Officers and Supervisors

Apart from those in-charge of training schools, other officers and supervisors in-charge of operation and maintenance should also take a keen personal interest in the trainees of all grades attached to them. They should deem it as part of their duty to guide the trainees and watch their progress. Training is a continuous process which helps the officers as much as the trainees not only in developing contacts on a personal level, but also in understanding the finer points of operation and maintenance. A record of progress achieved, the period of training given, etc. should be maintained for every trainee.

6.11 Examination at the End of Training

6.11.1 All trainees should pass the prescribed examination on completion of training. The scope of examination and the level of officers and supervisor responsible for examining will be laid down by CME. The examination should have a practical bias.

6.11.2 **Pass Marks For Trainees:** Pass marks in the examination conducted by training centers at the end of the course for safety categories including running staff should be 60% i.e. staff must secure 60% in written and 60% in practical /viva to qualify the exam with no relaxation for SC/ST. Where the examination consists of only written or viva or practical, staff must secure 60% marks in the same to qualify [Railway Board Letter No. E(MPP)2003/3/16 dated 09.06.2010].

6.12 Specialized Training

CAMTECH should organize training in specialized subjects, both technical and non-technical. Such specialized subject can be: Basics and Maintenance of Microprocessor Based Control System of locos, Working and maintenance of three phase AC-AC traction control system, Group Discussions on important aspects affecting reliability of locos, Fuel economy, Contract Management, Environment Management System, Contract Labour Act, etc. Railways should ensure deputing of staff, as per laid down quota, without fail.

6.13 Competency Certificate:

6.13.1 **Authorized Person:** An "authorized person" is the one who is duly authorized to perform specific duties pertaining to his Employment, the authorization being made by the competent authority empowered for the purpose by the Railway Administration.

6.13.2 **Competency Certificate:** Each authorized person will be given a "Competency Certificate", defining the works which he is certified as competent to carry out after he has been trained, examined and found fit.

6.13.3 The following categories of Diesel Maintenance staff shall be issued with the certificates by the official indicated against each category after written/oral test as shown:

Designation of staff	Category of certificate	To be issued by
Skilled staff	DL-1	SSE (concerned section)/ADME, after oral test
Welders	DL-2	SSE (concerned section)/ADME, after oral test

6.13.4 Sample of the Competency Certificates is shown below:

.... RAILWAY
MECHANICAL DEPARTMENT
CERTIFICATE OF COMPETENCY NO. DL-1
(For Skilled staff of Bogie Section)

No.............................
Shri .... has been examined for his knowledge of maintenance instructions and rules and he is authorised to work as a skilled Fitter in the Bogie section of Diesel Shed……………..
Date. ....

ADME(D)

.... RAILWAY
MECHANICAL DEPARTMENT
CERTIFICATE OF COMPETENCY NO. DL-2
(For Welder of Bogie Section)

No.............................
Shri ....Welder Gr…... has been examined for his knowledge in welding activities and rules and is authorised to work as a welder in the Bogie section of Diesel Shed……………..
Date. ....

ADME(D)

6.13.5 A fresh certificate should be issued to the staff when staff is transferred to a new section after the maintenance instructions and safety rules pertaining to the new section are explained to him and understood by him.

6.13.6 CME can decide on the "Competency Certificate" to be issued to other category/grade of the staff.

ANNEXURE - 6.1

Approved Stage wise Training Module for Supervisors

(Ref: Rly. Bd. Letter No. E(MPP)2009/3/10 dated 03.06.2011)

(A) TRAINING MODULE – MJR – D

Name of the Post / Category	Junior Engineer
Stream	Diesel
Mode of Appointment	Through RRB
Min. Qualification	Diploma in Engg. (Mech. / Electric. / Electronics)
Total duration of Training Period	52 Weeks

Session	Type	Subjects		Subject Code	Duration in Weeks	Activity Centre
I	THEO	Railway organization & Management		MRT - 01	03	STC
		Role of Mech. Dept.		MRT – 02	01	
		Rolling Stock Theory – Carriage		MRT – 03	03	
		Rolling Stock Theory – Wagon		MRT – 04		
		Rolling Stock Theory – Diesel Loco, DEMU, SPART		MRT – 05		
		Industrial Safety, First Aids & Firefighting		MRT - 06	01	
	PRACT	Field Visit	Coach Production Unit		01	ICF / RCF
			Wagon Production Unit/ RWF		01	Any Wagon production unit / workshop / RWF
			Diesel Production Unit and RDSO		03	DLW, DMW and RDSO one week each
II	THEO	Tender & Contract		MRT – 07	01	STC
		Accident & Disaster management		MRT – 08	01	
		Supervisory Skill		MRT – 09	01	
		Welding and Non Destructive Testing		MRT – 10	01	
		Stream Specific theory		MDT – 01	04	STC/DTTC
	PRACT	Field Visit	C&W Depot		01	Respective Places
			Workshop		01	
			Diesel POH shop		03	
III	THEO	Stream Specific theory		MDT-02 M/E	07	STC/DTTC
		Train operations with signaling		MRT - II	03	ZRTI
	PRACT	Field Visit	Stores, CMT Lab, RDI, Power Control (LMS, FOIS, ICMS)		02	Respective Places
			Drawing Office		01	CME Office
IV	THEO	Practical Training in Diesel Shed		MRT - 12	08	Parent Unit
	PRACT	On job Training			04	
		Refreshing / Examination / Viva			01	STC
TOTAL					**52**	

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(B) TRAINING MODULE – MSE – D

Name of the Post / Category	Sr. Section Engineer
Stream	Diesel
Mode of Appointment	Through RRB
Min. Qualification	Degree in Engg. (Mech. / Electric. / Electronics)
Total duration of Training Period	52 Weeks

Session	Type	Subjects		Subject Code	Duration in Weeks	Activity Centre
I	THEO	Railway organization & Management		MRT - 01	03	STC
		Role of Mechanical Dept.		MRT – 02	01	
		Rolling Stock Theory – Carriage		MRT – 03	03	
		Rolling Stock Theory – Wagon		MRT – 04		
		Rolling Stock Theory – Diesel Loco, DEMU, SPART		MRT – 05		
		Industrial Safety, First Aids & Firefighting		MRT - 06	01	
	PRACT	Field Visit	Coach Production Unit		01	ICF / RCF
			Wagon Production Unit/ RWF		01	Any Wagon production unit / workshop / RWF
			Diesel Production Unit and RDSO		03	DLW, DMW and RDSO one week each
II	THEO	Tender & Contract		MRT – 07	01	STC
		Accident & Disaster management		MRT – 08	01	
		Supervisory Skill		MRT – 09	01	
		Stream Specific theory		MDT – 01	04	STC/DTTC
	PRACT	Field Visit	C&W Depot		01	Respective Places
			C&W Workshop		01	
			Diesel POH shop		03	
			DEMU Shed		01	DEMU Shed
III	THEO	Stream Specific theory		MDT-02 M/E	07	STC/DTTC
		Train operations with signalling		MRT - II	03	ZRTI
	PRACT	Field Visit	Stores, CMT Lab, RDI, Power Control (LMS, FOIS, ICMS)		02	Respective Places
			Drawing Office		01	CME Office
IV	THEO	Integrated Course			04	IRIMEE
	PRACT	Practical Training in Diesel Shed			06	Parent Unit
		On Job Training			02	
	Refreshing / Examination / Viva				01	STC
			TOTAL		**52**	

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(C) TRAINING MODULE – MJP-D

Name of the Post/category	Junior Engineer
Stream	Diesel
Mode of appointment	Promotion through seniority
Min. Qualification	--
Total Duration of Training period	26 weeks

Session	Type	Subjects	Subject code	Duration	Activity Centre
I	THEO	Railway organization & Management	MRT-01	03	STC
		Role of Mechanical Dept.	MRT-02	01	
		Industrial Safety, First aid & firefighting	MRT-06	01	
		Tender & Contract	MRT-07	01	
		Accident & Disaster management	MRT-08	01	
		Supervisory Skills	MRT-09	01	
		Computer Awareness	MRT-14	01	
		Technical English	MRT-15	01	
		Manufacturing Process	MET-12	01	
		Industrial Engineering	MET-13	01	
		Mechanical Engineering Science	MET-14	02	
II	THEO	Stream specific theory (Common)	MDT-05	03	STC/ DTTC
		Stream specific theory	MDT-06 M/E	05	
	PRAC	Diesel Shed		02	Parent unit
		On job Training		02	
		Refreshing/Examination/Viva		01	STC
TOTAL				**26**	

(D) TRAINING MODULE – MJI-D

Name of the Post/category	Junior Engineer
Stream	Diesel
Mode of appointment	Promotion through LDCE
Min. Qualification	XII std./ITI
Total Duration of Training period	52 weeks

Session	Type	Subjects	Subject code	Duration	Activity Centre
I	THEO	Railway organization & Management	MRT-01	03	STC
		Role of Mechanical Dept.	MRT-02	01	
		Applied Mechanics	MET-01	09	
		Hydraulics	MET-02		
		Manufacturing Process	MET03		
		Engineering Drawing	MET-04		
		Electrical & Electronics Engineering	MET-05		
II	THEO	Strength of Materials	MET-06	10	STC
		Heat Engine & thermodynamics	MET-07		
		Theory of Machines	MET-08		
		Material Science	MET-09		
		Machine Design & drawing	MET-10		
		Introduction to Rolling stock (Coach, wagon, Diesel Loco, DEMU,SPART)	MRT-13	03	
III	THEO	Industrial Engineering	MET-11	02	STC
		Industrial Safety, First aid & Firefighting	MRT06	01	
		Tender & Contract	MRT-07	01	
		Accident & Disaster Management	MRT-08	01	
		Supervisory Skills	MRT-09	01	
		Computer Awareness	MRT-14	01	
		Stream specific theory	MDT-01	04	
IV	THEO	Stream specific theory	MDT-03 M/E	04	STC/DTTC
		Stream specific theory	MDT-04 M/E	04	
	PRAC	Diesel Shed (including one week EMD Shed)		02	Respective places
		On job Training		02	Parent unit
		Refreshing/Examination/Viva		01	STC
TOTAL				**52**	

Annexure 6.2

Module No.	***ME 06***	***Department***	**MECHANICAL**
Category	**SR. SECTION ENGINEER**	***Duration***	**18 days (Once in 5 years)**
Stage	**REFRESHER**	***Activity***	**DIESEL OPEN LINE**

Content No	Description	Duration in Days
01	Role of Senior Supervisors and Managerial skills	1
02	Labour Laws & Personal matters	1
03	Transactional Theory, Staff welfare, Industrial relations	1
04	Material Management	1
05	Latest developments in the field	2
06	Management	2
07	Work study	1
08	Reliability Engineering, Quality and Safety	2
09	Fire Fighting, First Aid and Hygiene	1
10	Short Study Tour	1
11	Basic knowledge of Computers	1
12	Works Programme, M&P Programme, RSP	1
13	Disaster Management	1
14	Budget and Estimates	1
15	Feed back, Assessment, Valedictory session	1
	Total	**18**

Module No.	***ME 07***	***Department***	**MECHANICAL**
Category	**JUNIOR ENGINEER**	***Duration***	**18 Days (Once in 5 years)**
Stage	**REFRESHER**	***Activity***	**DIESEL OPEN LINE**

Content No	Description	Duration 18 Days
01	Role of Supervisors and Managerial skills	2
02	Labour Laws & Personal matters	1
03	Transactional Theory, Staff welfare, Industrial relations	1
04	Material Management	1
05	Latest developments in the field	2
06	Management	2
07	Work study	1
08	Reliability Engineering, Quality and Safety	2
09	Fire Fighting, First Aid and Hygiene	1
10	Short Study Tour	1
11	Basic knowledge of Computers	1
12	Works Programme, M&P Programme, RSP	1
13	Disaster Management	1
14	Feed back, Assessment, Valedictory session	1
	Total	**18**

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Chapter 7

Stores Management

7. STORE MANAGEMENT

7.1 Diesel Store Organization:

7.1.1 Every diesel shed/shop shall have a stores Depot attached to it. The Stores Depot shall be under the Stores Department.

7.1.2 The issue of materials from the Diesel Stores Depot to the shed floor shall be in accordance with the procedure laid down in the Stores Code vide paras 1505 to 1513 Annexure-1 (enclosed), wherein the word ‘Sub-ward’ may be replaced by Diesel Stores and the word ‘Shops’ replaced by diesel shed and the total “workshop issue ticket” is replaced by “diesel shed issue ticket” The Diesel Stores depots shall observe the same working hours as that of the general shift of the shed/shop.

7.1.3 The Stores depot officer attached to the diesel shed/ shop shall be under the administrative control of the executive in-charge of the diesel shed/shop for his day to day working.

7.1.4 The stores officer shall be responsible for procurement, proper stocking of all stock items in the depot. He shall review the AAC requirement based on the past consumption pattern and ensure availability of the required material. For this, he should utilize the normal procurement cycle of COS office, local purchase and bulletin powers, as available with him at the shed level.

7.1.5 All non stock items shall be indented by the shed in-charge. Stores organization in the shed should keep a track of these non stock indents and follow up by timely chasing in their office and in COS office.

7.2 Inventory Control:

7.2.1 Stock Items & Requisitioning:

7.2.1.1 Items having recurring consumption should, as a rule, be only obtained through the Store Depots. Procurement of stores against requisition for direct delivery by the trade to the consuming units should be avoided, except in the following cases:-

a) Items which have a very low annual consumption and hence cannot be included as stock items and at the same time do not fall within the definition of 'Emergency Stores’ e.g., bearings of particular sizes only a small number of which may be required per annum;

b) Stores required for special works, modifications or programmed replacement of parts;

c) Items, although stocked by the depot, which have a non-recurring demand for a specified purpose and cannot be met from the stocks held for normal consumption e.g. Wires/cables required for special rewiring of Diesel locos and DMUs;

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d) Non-standard items and other items required regularly but not stocked by stores Depots, pending standardization.

7.2.1.2 Requisitions for non-stock stores and special requisitions for stock items as mentioned above are required to be scrutinized personally with regard to specification and quantity and signed by Technical Officers having powers upto the value of the indent. Officers/ Supervisors initiating such requisitions should enclose a brief note for the information of the officer empowered to sign the requisition, bringing out the need for the procurement and explaining how the quantity has been arrived at.

7.2.1.3 Stocking of items should be done as per the requirement of the shed. Stocking should preferably be done on unified PL numbers. The stores officer should regularly review (at least once in six months) his PL directory to close inactive PLs.

7.2.1.4 Stock items should be indented by the stores depot in-charge as per procurement calendar and ensure availability.

7.2.1.5 The shed should submit requisition form electronically for issue of individual item. This data, as available, should be used periodically by the shed in-charge, in consultation with the stores officer to review individual AACs.

7.2.1.6 In case of drawal of any items is required more than the AAC, then requisition form should be personally approved by Shed in-charge, who should review the need of overdrawal and accordingly take necessary action.

7.2.1.7 Sometimes special drives are ordered to attend a specific issue across all locos. This may warrant 100% replacement and would require material availability beyond the AAC. Special demand for such purposes may be processed by the shed.

7.2.2 Pricing of items and consumption:

7.2.2.1 Each supervisor of a section shall maintain a record in which the cost of various items used in his section and their past consumption is entered.

7.2.2.2 Different sections should be connected through MIS to stores depot and the current price when updated by the stores personnel at his end gets automatically updated across the shed.

7.2.2.3 Individual section supervisors while issuing/fitting material for a loco should update the same on the MIS based system so that cost of maintenance of loco is correctly reflected. All general issue/low value items like grease, gaskets, nut etc. should be booked under the miscellaneous head in the MIS so that it can be apportioned over shed holding.

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7.2.3 Estimated Annual Requirements:

7.2.3.1 The stock position, consumption trends and the estimated annual requirements should be reviewed periodically (at least once in 6 months) jointly by the Mechanical and Stores Officer concerned at each depot. This periodic review has to be strictly ensured and Estimated Annual Requirement shall be revised accordingly.

7.2.3.2 The stocking AAC of individual items may be compared across other sheds of the zone. This list may be used by the Shed in-charge as a tool to establish if any good practice needs to be copied from a sister shed, if there is a wide variation in AACs.

7.2.4 Inactive items:

7.2.4.1 Dead Surplus items, if they have finished their shelf life, should be segregated and disposed off by the stores depot with the approval of depot stores officer, if falling within his powers, and through survey committee, if beyond his powers.

7.2.4.2 For dead surplus items which are yet to complete their shelf life or items which may not be required due to technical obsolescence should be offered to other sheds, workshops, other Railways, Production units, training schools (for use as training aids), etc. If no demand comes after offering twice, these should be put up to survey committee for condemnation and disposed off and office of controller of stores advised.

7.2.4.3 Items which are not likely to be required in the near future should be offered as stock assistance to other sheds, Railways and Production Units.

7.2.4.4 Items which are damaged due to storage handling etc., borne in books, should be surveyed and suitably disposed off, according to the recommendations of the Survey Committee.

7.2.5 Control over consumption:-

The Mechanical Officer in-charge of the shed should identify specific critical and high value items, for the renewal of which, the supervisor in-charge of the section will have to seek approval from the Officer/Supervisor nominated by him, before effecting replacement, who will personally check the item before authorizing such replacement.

7.2.6 Fast Moving Items:

7.2.6.1 A list of fast moving spares should be prepared by the Mechanical Officer in-charge of the shed in consultation with stores office. A monthly review of the consumption of the fast moving items should be effected at the shed/depot level. Each supervisor should have access to computer in which he can check the stock position of the materials affecting the day to day working. This record will help the Shed Engineer & Stores Officer to pinpoint the items to be dealt on priority. Specimen proforma of the report to be taken out from computer is shown below:-

Sr. No.	Date	Items required	Stock position in stores	Remarks
1	2	3	4	5

7.2.6.2 Only such items which are pinching the supervisor in his work should be entered in this report and not items which are freely available.

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Recoupment of stock:

7.2.6.3 Whenever recoupment sheet/ Balance Return is placed by the Store Officer of the depot, it should be got vetted by the shed engineer, before submitting the same to Head Quarter Office for procurement. It will ensure:-

a) That the estimated Annual Requirement / Average Annual Consumption based on which procurement section is proposed is correct and current;

b) That subsequent to a design change or modification done since the time of last review, no obsolescence of the product has resulted;

c) Selective procurement possible in times of financial stringency based on realistic technical appreciation of the requirements;

d) For proprietary items, necessary certificate duly signed by engineer in-charge shall accompany the recoupment sheet/ balance return.

7.2.6.4 The Recoupment Sheet/Balance Return on receipt in Headquarters shall be routed through the CMPE/D, who shall attach the requisite number of drawings and specifications. Enquiries will, thereafter, be sent by COS only to the list of firms duly approved by RDSO/PUs. The quotations received shall be sent to the CMPE/D for technical scrutiny**.** On receipt of which, COS shall place Purchase Order duly examining the procedural and other related aspects involved.

7.2.6.5 Every PL stocked in the stores depot should have a minimum recoupment level specified for it. As soon as the same is reached, an auto report should be generated and mailed to the Shed in-charge and the stores depot in-charge.

7.2.6.6 Proprietary Articles

a) Proprietary articles are required to be purchased from the specified firm on single tender basis. Only when acceptable alternatives cannot be used, a 'Proprietary Article Certificate' be issued. The officer signing a Proprietary article certificate should satisfy himself on this point.

b) A proprietary Article Certificate in the prescribed form should be issued only by empowered technical officer. The name and designation of the officer signing the certificate should be clearly indicated in the certificate.

c) While the greatest care should be exercised before issuing a Proprietary Article Certificate, when the Technical officer is personally satisfied in his judgment that the item of the required quality suiting the desired technical requirements can only be obtained from the original manufacturer, there should be no hesitancy in issuing the Proprietary Article Certificate.

7.2.6.7 For DLW, RDSO, DMW, ICF/RCF, CME approved items, limited tender shall be done on approved sources. After technical scrutiny by CME's office, order shall be placed by COS office as per rules in vogue.

7.3 Procedure for procurement of materials:

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7.3.1 Items which have low AAC value should be procured, as far as possible, in form of kits, to minimize the procurement effort.

7.3.2 Items which are occasionally required and generally non-recurring in nature shall be indented by the sheds/shops on non-stock requisitions. All such materials on receipt will be charged off to the consignee and kept in stores as "custody stores" until fully consumed.

7.3.3 **Preparation of Indents**: When indents are prepared, the essential points to be borne in mind are listed below:-

7.3.3.1 The description should be complete and written out clearly. Figures in the description (e.g., hp & rating etc.) should be spelt out in words also. If the space in the standard form is not sufficient to write out the description in full, it should be given in a separate attached sheet, preferably typed.

7.3.3.2 When a local drawing or specification is mentioned, requisite number of copies with latest amendments should be attached. However, procurement of each item as per local drawing or specification should be critically reviewed by the indenting Officer to find out as to why this item cannot be procured as per standard drawing and specification issued by RDSO/PUs.

7.3.3.3 The quantity should invariably be mentioned in words and figures in the respective columns.

7.3.3.4 When a non-standard item is asked for, particulars of the last supply, if any, should be given to enable the Store Department to locate likely suppliers.

7.3.3.5 The designation and full postal address of the consignee and the controlling officer should be given to facilitate correct dispatch of Railway Receipt and other documents.

7.3.3.6 When the requisition is for a proprietary article, the ordering reference as given by the Manufacturer should be quoted and carefully tallied and a Proprietary Article Certificate in the prescribed form should be attached, duly signed and countersigned by the Competent Authority.

7.3.3.7 The rate should be either on the basis of last purchase rate suitably adjusted for price variations or on the basis of actual market quotations or a reasonable estimate. It will be helpful if the basis on which the rate is quoted is mentioned on the indent itself or in the covering letter.

7.3.3.8 The chargeable head of account should be correctly indicated.

7.3.3.9 Any corrections should be initialed by the officer signing the requisition.

7.3.4 The stock items will be classified into:

7.3.4.1 BIM items, including DLW/DMW manufactured items and import items
7.3.4.2 Items to be procured from Trade- indigenous

7.3.4.3 Items to be procured from Trade- imported

7.3.4.4 Items to be obtained from BHEL

7.3.4.5 Items to be manufactured in Railway Workshops

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7.3.5 The items mentioned in para 7.3.4 will be indented depending on their average lead time of procurement.

7.3.6 As far as possible, long term contracts of 3-5 years duration should be placed on vendors with PVC clause for trade procurement items.

7.4 Procedure regarding approved suppliers of items to be procured from Trade:

7.4.1 For procurement of items appearing in RDSO/PUs/Zonal Railway list, order shall be placed only on approved vendors.

7.4.2 There shall be no duplication of items in above approved lists. In case any such duplication is noticed, it should be promptly intimated to respective approving authorities and railway board.

7.4.3 Zonal Railways will form a list of approved vendors for Items having bearing on safety and items which are having critical applications, but not included in RDSO/PUs approved list. In preparing such list, field performance of the items supplied by vendors in past, timely delivery, response to problems reported, timely settlement of warranty claim, etc. will be considered. Diesel wing will prepare such list and it should be got approved from CME of the Zonal Railway.

7.4.4 Performance review of suppliers should be conducted by the Zonal Railways w.r.t. quality of supplies and adherence to delivery period and RDSO/PUs advised for their respective items, as per prescribed periodicity or as warranted.

7.4.5 In case any defect is noticed in the item/component/material, having high bearing on safety or very costly consequences, which is attributable to manufacturing methodology and it is suspected that all the items/components/materials pertaining to the lot in question may have the same or similar defect, then supplier should be asked to replace all such items, without waiting for the items to fail. This is basically a system of positive recall, which is being followed by reputed international firms.

7.4.6 Supplies received against developmental/trial orders placed should be scrupulously monitored for their field performance and feedback given to vendor approving agency, as per laid down frequency.

7.5 Procedure for inspection and acceptance of materials:

The inspection and acceptance of materials shall be done by the Mechanical Officer in-charge of the shed/shop. For this purpose, he shall be assisted by the Stores officer of the shed on the procedural side and Supervisor/Material Cell on the technical side. The functions of the Supervisor/Material Cell are described at **Annexure-II**. Following is to be noted in this regard:-

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7.5.1 For non stock items for which the shed is the inspecting agency, shed in-charge will get the material inspected as per Purchase order with assistance of CMT, wherever required.

7.5.2 Inspection of the equipments supplied should be carried out carefully in accordance with the specifications and drawing mentioned in the Purchase Order. Metallurgical tests should invariably be arranged through the Chemist and Metallurgist of the Railway, when required particularly for alloy steel components of rolling-stock, etc., where strict adherence to the specified material is very important.

7.5.3 Quantity check should be carried out carefully: number, weights and lengths stated by the suppliers on packages should he checked at random and based on these checks, if required, 100 per cent checks should be carried out. Where Railway samples have been made available to the manufacturer these should be taken back and accounted for.

7.5.4 The seal and/or hologram on the Inspection certificate should be carefully matched with that on the material. In case the seal is found to be broken/tampered with, it should be informed to the firm and inspecting authority. Hologram pasted on the product should be checked for its adhesiveness, it should not come out without getting torn. In case it can be removed without getting torn, the matter should be informed to the inspecting authority and that product should be used only after getting their clearance.

7.5.5 The quantities accepted are required to be entered forthwith in ledgers and the details of entries made mentioned on the bills, before they are certified. Controlling Officers should test-check these entries frequently.

7.5.6 Where the supply has been received after the due date stipulated in the order, sanction of the Competent Authority should be obtained before the supply is accepted.

7.5.7 In the event of rejection, a letter, duly countersigned by the controlling officer, should be addressed to the firm forthwith detailing the reasons. Rejected supplies when dispatched by rail to the supplier, should invariably be sent on ‘freight to pay’ basis. Rejected supplies not removed by local suppliers from the consignees premises within the stipulated time are liable to levy of storage charges as laid down by local instructions.

7.5.8 Vendor approving authority to be advised to take off the name of the Vendor from approved vendor list if material supplied by him is in non-conformance to purchase order placed.

7.5.9 Sr. DME should assist Stores Depots in regard to technical inspection of stores received by the depots. Sr.DME/DME should carry out surprise checks as often as possible to make sure that accepted items do comply with the specifications and items rejected are for sufficiently valid reasons. All inspection reports should be sent to the Stores Depots duly countersigned by an officer.

7.6 Trial Orders:

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7.6.1 For items which do not figure in approved vendor directory of RDSO/PUs, zonal railways may permit trial order on a vendor with the objective of multi-sourcing. The performance of item on trial shall be monitored on a well defined trial scheme and decision taken for inclusion or not, based on trial results.

7.6.2 Trial of items appearing in the RDSO/PUs approved list, developed by a new vendor cannot be done on a loco without respective vendor approving authority's approval.

7.7 Cash Imprest & Emergency Purchase:

7.7.1 A cash imprest of minimum Rs.100,000/- shall be provided with the officer in charge of the stores depot and the diesel shed in-charge each.

7.7.2 A cash imprest of Rs.50,000/- shall be provided with the Engineer in-charge of the shed , for repairs / reclamation of machinery and plant, tools and Diesel Loco components.

7.7.3 Stores/Mechanical Officer in-charge shall have powers for emergency purchase of single items, upto a particular value specified by the board, at a time, from the cash imprest without going through the formalities of calling quotations, etc.

7.7.4 Purchases exceeding the above limits will be done by the COS

7.8 Safe Custody of Stores:

7.8.1 It shall be the responsibility of the stores officer in-charge of the depot that correct material storage conditions are created for storing the items in the depot.

7.8.2 Due care should be taken to ensure that the material does not deteriorate while in stores custody.

7.8.3 Shed shall have small sub-store for keeping the non-stock items. This sub-store will be under the control of Shed in-charge. However, proper accountal of receipt and issue and other related things, more or less as applicable to main stores depot, should be ensured.

7.8.4 Stores in-charge shall be responsible for stores verification.

7.9 Check on Bills:

Detailed instructions issued by the Stores Department are available with regard to the procedure to be followed for checking and passing of supplier's bill. The 'original' bill is sent to the consignee and the 'duplicate' to the controlling officer. The original bill checked and signed by the consignee is sent to the controlling officer for countersignature and onward transmission to the supplier under advice to the bill passing Accounts Office. A few illustrative points in regard to technical and other checks to be exercised by consignee and controlling officer are explained below for guidance. These are supplementary to the procedural instructions of the Stores Department referred to above:

7.9.1 Sometimes Purchase Order are placed FOR destination station. Freight then is required to be borne by the suppliers and the accepted rate is inclusive of this. In some other cases Purchase Order specify dispatch of the stores FOR dispatching station, when freight is to be borne by the consignee. Only in the latter case should the consignee ordinarily give a credit note to cover the freight charges. In the case of the first type of Purchase Order i.e. FOR destination, if erroneously the stores are booked by the supplier on 'freight to-pay' basis, the freight, for which a credit note is given by the consignee, is recoverable from the bill and the controlling officer should be advised accordingly.

7.9.2 To avoid errors of this type, it is advisable for consignees to maintain separate registers, preferably in different colors, to register purchase orders of the two types. It should also be remembered that loss suffered by the railway due to such errors is recoverable from the supervisor responsible.

7.9.3 Occasionally suppliers allow a small rebate if their bills are passed within a specified period. This condition is incorporated in the order itself at the time of analyzing the order or it may be indicated by the Supplier when submitting his bill. Such bills should be specially watched and passed in time, both by the consignee and the controlling officer, to take advantage of the rebate admissible. It should, however, be noted that tests required to prove the quality of the supply should not be waived merely to pass the bill by the stipulated date.

7.9.4 Occasionally, orders are placed on ‘time preference' basis i.e., a lower quotation is passed over and higher quotation accepted to take advantage of the early delivery offered by the latter. In such cases, delivery of supplies after the stipulated date will automatically involve imposition of certain penalties on the supplier. Acceptance of delayed supplies against time preference orders should be in accordance with instructions on the subject, issued by the Stores Department.

7.10 Verification of Stock:

7.10.1 Instructions for verification of stock by stock verifiers of the Accounts Department are contained in the Stores Code.

7.10.2 Each stockholder should verify his stocks once in 6 months. He may do so by verifying certain items every month provided the whole stock is verified in the course of 6 months prior to April and October every year. The date of verification should be entered in the relevant page of the tally book/tally card along with the signature and designation of the official. Excesses and shortages discovered during the verification should be dealt with as laid down in the Stores Code.

7.10.3 Officers should carry out test verification of stock with Stock Holder under them to cover important items, the charged-off, surplus stocks and items in which deterioration is liable to occur, such as insulating varnishes, rubber items and lubricants which have limited shelf-life. The test verification should not be confined to new items only, but should also include second-hand stores and scrap returned to stock and released from works.

7.10.4 During the test verification the officer should initial tally books and ensure that-

7.10.4.1 The materials and tools are borne against proper classifications;

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7.10.4.2 Surplus stores for which no immediate use can be found are referred to Sr.DME for orders regarding disposal;

7.10.4.3 Unserviceable items that have scrap value are returned to the Stores Department;

7.10.4.4 Unserviceable items that have no scrap value are written off with Sr.DME's approval and a certificate recorded to this effect;

7.10.4.5 Repairable or re-conditionable items are sent to workshops with work orders;

7.10.4.6 The issues shown are commensurate with requirements. Heavy issues soon after receipts should be particularly scrutinized carefully.

7.10.5 DME/ADMEs, in-charge of stores, should carry out such test verification of shed sub-store, as explained in para 7.8.3, once in 6 months and shed in-charge once per annum.

7.11 Works Contracts:

7.11.1 Activities such as shed cleaning, loco cleaning, sanding, loco painting, activities highly complex in nature for which necessary technical expertise is not available in shed, minor repair and reclamation of components which assists in improving material availability, etc. should invariably be got done through works contract. Normal activities can also be got done through works contract, if staff shortage, caused due to various reasons: increase in holding of diesel units, retirement of staff, delay in recruitment, etc., is there.

7.11.2 For repairs to rolling stock, machinery and plant, tools, etc., costing less than Rs.50000/-, the shed in-charge can directly enter into a contract dispensing tender formalities. Works costing more than Rs.50000/- shall be processed as per SOP.

7.11.3 For all works contracts proposed, shed shall take technical approval of CMPE/D, before processing as per SOP.

7.12 Differences in the provisions of this Chapter and Board's Code/Rule/Instructions:

7.12.1 In case of any difference/variation/contradiction in any of the rule, method, system, financial power mentioned in this chapter with the provisions given on date or in future in the Stores Code/Finance Code/Rules or Instructions issued by Railway Board, then provisions given in the latter (Stores Code/Finance Code/Rules or Instructions issued by Railway Board) will prevail.

7.13 Enforcement of Warranty:

7.13.1 The warranty shall be as stipulated in Clause 3200 of IRS Conditions or as mentioned in the special conditions of contract, in case deviation from IRS conditions are desired.

7.13.2 For enforcement of settlement of warranty claims, the contractor should be asked to submit Bank Guarantee (valid for a period as stipulated under Clause 3200 of IRS Conditions of Contract or as mentioned in the special conditions of contract) for 10% contract value to cover the said warranty from a Nationalised Bank acceptable to the Purchaser.

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7.13.3 If material is such that it can be used after repairs, which contractor/supplier refuses to undertake, then same can be got done by the user. Cost towards such repair can be debited to bank guarantee submitted by the contractor/supplier.

7.13.4 In case warranty claims, which are not settled by contractor/supplier, are more than the value of bank guarantee submitted, then same should be got debited from the other pending bills of the contractor/supplier for the same item or other items supplied in same zonal railway or others.

7.13.5 **Quality Procurement of Materials:** It is important to ensure that materials being procured is of good quality. In this regard cognizance should be taken of Para 1.11 of Board's letter no. RS(G)/709/1 dated 06/09/1999 which states as "during consideration of tenders for ordering on approved sources, due weightage should be given to for the past performance both for quality and delivery in distribution of quantities wherever required, so as to ensure timely receipt of quality materials."

7.13.6 **Integration of MMIS:** Integration of Material Management Information System (MMIS) should be done with the monitoring of quality/performance of material. All information related to performance of material supplied vide a particular P.O. should be entered in MMIS by Stores (for new rejection or delay in supply) and by user for failures, warranty claims and other quality issues. Necessary changes in the MMIS for facilitating entering of this information should be made at the earliest.

Annexure-I

Procedure of Issue of Materials

1. The Diesel Stores should carry stocks only of such items as are constantly required by the Diesel Sheds/ Shops, which they serve, for their day to day requirements.

2. Schedule of Diesel Depot – Schedules of items (S.1506) showing also the quantities of such items that are required to be held in each Diesel Depot should be fixed by the Stores Department in consultation with the Mechanical Department and stocks in excess of such fixed quantities should not be held by the Diesel Depots. Copies of the Schedules should be supplied to the Stores Accounts Officer for the use of his Verification Staff.

3. If it is more convenient, a separate sub-ward may be maintained for consumable stores and small tools to meet the requirement of the shed.

4. Forecast Schedules of Stores Required - Forecast Schedules (S. 1508) of all stores, tools, assemblies, fittings, component and parts required by the workshop for periodic

overhauls and the sheds for running maintenance of Diesel Locos should be prepared as early as possible, in advance of the actual day on which they would be required and these schedules should be furnished to the Ward-keeper to enable the latter to keep such materials ready for early issue. These Schedules should be submitted over the signature of the Works Manager or Diesel Shed in-charge. Such forecasts should not be issued piecemeal, but one consolidated forecast should be made out for the loco expected to be overhauled/serviced in the month.

5. Advance Lists of materials – Supervisor or other responsible subordinates of the respective Sections should prepare manuscript advance lists (S 1509), in carbon duplicate, of materials likely to be required by them during the next few days. These lists should be scrutinized and countersigned by the concerned supervisor in-charge and copies thereof furnished to the Ward-keeper whose duty will be to see that the materials are kept ready for delivery.

6. *Issue Tickets*– All materials required by the Sheds/shops shall be drawn, only as and when required, the requisitions being made in carbon duplicate on “issue tickets” in the form shown below:

Form no. S 1510

DIESEL SHED/SHOP ISSUE TICKET

Serial No.------------------------ Dated ------------ Shop----------------------

Index Number of Supervisor---------------------- Shed ---------------------

Ward Keeper please issue --------------------

Class and Price	Description of Stores	Quantity	Work Order no.

Received Signature of Indentor

7. These tickets may be signed by a Supervisor, provided the items appearing therein have already been included in the advance lists approved by the Supervisor in-charge (paragraph 5) and find a place in the forecast schedules referred to in paragraph-4.

8. Issue tickets for items of stores that do not appear in the advance list should be signed by the Supervisor in-charge of the shop/section concerned.

9. Issue tickets for items of stores which do not appear in the forecast schedule should be signed by a gazette officer or by a senior selected subordinate, especially given powers by the Chief Mechanical Engineer to countersign such tickets.

ANNEXURE- II

Functions of the Supervisor, Material Cell

1. Responsible for inspection and certification of stores received (indigenous and imported) and related correspondence.

2. Scrutiny and certification of drawings and obtaining specifications of materials, processing of stocking applications, following up of indigenous developments and trials.

3. Supervision over demands, supply and consumption of lubricants and stores and review of estimated annual requirements.

4. Keeping track of supply and chasing of vital items from Stores, Shops and Trade. (other functions of this Supervisor/Material Cell are indicated in Annexure-4.2 of Chapter 4)

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Chapter 8

Fuel & Lubricants

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8. FUEL & LUBRICANTS

A. Storage, Handling and Dispensing of Diesel Fuel oil

8.1 General

8.1.1 Fuel is a major item of expenditure in railway operation. Conservation of fuel, therefore, is an important factor in bringing down operational costs. Proper attention needs to be given to the handling of fuel oil, in order to prevent losses from spillage and over filling of tanks. In addition a proper fool proof system of accountal of fuel receipt and issue be in place for taking various managerial actions on reports.

The fuel injection equipment on a diesel loco is manufactured to fine tolerances. Dirty and contaminated fuel can lead to troubles on the diesel engine. Just as it is the responsibility of the oil company to supply commercially clean fuel oil according to specifications, it is the responsibility of the RCD staff to see that fuel is not contaminated in any way with water, dust, sand, dirt, etc. during its handling.

8.2 Fuel Oil Servicing Facilities :-

8.2.1 Fuel oil servicing facilities usually consist of :

a. Unloading facilities
b. Storage facilities
c. Pumping facilities
d. Distribution facilities
e. Facilities for delivery to locos
f. Fire protection arrangements

8.3 Fuel Oil Unloading Facilities:

8.3.1 The fuel unloading facilities should be provided at a convenient place which can be approached by both rail and/or road, depending upon how the supplies have to be received. Zonal Railways has been advised by Board Vide Letter no.2006/Fuel/282/5 dated 8-6-2006 to shift transportation of HSD Oil from Rail to Road, wherever feasible. However where HSD Oil supplies are still being received through rail tank wagons, the following may be ensured:

8.3.2 Tank wagons may discharge their diesel fuel oil either through a valve located at the bottom of the tank wagon or through the dome opening at the top. Bottom unloading is more common and one of the advantages of this is that it affords a flooded suction for pump operation. However, the chances of spillage with this method are greater. The overhead or dome unloading method is preferable on this account and may be used where the track centres permit the overhead unloading facilities being accommodated in the space available.

8.3.3 Bottom Unloading:

8.3.3.1 The number of decanting pumps to be provided depends upon the numbers of tank wagons required to be unloaded at any one time. The decanting points with suction line connections should be located along side the unloading track properly spaced, depending on the length of the tank wagons and at standard clearance from the track. The connection should be of 75-100 mm size depending upon the capacity of the unloading pump. Arrangement should be provided to isolate any of the connections, if so required. The area around the decanting points should be properly paved, so that it is easy to keep it clean.

8.3.3.2 The hose should be of adequate length and be of an oil resistant material. It should conform to Indian Standard Specification. It is preferable to ensure that the delivery hose ends do not drop on the ground when not in use and are suitably protected from rain and dust. This could be achieved by having a stand on which the hose could be hung. If the hose is of a length which makes it difficult to be hung on a stand, an open metal trough for the hose to be stored when not in use, is recommended. A cover should be provided for the metal trough or detachable cover may be arranged for the hose ends to prevent ingress of dirt and other foreign particles into the hose when not in use. It is necessary that the oil remaining in decanting hose pipes is collected in drums and utilized, as otherwise there is likely to be pilferage or wastage.

8.3.4 Dome Unloading:

8.3.4.1 Dome unloading is usually handled by means of overhead fixtures. These fixtures usually consist of a riser pipe from the suction line with a swing joint at top, an extension arm that normally stands horizontal but which can be pulled down and across to the dome of the tank wagon, and a light weight non-ferrous metal drop pipe of sufficient length which can be lowered into the tank wagon to serve as the suction pipe for drawing in fuel from the tank wagon. The riser pipe should be slightly higher than the height of the tank wagon and should be properly secured at the bottom in a concrete base pedestal. A valve in the riser pipe and a strainer at the end of drop pipe are also provided. The swing joint is fitted with ball bearings with sealed in lubricant and non leaking ring seals. Figure 8.1 illustrates this type of fuel oil unloading arrangement.

8.3.4.2 It is good practice to provide a push button start-stop switch at a central convenient point in the unloading area for starting and stopping of fuel unloading pumps. The provision of green and red electric light visual indicators helps in ensuring proper functioning of the unloading arrangements when large quantities of diesel fuel are to be handled in big RCDs.

8.3.5 When fuel oil supplies are received through Road Truck Tankers (RTT), the following may be ensured:

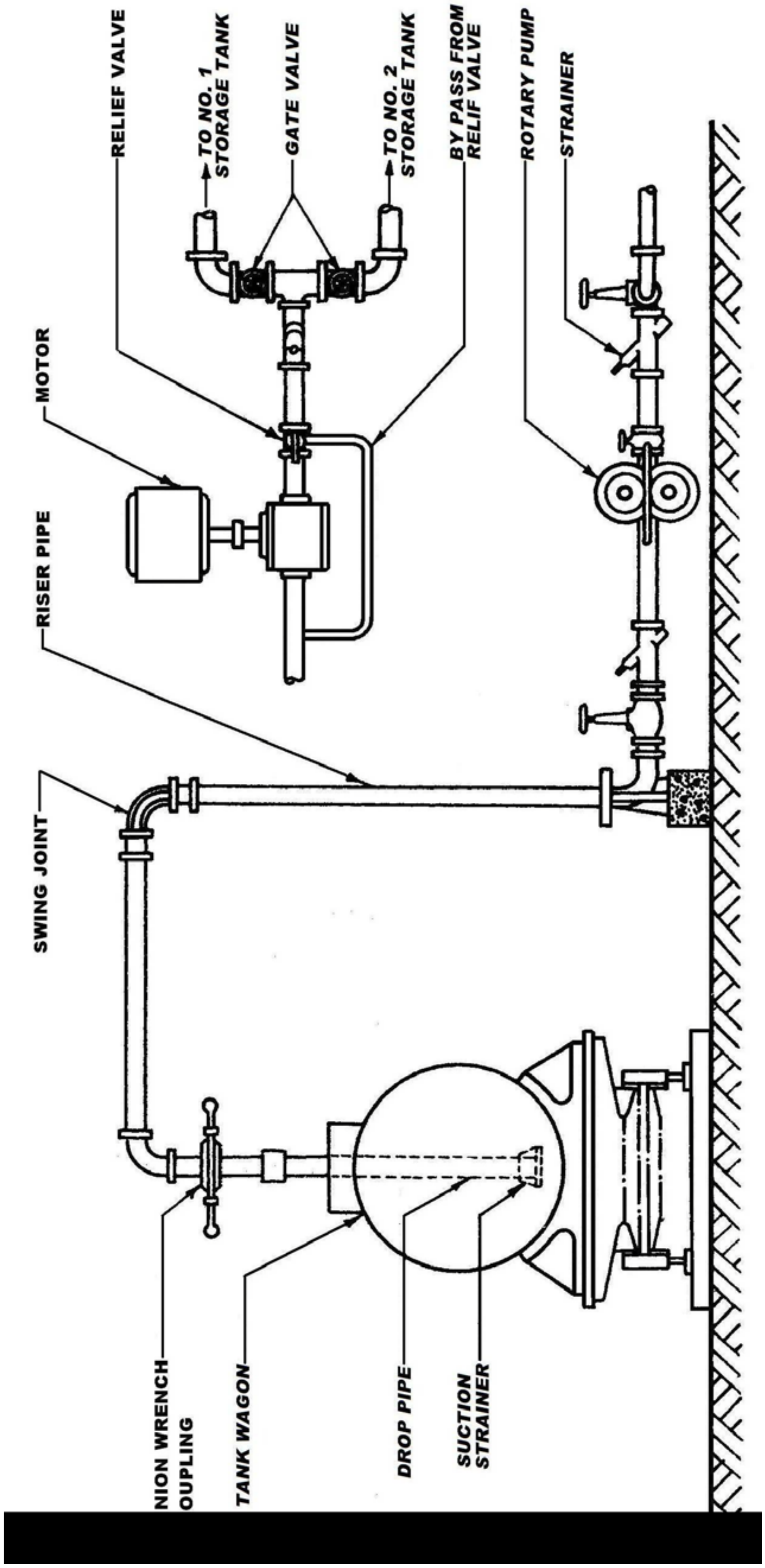
RELIEF VALVE
TO NO. 1 STORAGE TANK
GATE VALVE
TO NO. 2 STORAGE TANK
BY PASS FROM RELIF VALVE
ROTARY PUMP
STRAINER
MOTOR
RISER PIPE
SWING JOINT
NION WRENCH OUPLING
TANK WAGON
DROP PIPE
SUCTION STRAINER

Figure 8.1

8.3.5.1 Wherever supply of HSD oil to RCD is exclusively done by the tank lorries:

a. Good approach road to RCDs should be made available
b. A ladder with platform, canopy facility and level flooring/platform must be made available at RCD for placement and recording of dip level of lorries.
c. The decanting of such lorries is to be personally inspected by a Gazetted Officer at least once in two months to ascertain that the instructions and accountal procedure are being properly followed, as stipulated vide Para 2.7 of RBs JPO 2010.

8.3.5.2 Procedure of Decanting:

a. As soon as RTT is placed for decanting, the supplier's seal arrangements at the top and bottom should be checked. If they appear tampered with, an immediate joint inspection by representative from Oil Company & RCD in-charge along with the Truck Driver should be conducted. The actual quantity assessed in their presence by dip measurement is to be recorded jointly. Stern action is to be initiated by the Oil Company in this regard to avoid such lapses.
b. No RTT should be decanted after the sun set except in exceptional circumstances.
c. Before decanting the RTT, dip measurement should be taken and the time of decanting and the temperature should be recorded.
d. The RTT should have been at rest at least 15 minutes before the dip readings are taken.
e. Vent hole cover to be kept open at the time of taking dip.
f. It should be ensured that the Dip Rod/Tape touches the bottom of the Tank Wagon/RTTs while taking the dip measurement.
g. The quantity so assessed by measurement should be shown in respective Register.
h. Sample tests from tank lorry with water soluble paste must be carried out before decanting. In case water contamination is noticed, the decanting should not be done and immediate joint inspection by representative from Oil Company & RCD in-charge along with the Truck Driver should be conducted. Lorry returned to supplier, if water contamination is confirmed.
i. It must be ensured that the RTTs are fully emptied. To prevent any Oil being left over all delivery valves should be opened when Lorries move out of the Installation.
j. A ramp should be available in the decanting area where RTT can be taken so that it leans sideways to check whether fuel has been emptied fully or not.
k. Similarly before decanting and after decanting a Truck or a group of Trucks dip reading of the Storage Tank should be taken and recorded in respective register. To allow for any turbulence to subside, at least 15 minutes should be allowed to elapse after decanting, before dip measurement of Storage Tanks are taken.

8.3.5.3 Marking of Weights and Measures seal (embossed arrow mark at the bottom tip of the dip rod) on the dips to be examined for wear in the rod and any bendiness in dip rod also to be examined. Any discrepancy should be promptly pointed out for rectification in the next trip duly advising the Oil Company.

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8.4 Fuel Oil Storage Facilities:

8.4.1 Capacity: Adequate storage capacity must be available so that even in the event of interruption of deliveries, there is adequate reserve available for operation. Storage capacity provided should be enough for about 10 to 30 days consumption.

8.4.2 Location of Storage Tanks:

8.4.2.1 Location of the main storage tanks should be so arranged that the piping from the tank to the fuelling points will be as direct and as short as possible. At the same time the lead to the storage tanks from the fuel decanting (unloading) points should be convenient and short so that complicated unloading arrangements are not necessary.

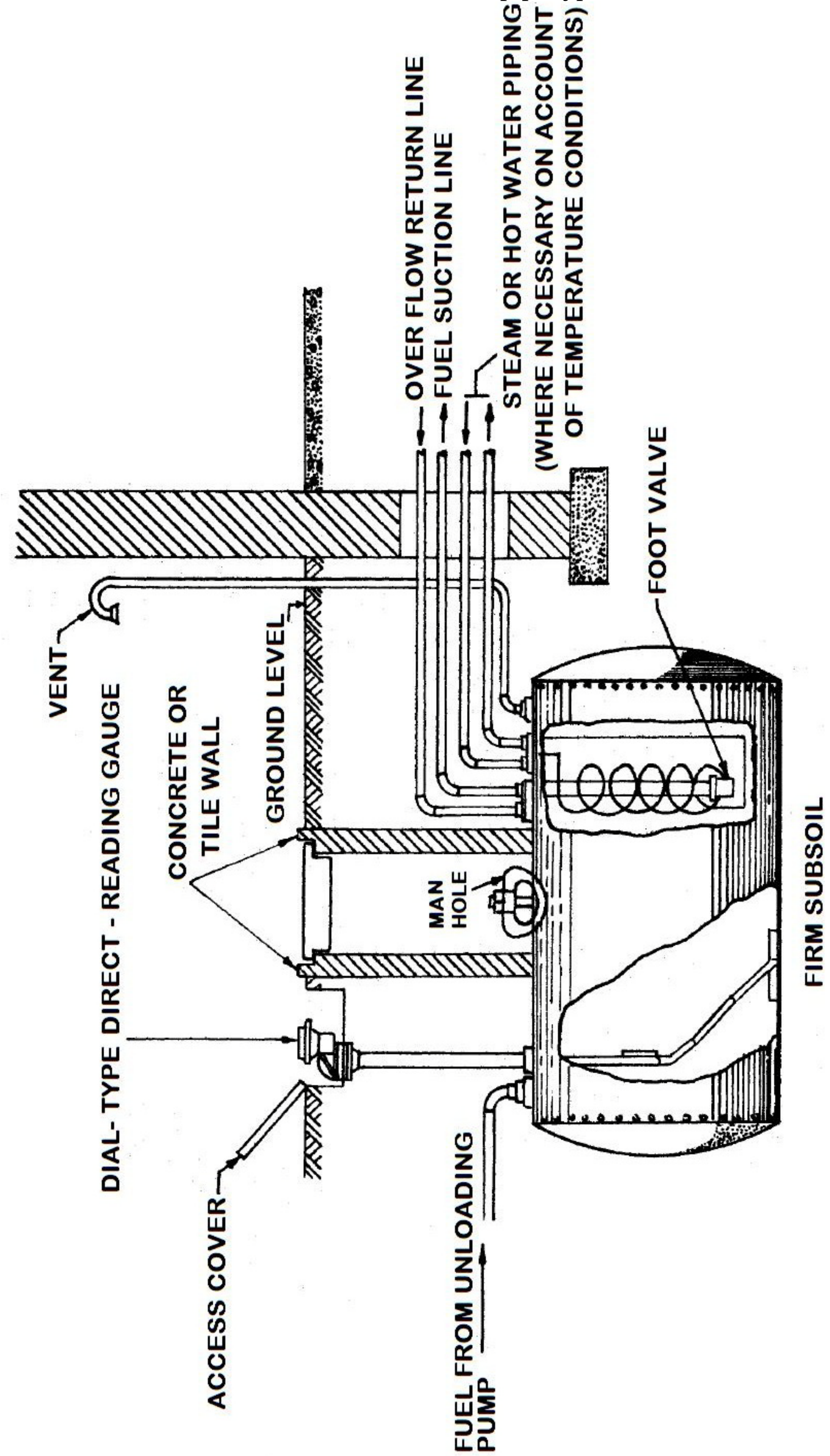
8.4.2.2 Instead of providing one big storage tank, it is preferable to have two or more storage tanks so that while one tank is in use, the other can be filled and allowed time for settling and periodic bleeding of collected water. No fuel should be drawn for several days after filling of the tank to allow sufficient time for settling.

8.4.2.3 The storage tanks should be separated from each other by a distance at least equal to the diameter of the tank.

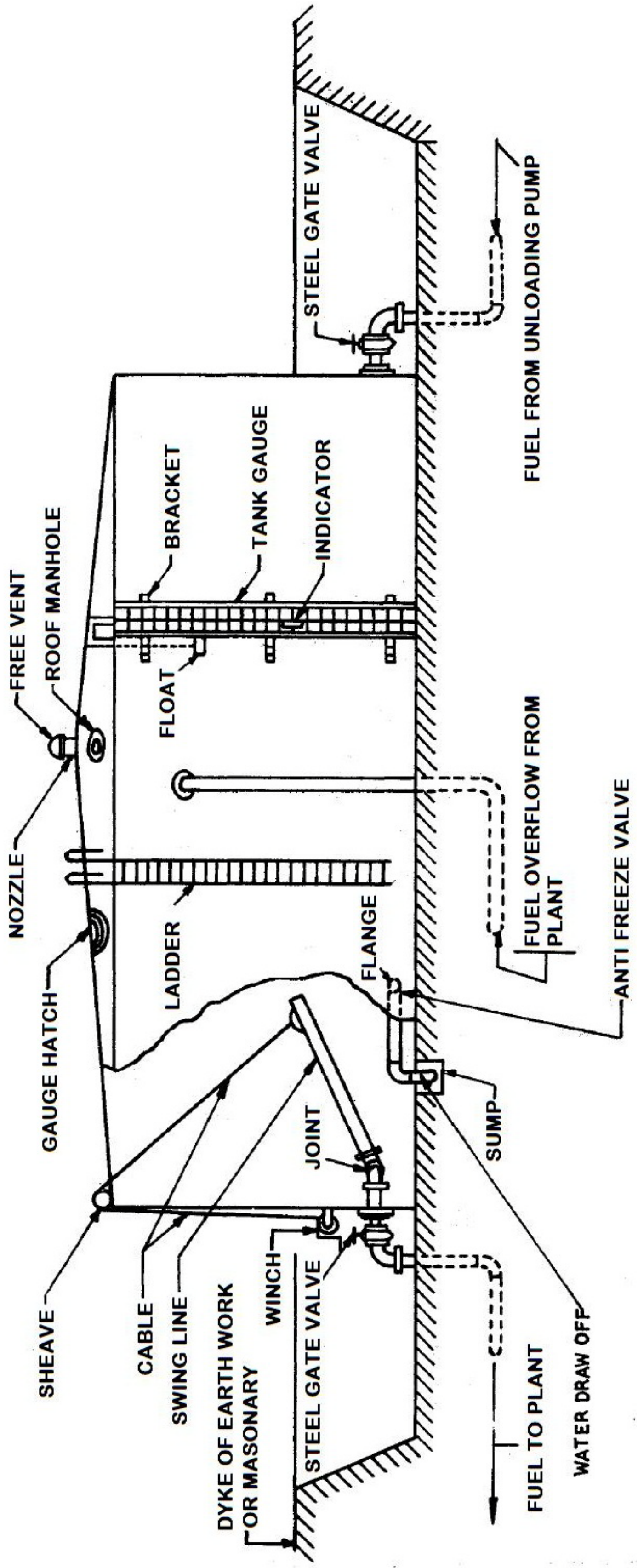
8.4.3 Types of Storage Tanks:

8.4.3.1 The storage tanks may be either of the overhead or the underground type. The under-ground type is considered safer from the fire hazard point of view and if the tanks are to be located in crowded areas, underground types may be an absolute necessity both because of space limitations and safety regulations. Underground tanks can be filled by gravity feed from the incoming tank wagons with the result that fuel unloading arrangements are simpler. The disadvantage of this type of fuel tank is that, even though roofed over the excavation, it is always liable to be flooded by seepage of underground water making the provision of a drainage pump necessary. The tank de-sludging arrangements are also awkward. When space and local conditions permit, overhead (above ground level) tank is preferable, since it is both cheaper to install, permits easier inspection for leaks and corrosion and de-sludging arrangements are more satisfactory.

8.4.3.2 Generally in the RCDs pre-fabricated (welded steel construction) cylindrical type tanks are used. For storage of very large quantities of fuel, field erected vertical stand pipe type tanks are used. (These types of tanks are mostly used by the oil companies for storage of large quantities of fuel in their distribution depots). Figures 8.2 and 8.3 show respectively typical underground fuel tank with connections and vertical outdoor stand pipe type tank installation.



Figures 8.2


STEEL GATE VALVE
FUEL FROM UNLOADING PUMP
BRACKET
TANK GAUGE
INDICATOR
FREE VENT
ROOF MANHOLE
FLOAT
NOZZLE
FUEL OVERFLOW FROM PLANT
LADDER
GAUGE HATCH
FLANGE
ANTI FREEZE VALVE
SUMP
JOINT
SHEAVE
CABLE
SWING LINE
WINCH
DYKE OF EARTH WORK OR MASONARY
STEEL GATE VALVE
FUEL TO PLANT
WATER DRAW OFF

Figures 8.3

8.4.3.3 The cylindrical tanks, of the type most commonly used in RCDs, should be provided with a fall of about 4-5 cm per meter length from the outlet end (fuel discharge end) towards a drain cock provided at the rear. This will enable the water and sediment to gravitate towards the drain cock from where sludge can be taken out before the tank is refilled with fresh fuel.

8.4.3.4 The cylindrical storage tanks should be mounted on a brick cradle, which could alternatively be of steel or concrete. The installation may be either in a shed or in an open enclosure. If the tank is to be underground, it may be housed in a specially constructed cradle of concrete. It is, however, important that the tank should be protected by a heavy coating of asphaltic bitumen or a bituminous compound to prevent corrosion by moisture and seepage water.

8.4.3.5 It is also good practice to provide a high level day-tank (with gravity feed) holding approximately one day’s fuel consumption so that in case of failure of the regular fuelling arrangements, no difficulty is experienced in fueling of the locos.

8.4.4 **Water Drain off Sump and Valve:** A small sump at the bottom of vertical type tank should be provided with proper pipe and valve connections to draw off accumulation of water.

8.4.5 **Location of Tank Outlet:** The outlet for fuel discharge from the tank should be so located that the fuel oil will be drawn off at a level of about 20cm above bottom of the tank thus allowing space for collection of water and sludge.

8.4.6 **Internal Checks Valves:** An internal check (safety) valve in the outlet pipe should be provided which will automatically close in case of a fire.

8.4.7 **Vents:** Mushroom, goose neck or ‘T’ type vents are used. They should be screened to prevent entrance of birds and insects into the tank. If the tank is under cover, the vents should terminate in the open atmosphere. The vent pipe should be of ample size and its end should be protected with a flame arrestor and so arranged as to prevent rain from entering or draining into the tank.

8.4.8 **Level indicators:** Several types of level indicators are used. They should cover the full height of the tank and should be of a design that will permit accurate determination of the amount of fuel in the tank at any time.

8.4.9 Painting of the Tanks:

8.4.9.1 In preparation for painting, the steel tanks after fabrication should be immersed in hot phosphoric acid bath to ensure complete removal of mill scale and rust. These should then be painted with a red lead of zinc chromate primer. After erection at the site, the tank should receive a second coat of primer followed by the finishing coat. Aluminum or white paint is preferable since it reflects, rather than absorbs heat from the sun and thus tends to keep the stored fuel oil at a lower temperature.

8.4.9.2 The inner side of the bottom plate should be given a bituminous coating prior to welding. There is no need to paint the interior of the fuel oil tank.

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8.4.10 **Drawing out of impurities:** Sludge gets collected in the HSD Tank – both in underground and above ground level tanks, in spite of all precautionary measures including periodical draining. Presence of silica in the ash analysis gives an indication that dust invariably finds its way into the tank in course of time. Presence of iron is perhaps due to corrosion products from the plates. It is however, difficult to estimate the rate of collection of sludge in any tank since lot of variables are involved. The cleaning and painting of the storage tank should be done after 5 years by the oil company. However, inspection of storage tanks will be done jointly by the representatives of the Railways and the Oil company every 4 years from the date of installation/last cleaning. If conditions warrant, the tanks will be cleaned and painting will be done after 4 years. During cleaning of the storage tanks, the accumulated sludge is to be collected and disposed off as stipulated in para 3.4 of Rly Board's JPO of Feb'10. This will also give a chance to attend to any damages to gusset plates of the tanks and an inspection for leaks can, in addition, be made. For this purpose a hand pump may be provided, taking suction through a line reaching down nearly to the bottom of the tank at its lower end. In the absence of this arrangement, ordinary drain cock for de-sludging may be provided.

8.4.11 Fuel feed pipes:

8.4.11.1 Fuel supplies are pumped into the tank through the fuel feed pipe going down about 5 to 7 cm into the tank from the top. The filling connection at the top should be protected by a dust cap.

8.4.11.2 The essential fittings on fuel tanks are –

a. Vent pipes
b. Man holes to facilitate interior cleaning and inspection
c. Weather proof filler cap and suction valves
d. Sludge drainage cocks and pumps.
e. Fuel level indicators
f. Suitable pumps along with filters and strainers, both for the incoming supply as well as the outgoing supply from the storage tanks

8.5 Fuel Oil pumping Facilities

8.5.1 Selection of Pump:

8.5.1.1 Electric motor driven pumps of the centrifugal, the rotary displacement or the reciprocating piston type are usually employed. The centrifugal pumps with self-priming arrangement may be used where there is a flooded suction or very little suction lift. Rotary displacement type pumps are ideally suited to locations where appreciable suction lift is involved. These pumps must be equipped with relief valve and by-pass arrangement to prevent development of excessive pressure when outlets are closed. A check valve should also be placed in the pump discharge line, before the shut off valve, to prevent back flow of the oil from the tank when the pump is shut down.

8.5.1.2 In addition to Electric Pump, a diesel pump as stand-by should also be provided.

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8.5.2 **Pump Capacity:** The following capacities are recommended:

a. 2000 – 2500 liters per minute at major RCDs and mainline servicing points where fast fuelling rates are required.

b. 1000-1500 liters per minutes for smaller RCDs and shunting loco fuelling points.

8.5.3 Number of Pumping Units:

Either separate pumps can be provided for unloading fuel from tank wagons into storage tanks and for feeding fuel from the storage tanks to the locos or the same pumping unit can be so connected that it can be used either for unloading fuel from tank wagons or for feeding the locos from the storage tanks. Whereas at bigger RCDs, separate pumping units would be justified, at small consumption RCDs one unit to serve both the purposes is all that is needed.

8.5.4 **Housing of Pumping Equipments:** Pumping equipments should be protected against bad weather and also unnecessary meddling by unauthorized persons. The pump house should also have a proper office for the RCD in-charge and for keeping records concerning the RCD.

8.5.5 Pumping Plant Accessories:

8.5.5.1 In addition to the pumps, the proper handling of diesel fuel requires use of certain accessories such as fuel flow-meters, filters and strainers, air eliminators, electrical facilities, etc. These are described in brief below:

8.5.5.2 Fuel Meters:

a. They are necessary to gauge the amount of fuel oil supplied each time. Fuel meter is necessary between the storage tanks and the loco being fuelled to record the fuel supply made to each individual diesel loco. Fuel meter is required to be installed in motor room. Since in some cases simultaneous fuelling of two locos (e.g. one in Up direction and other in Dn direction) may be required, two fuelling system with both having separate pump and separate pipeline may be provided. Both these separate pipe lines should be provided with fuel metering arrangements. It is good practice to have a common pipe also which is connected to these two independent fuelling pipes. This common outlet shall also be provided with fuel meter. This common outlet can be used in case any of the two flow meters become defective. The fuel flow-meter should have a rated capacity somewhat greater than the maximum pumping rate. Fuel oil meters are generally of the positive displacement type and should cause little resistance to flow of oil. Unless provided with automatic temperature compensation, meter readings will require correction for oil temperature.

8.5.5.3 Fuel oil filtration unit:

a. Filters and strainers are necessary to prevent dirt, scale, etc., that may be present in the fuel oil, from damaging the various components in the fuel oil system. To protect the fuel meters, filters or strainers are placed ahead of the meters to remove any coarse sand or grit that might damage the meters' parts. In large oil installations, the filter elements might well be of the duplex type which would permit each element to be cleaned in turn, without stopping the fuel deliveries.

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b. Filter equipment should preferably be installed both before the inlet to and in the discharge line from the main storage tanks. This will ensure that the fuel is filtered (1) as it is unloaded from tank wagons to storage tanks and (ii) when it is pumped from storage tanks to the locos.

c. The size and type of the filtration unit will depend upon the quantity of fuel in use. The filters selected should have ample capacity to handle the fuel demand of the installation at peak requirements. The more liberally the filter is sized, the less frequently it will have to be cleaned and up to a certain point, the filtering performance will be better.

8.5.5.4 Air Eliminators:

a. When fuel oil is to be pumped though a pipe line which has not been used for some days, it is better to prime the pipe line first to remove the air present in it. This safeguards against any possible air lock. For purpose of priming, the fuel oil is pumped back through the line, till air has been exhausted from it and then the pumping in of fresh quantity of fuel is commenced. Even on the diesel engine fuel system, air may enter the lines when filters are changed or cleaned or when the fuel lines are disconnected for any reason. Running of the engine until the fuel is exhausted or running the engine for some time with fuel supply switched off or leaving the engine unused for some period resulting in the fuel draining back from the injection pump, will also lead to the entry of air in the system.

b. Normally, air vents are provided on the fuel filters and on the fuel pumps so that they can be opened for venting the air from the fuel system. After opening the air vents, the fuel is pumped through the system and when it becomes apparent that the fuel stream contains no air bubbles, the air vents are closed.

c. Air eliminators are normally installed on pump housing on the discharge side and ahead of the filters and the meters. They release any trapped air from the pipe lines and thus prevent it from entering the filters or affecting the accuracy of the meters.

8.5.5.5 **Electrical facilities:** The electrical facilities consist of power supply to the pump house and surroundings, circuit breakers and start and stop control system for the pumps. The start-stop pump control system should be made as automatic and fool-proof as possible.

8.6 Fuel oil Distribution Facilities:

8.6.1 The fuel lines can be installed either above or underground. Freezing of fuel oil is a problem only in extreme climates and does not come into the picture generally in this country. The pipes placed above ground must be supported at proper spacing and provision made for their expansion. Underground piping should be protected against corrosion. Generally, underground installation is preferred.

8.6.2 Sizes and types of pipes and joints:

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The pipe may be either of steel or wrought iron. It should be sized to reduce friction losses as much as possible and normally 75, 100, 150, 200, and 250 mm dia pipes are used for pumping rates of 800, 1000, 1500, 2000 and 2500 liters per minute of fuel, respectively. Flanged joints are preferred for valves and for equipment located in pump houses. Line joints may be welded, flanged, screwed or bolted.

8.6.3 Depth of Bury for Underground Pipes:

The depth of bury for underground pipes varies from 30 to 120 cm in the open and from 60 to 175 cm under tracks. The National Board of Fire Underwriters (UK) recommends 90 cm bury for the open ground areas and 150 cm under tracks. Piping under tracks should be installed in cast iron or steel pipe casing, the inside diameter of which is at least 50mm greater than the maximum outside diameter of the joints of the fuel oil pipes. Railways in their future indents may include a provision for brick wall by the side of the pipe line for underground-storage installations to avoid sinkage problem.

8.6.4 **Protection against Corrosion and Leakage:** Leaks in the underground fuel oil lines are hard to detect and can result in considerable loss. Recommended practice for underground works is to coat the pipe with an anti-corrosive preservative and to wrap it with tarred or plastic wrapping, either before or during installation. Additional precaution recommended is to back fill the area around the pipe with sand or clay.

8.6.5 Installation of above Ground Pipe Lines: The supports for above ground piping should be spaced 5 to 6 meters apart and may be constructed of rail or reinforced concrete. The total expansion/contraction due to changes in temperature may be provided for by the use of convention methods such as provision of loops, swing joints, expansion joints, etc.

8.7 Fuel Deliveries to Locos:

8.7.1 In a shed, diesel locos may be fuelled either at the time of their entrance or at the time of their exit from the shed. In the case of locos which come into the shed only for servicing and light schedule inspection, it is preferable to fuel them at the entrance in which case the sequence of movement could be arranged as under:

a. Under gearing washing
b. Body cleaning and washing
c. Sanding
d. Fuelling
e. Schedule inspection
f. Departure

8.7.2 In the case of loco requiring heavy schedule inspection or necessitating the emptying of fuel tanks, it is preferable to fuel the locos after inspection and repairs. Thus, fuel feeding points are necessary both at the incoming as well as the outgoing ends of the shed.

8.7.3 The fuel tapping point should be at a slightly higher level than the fuelling point on the loco fuel tank to avoid spillage during the fuelling operation.

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8.7.4 The fuel hose should be constructed of oil-resistant material and provided with special fittings and couplings on the outlet end to match the connecting arrangements on the loco fuel tanks. It is preferable to have the fuel tapping point as near the track as possible so that the length of the hose should not be more than 3 to 4 meters. If the hose is short, it can be hung on a stand but in the case of a long length hose, the part that would otherwise drag on the ground should be placed in a metal trough with adequate protection against dust and rain and with provision for spilled oil and residual oil in the hose pipe to be collected without being allowed to contaminate the ground area.

8.7.5 Adequate pump control and fuel metering arrangements should be provided.

8.7.6 The area of fuelling point should be concrete paved for ensuring easy cleaning of the area and prevent seepage of spilled oil into the ground. Also, the track portion where loco stands during fuelling should have concrete apron for the same purpose.

8.7.7 **Overhead Fuelling Mast:** An overhead fuelling mast with hose permanently attached to it, is recommended for fast fuelling of the diesel units. The arrangement usually adopted is somewhat similar to that used for dome unloading of fuel as illustrated in fig. 8.1. The riser pipe is connected to the fuel supply point and a horizontal extension pipe of the pull-down type is connected to the riser pipe with a swing joint. The fuelling hose takes the place of the suction drop pipe and makes the final connection to the fuel tank of the diesel unit. This vertical swing mast arrangement provides greater working range with fairly small length of hose and occupies less space. Usually, a shut off valve is installed in the riser pipe and a trigger-operated nozzle valve is fixed at the end of the hose. One drawback of this arrangement is that, when the hose is full of oil, it is rather awkward to handle. Also, the oil confined between the shut off valve and the trigger-operated nozzle valve may expand with heat and either rupture the hose or leak through the nozzle valve. To overcome this, sometimes, the nozzle valve is removed from the end after every fuelling operation and this leaves the hose drained and dry except when it is in use. Arrangements are incorporated in the system to ensure that the hose does not contain any oil after the main valve in the riser pipe has been shut off so that no fuel oil wastage takes place when the nozzle valve is removed from the hose.

8.7.8 **Automation of fuel filling process:** Railways should strive for automation of the fuel filling process, to the extent possible, as mentioned hereunder:-

8.7.8.1 When loco arrives at fuelling point, entry of loco number, date, name of LP/Shunter, name of fuelling staff and amount of fuel level required to be maintained in the loco tank should be made by the filling staff in a console and fuel filling pipe connected to the loco tank.

8.7.8.2 Automatic sensing of the fuel level in the loco tank should be done through the ultrasonic fuel level sensor fitted in the loco.

8.7.8.3 Depending on the fuel level in the loco tank and level required to be maintained, calculation should be done by the console and accordingly fuelling pump started and cut off, after completion of the filling of the required amount of fuel.

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8.7.8.4 The fuelling pumps should have facility of remote on an off for facilitating automatic fuelling in the locos.

8.7.8.5 Storage tanks should have the facility of automatic measurement of fuel level, accordingly it can be decided as to from which storage tank how much fuelling can be done. The level so recorded should also be periodically relayed to a central server for record and viewing by the division and HQ officials.

8.7.8.6 Fuel meters should also have the facility of automatic relaying of the amount of fuel filled up in the locos.

8.7.8.7 The amount of fuel filled in the loco and other details should be automatically relayed to the central server for record and viewing by various divisional and HQ officials.

8.8 Periodicity of Maintenance of RCD installation: Summary of periodicity of maintenance of various parts of RCD is as under:-

SN	Activity	Frequency	Authority
1	Cleaning of Storage Tanks	Every 5 years (4 years, if need be)	Para 3.4 of Rly. Board's JPO of Feb'10
2	Painting of Storage tanks	Every 5 years (4 years, if need be)	Para 3.4 of Rly. Board's JPO of Feb'10
3	Changing of Flowmeters	15 years after installation or dispensing of 4 lakh kl, whichever is earlier.	Para 5.3 of Rly. Board's JPO of Feb'10
4	Calibration of flowmeters	Once in a year by Oil company	Para 5.3 of Rly. Board's JPO of Feb'10
5	Joint Inspection with Oil Firms's representative	Once in a Quarter	As per agreement between the Railways and Oil Firms

8.9 Security and Safety of RCDs:

8.9.1 RCD holds precious and inflammable commodity. Hence, it is very important that proper security at each RCD is provided. As per Standing Order No. 88 of Rly. Board, communicated vide letter no.2003/Sec/(E)/PO-2/5 dt 13th May 2009, RPF should provide security at RCDs, as it falls under core activity (it does specifically state so but since it has not been mentioned as one of the non-core areas, it is inferred that it is core activity). But, later on this Standing order has been held in abeyance by Board. Nonetheless, Railways to ensure that security at RCDs is provided at the earliest.

8.9.2 In terms of Railway Board's letter No. 2009/Fuel/282/19 dt. 30/11/2009 all Railways should ensure that a current valid clearance of the Chief Controller of Explosives, Nagpur is obtained for every RCD duly meeting all conditions and a copy is kept in the RCDs, without fail.

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8.9.3 The inherent danger of fire around a diesel fuelling installation is due to the formation of inflammable vapours resulting from the leakage or spillage of oil. Fire prevention measures must, therefore, curtail oil leakage and avoid practices which may allow vapours to form or collect. The possibilities of ignition can be minimized by ensuring that the equipment is in good condition and that the operating instructions are worked to properly. Proper fire fighting facilities should be available so that in case of a fire breaking out, it is possible to combat it.

8.9.4 The following will help to minimize oil leakage and spillage and, thus, safeguard against fire hazards:

a. Welded pipe joints in fuel lines reduce oil leakage.

b. Air vents should terminate in open atmosphere outside the pump house.

c. Pressure relief valves should be piped back into the storage system and not discharged to atmosphere.

d. Fuel pumps should be equipped with proper seals to safeguard against fuel oil leakages.

e. Areas around fuel installations should be paved so that if any oil is spilled, it is possible to clean it easily. Concrete paved platform with proper slope to provide quick drainage into sumps or drains is recommended.

f. Naked lights should never be brought near the tanks even when they are empty. Oil rags and waste easily catch fire and therefore should not be allowed to accumulate near the fuel installation area.

8.9.5 Exposure to extremes of temperatures would result in evaporation and loss of fuel, besides involving risk of fire. Leakage also has the same harmful effects. Tanks containing fuels should, wherever possible, be shaded from direct sun light otherwise wide temperature variations will increase the chances of water condensation within the tanks. When fuel becomes hot, it expands and forces some of the air above it to go out of the tank. On cooling, the air and water vapour are drawn into the tank resulting in water contamination of fuel.

8.9.6 In terms of Railway Board's Lr.No.2009/Fuel/282/19 Dt. 09-11-2009 Railways should ensure following fire fighting facilities at fuelling installations :

Items	Major installation	Medium Installation	Minor Installation
DCP fire extinguishers- 70 Kg	4 nos. around storage tank	4 nos. around storage tank	4 nos. around pump room Generator Room

Items	Major installation	Medium Installation	Minor Installation
DCP fire extinguishers- 10 Kg	8 nos. around pump room Generator Room	8 nos. around pump room Generator Room	--
DCP fire extinguishers- 5 Kg	1 No. at each fuelling point	1 No. at each fuelling point	1 No. at each fuelling point
CO2 fire extinguishers- 5 Kg	3 Nos. for tackling computer and electrical fires	2 Nos. for tackling computer and electrical fires	1 No. for tackling computer and electrical fires
Sand Buckets	8 Nos.	8 Nos.	4 Nos.
Hand Operated Siren (dynamically balanced) with range of 1.5 Kms	01	01	01

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8.9.7 Proper mechanism of maintenance of the above-mentioned fire fighting facilities should be in place in each RCD.

B. Procedure for Accountal of Diesel Fuel

8.10 Indenting

8.10.1 Each Railway will work out a time table so that the indent is prepared and submitted in time.

8.10.2 Division/Diesel Shed should work out the requirements of HSD oil for the RCDs in their jurisdiction. These should take into account anticipated variation in the train operation during the next financial year. Arrangement for new/additional storage capacity (normally being 15 days consumption plus lead time) / pumping should be reviewed and specific proposals along with the requirements of next financial year sent to fuel branch. Fuel branch will forward the requirement of HSD oil and new/additional storage capacity along with details of direct demanding officers to Controller of Stores for procurement. In case of placement of rate/running contracts, COS will advise fuel branch of the Railway and all Divisions/Diesel Sheds and RCDs in-charges.

For rate contracts, supply orders shall be placed by COS. For running contracts direct demanding officers will place orders on suppliers. A fresh order should be placed when balance quantity due on a supply order is reduced to two months consumption.

Fuel branch should control and regulate day to day supply of HSD oil by tank wagons or by RTTs. A close watch on the trend of consumption vis-à-vis rate/running contract should be kept and amendments called for through COS, as and when necessary.

8.11 Loading advice and Railway receipt:

8.11.1 Loading advices should be sent by suppliers by postal dak within 24 hours of loading to the consignee. These should be serially numbered for each consignee separately and should contain the following particulars for each loading day :

a. Tank wagon number/lorry number
b. Carrying capacity
c. Net quantity loaded in liters
d. Date of loading
e. Loading station code

Copies of the loading advice will be simultaneously dispatched by postal dak to the FA&CAO and fuel branch

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8.11.2 The RR should be sent to consignee immediately by the supplier to enable the former to take delivery.

8.11.3 The supplier will prepare a statement in Form No.1 in respect of each bill and send two copies to consignee and one copy to FA&CAO. The form should be serially numbered for each consignee and this serial number should be indicated in the bills sent for payment.

8.12 Pocket Card Labels and Tie-on-labels:

8.12.1 It shall be the responsibility of the base stations to provide pocket card-labels and tie-on-labels on both sides of tank wagons showing:

a. Tank wagon No.
b. Full booking particulars.
c. Supplier's name
d. Consignee's name and station booked to
e. Quantity loaded in litres as per RR at temperature ------ ^{0}C and dip measurement in cm.

In a case of short receipt, these should be preserved until the cases have been resolved.

8.13 Receipt and Accountal in the RCDs:

8.13.1 On arrival of HSD Tank wagon(s) at the destination, the same will be received by the official-in-charge of the RCD and in case there is any evidence of the seals having been disturbed/ tampered with, the delivery should be effected in the presence of the traffic and RPF representative (if posted), Dip measurements taken and damage deficiencies message, if found, issued in accordance with the IRCA rules in vogue. Whenever shortages are found, these will be recorded in Form No.2 and should be pursued with the Commercial Branch through FA&CAO (Stores). The provision of section 76C of Indian Railways Act for delivery of goods at sidings will also be applicable.

8.13.2 For short receipts detected in seals intact tank wagons booked under "Said to Contain" RRs covered by modified transit risk clause, claims for the cost of HSD oil received short with proportionate freight charges should invariably be advised to the Company within 30 days of the receipt of the tank wagons. A copy of this claim should be endorsed to the CCM (Claims) with the request that if supplying oil Company does not issue credit notes for the claims preferred within 15 days of preferring the claims, the same should be recovered from supplying oil Company's subsequent bills by FA&CAO (Stores).

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8.13.3 Placement Memo:

The placement of tanks in the RCD will be supported by placement memo in Form No.3 which will be produced before Official-in-charge of the RCD by the representative of Transportation Department. The placement memo will be prepared in four copies, which will be distributed as under:

a. One copy for station record
b. Three copies for the official –in-charge of the RCD

The official-in-charge of the RCD will take receipt of the oil tanks with the placement memo and return one copy of the placement memo to the Representative of the Transportation Department, duly acknowledging the receipt of oil tank showing release of the oil tanks. Of the remaining two copies, one will be submitted to the Senior Divisional Finance Manager / Divisional Finance Manager of the concerned division along with the periodical receipt return.

8.13.4 No tank wagons shall be decanted after sun-set other than in exceptional emergent circumstances. The temperature of the oil should be taken before decanting. While taking dip measurement, tank wagons should have been allowed to settle for at least 15 minutes before the dip readings are taken and care should be taken to see that the dip rod touches the bottom of the tank wagons vertically while taking dip measurement.

8.14 Quality Control:

8.14.1 Sample should be drawn from top and bottom and tested for the following properties:-

a. Visible suspended impurities and sludge.

b. Crackle Test: This will indicate a water free sample. Silent but audible crackling sound indicates traces of water. Vigorous cracking sound indicates appreciable water.

c. Colour Test: Colour comparison with a 2% solution of potassium bi-carbonate in water should be made. Samples with dark colour should be further analysed for gum content according to ASTMD – 381

8.14.2 If the samples drawn reveal no contamination, decanting into the storage tank should be done.

8.14.3 The following measures should also be adopted for comprehensive quality control:

a. Fuel oil samples from primary fuel oil filter casing should be drawn at least once in a month and tested for contamination. In case presence of water is detected, the cause of such contamination should be investigated and water should be drained out from the loco fuel tank.

b. The ground storage tanks should be drained of water at least once in a week.

c. At least two samples per month from incoming supplies/storage tanks from each fuelling installation should be tested in detail in the Railway laboratories to ensure that the HSD oil supplies conform to the current Indian Standard Specification. A monthly statement in Form No.4 should be sent by RCDs to Fuel Branch of the divisions.

8.15 Procedure in case of contaminated supply:

8.15.1 Provided that the sample from the top is satisfactory, another sample from the bottom should be drawn after draining out approximately 20 litres of HSD oil. This will drain out bottom sludge. Such drained oil should be collected in a tray or drum kept under the bottom valve for issuing for engine cleaning purposes.

8.15.2 If the HSD Oil, on testing, is found below or off specification and it is satisfied that the same is not due to any malpractice in transit or at destination, the following procedure should be adopted:

a. Immediately re-seal the tank wagon

b. Intimation to suppliers' nearest location must be given by Fax and over the telephone about re-booking of the tank wagon. If the representative from supplying oil company does not appear then the particular tank wagon may be re-booked to suppliers' nearest or nominated location ensuring that no demurrage arises.

c. Laboratory test report in respect of each tank wagon rejected should also be forwarded to supplying oil depot of such action.

8.15.3 In case where HSD oil is suspected to be contaminated with water the following procedure should be adopted:

a. Immediately re-seal the tank wagon

b. The nearest suppliers Depot should be advised by Fax and over the telephone to fix up a date for joint examination, endorsing a copy to the supplier's head office and fuel branch of the Railway.

c. During joint inspection, if after further draining and testing to the maximum extent of 1000 litres the balance quantity in the tank wagon is found free from contamination; a certificate as per specimen below should be prepared in four copies and jointly signed by suppliers' representative and the ACMT/ RCD Representative:-
"We hereby certify that ------- litres of contaminated oil were drained out from Tank wagon No………….. booked ex………… to…. under R R No……… dated …………. before the contents could be declared as free from impurities and water contamination and fit for use"
One copy of the above certificate will be immediately forwarded by the RCD In-charge to the Pay & Accounts Officer, Parliament Street. New Delhi, one copy to FA&CAO (Stores) one copy to the Division concerned and one copy to Fuel Branch.

d. The quantity of oil drained out will be deducted from the invoiced quantity and the balance quantity certified will only be taken in books as receipts against the wagon found contaminated and dealt with as above.

e. In the event of the sample (from the top of the rank wagon) showing contamination, the impurities should be allowed to settle down for a period of 24 hours. If after this settling period, samples from the top is free from contamination, the procedure in paras above is to be followed.

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f. If after the settling period of 24 hours, the samples from the top is still found contaminated (in other words if the contents are fully contaminated) the tank wagon should be re-sealed in presence of the Supplier's representative and then returned to base station from where booked or to the station specified by the Supplier's representative with the freight charges to be borne by the Supplier. A joint certificate (as per specimen given below) should be prepared in quintuplicate and forwarded to all concerned as indicated:-
"Certified that the tank wagon no………. booked from ….. to ……… and placed on the decanting siding of ------ RCD at --------hours on ……… has been jointly inspected by us at………. hours on …………… We declare that the fuel oil contained in the said Tank Wagon is unfit for use on the Diesel Locos and Tank Wagons is ordered to be re-sealed and re-booked to the base station, the freight being on supplier's account
Sd/- RCD Representative with designation Sd/- Supplier's Representative With Designation.

g. The disposal of five copies of the above certificate will be as under:

   i. Original to Pay and Accounts Officer, New Delhi requesting deduction for this wagon from bills of the supplier

   ii. Second copy to FA&CAO requesting further pursuance with Pay and Accounts Officer

   iii. Third copy to Fuel Branch, Headquarters office

   iv. Fourth copy to Diesel Shed/Division concerned

   v. To be retained as office copy

h. Such a wagon returned due to contamination is not to be taken on the books. Such a rejected wagon remains the property of the supplier who should be advised to take over the same within one month, after the expiry of which period, the Railway has the right to dispose off this quantity without affording any value to the Supplier. The supplier would also be liable to payment of demurrage charges, etc., that may accrue. All tank wagons should be fully emptied and it should be ensured that no oil is left in them.

8.16 Temperature correction:

To ensure correct accountal, temperature compensation must be made. Procedure for the same is outlined in Annexure -1.

8.17 Accuracy of measuring instruments: To remain within the stipulated overall 0.1% limit of handling losses (Para 6.2 of RB's JPO of Feb 2010),etc, it is essential that flow meters used should have an accuracy of ±0.02 %. This should be checked by calibration every year (as stipulated vide Para 5.3 of the said JPO).

8.18 Tank Wagon Registers

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8.18.1 Official in-charge of the Diesel Installation/Fuelling Depot will maintain a Register in Form No.5 for HSD Oil Tank Wagons received date-wise containing the following information:

a. Date of receipt.
b. Tank Wagon no.
c. Time of placement, release and time of making over the Tank Wagon to Traffic
d. Initials of the Traffic Representative.

8.18.2 Except in case of contaminated Tank Wagons/RTTs, the dip quantity should be taken for all accountal purposes at receipts. In the case of partially contaminate wagons/RTTs, only the quantity certified as free from contamination will be entered as receipts with a suitable entry for drained out quantity under Remarks Column.

8.18.3 The official in charge will ensure that the Storage Installations is operated by authorized Railway Staff and that issues are made either on the basis of Flow Meter Reading (where flow meters have been provided) and wherever flow meters are not provided or are defective, on the basis of Fuel Gauge readings on the locomotives. Cases wherever flowmeters have not been provided or are defective be informed to HQ/Control who in turn should keep CME of ZR informed on such cases. Issues to running engines will be made on the Form No. 6, which is to be serially numbered. Oil issues to individual running engines will be shown in the Form No. 7 daily. This form will show the Storage Tank Number, Date, Engine no., Quantity issued and the total Quantity issued during each date. Acknowledgement of issues of HSD oil should be obtained from each of the Loco Pilots to whom the oil is issued on Form No.6. This should be prepared in three copies: one for submission to Divisional Accounts Office as a supporting voucher for issues with Form No.7, one for the Loco Pilot and one as office copy. All the oil received during the month and issued to running engines as per Form No. 6 should be entered daily in Form no.7. Balance should be struck at the end of each day and Form No. 7 sent to Senior Divisional Finance Manager / Divisional Finance Manager of the concerned division of the concerned division monthly along with Form No.6.

8.18.4 The official In-charge of the RCD will fill up the columns 14 and 15 in Form No. 1 received from the suppliers and send the same to FA&CAO (stores) in respect of Wagons received and decanted in the Storage Tank.

Note :- Where part quantities are decanted from a Tank Wagon and the balance re-booked to other RCDs, the RCD official will prepare Form No. 8 and also make an endorsement in Column no. 16 of Form No. 1 against the entry of the particular wagon.

8.19 Missing Tank Wagons:

8.19.1 A separate statement in Form No. 9 (monthly statement of missing tank wagons of HSD oil) should be prepared and sent to FA&CAO (Stores) indicating "tank wagons not received even though RR has been received" duly filling in columns Nos. 1 to 4.

8.19.2 Cases of Tank Wagons reported "not received but subsequently received should be reported on the same Form No. 9 by filling in Column nos.5 to 10.

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8.20 Oil Tank Wagons Diverted to other RCDs:

8.20.1 In case where the tank wagons have to be diverted from one installation to another, the original consignee will prepare a Issue Note in Form No. 8 in quadruplicate. The original is to be sent to FA&CAO (Stores) and the duplicate and triplicate to the new consignee concerned, retaining one copy with original consignee. The new consignee should acknowledge the receipt of the Tank Wagons in the duplicate and send the same to FA&CAO (stores), retaining the triplicate as his office copy.

8.21 Periodical Return:

8.21.1 A 10 day receipt statement in Form No. 10 should be prepared by the RCD showing the receipts during 10 day period i.e 1^{st} to 10^{th}, 11^{th} to 20^{th} and 21^{st} to the last day of the month. This should be prepared in 5 copies and distributes as under:

a. Office copy
b. One copy to HQ Fuel Accounts Officer
c. 2 copies to DFM (One for posting the price ledger and the other for linking of receipts with payment)
d. 5th copy to Headquarters Fuel Branch

8.21.2 At the end of the month, a summary of the three periods will be compiled by the consuming RCD and sent along-with the 10 day receipt statement of the last period of the month. The receipts will be accounted for by the RCDs in the 10 day returns, on the basis of the invoiced quantity.

8.22 Issues to Engines of other Railways:

8.22.1 The RCD staff should prepare an Issue Note in Form No. 11 and obtain the signature of the Loco Pilot of the engine with complete particulars: name of the Loco Pilot, engine no., quantity issued, etc. At the end of each month, two copies of such Issue Notes duly acknowledged by Loco Pilot of the foreign railway engine should sent to the DFM concerned to enable him to raise debit against Foreign Railway concerned.

8.22.2 In respect of Zonal Railway engine working for other Railway system, the basis of adjustment is the rate of consumption per 1000 GTKMs in terms of Para 10 of Board's letter no. F(X)68-IRA/1 dated 14.8.70. The rate of consumption and the figures of GTKMs earned, etc., would be advised by operating (fuel) branch of the zonal Railway to FA&CAO of the Railway.

8.23 Supply to other Departments of the Railways:

8.23.1 In terms of Railway Board's letter No.99/Fuel/282/2, dt. 23-12-1999, no oil received against the P.O. placed for fuelling of locos is to be issued for non-loco purposes from the RCD.

8.23.2 In case it is essential to have supply from RCD for the other departments, then it shall be authorized by traction directorate of Rly. Board. After board's approval, separate vetted indent for this purpose shall be submitted by the respective department to HQ fuel official for processing the procurement against such indents.

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8.23.3 Proper accountal of such fuel shall be kept by the RCD in-charge.

8.24 Schedule of issues:

8.24.1 Based on the Issue note (Form No. 6) and Daily classified summary of issues to other than locos purposes (Form No. 12), the RCD should prepare a Monthly Schedule of Issues.

8.24.2 Form No.13 showing the consolidated monthly issues separately for locos and other than loco purposes, will be prepared in triplicate and distributed as under:-

a. Divisional Accounts Officer
b. Divisional Fuel Branch
c. Office Record.

Before submission of monthly schedule of issues, the same should be reconciled with the total issues recorded in the stock ledger.

8.25 Stock Registers:

8.25.1 **Tank Register:** A tank Register should be maintained for each tank of oil installed at the consuming RCD in Form No. 14. All the receipts shown in this Register will be accounted for, according to the invoiced quantity.

8.25.2 The receiving RCDs should check receipts by " DIP" with the help of calibration chart of the tank wagons. If the invoice is received before the arrival of the tanks, the quantity checked by "DIPs" should be recorded and tallied with the invoiced quantity; but if the tank wagon is received before the arrival of the invoice, the invoiced quantity of the tank wagon should be taken into account later after checking the same with the "DIP" quantity. To facilitate linking, the particulars of the supply order against which tank wagons have been supplied to the Consuming depot, should be recorded in this register. The issues made should be recorded in this register, separately for each oil tank daily.

8.26 Stock ledger :

8.26.1 The RCDs will maintain a stock ledger in Form No.15 which will be posted from tank register so far as receipts are concerned, and the issues, from the issue notes, Form No. 11, and from summaries of issues for other than locos purposes, Form No. 12. The total issues posted in the Stock Ledger will also be provided with issues as appearing in the Tank Register Form No. 14.

8.27 Monthly HSD Oil Accountal:

8.27.1 The RCDs will prepare monthly HSD Oil Account on Form No. 16, showing the opening balance, total issues and the closing balance for the month. This will be reconciled with "stock ledger" and Tank Register for opening balance and receipts and with monthly schedule of issues for issues. Issues to loco of other Railways will be shown separately. This will be prepared in three copies and distributed as under

a. Divisional Accounts Office
b. Divisional Fuel Branch
c. Office Record.

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8.28 Manning of the Installations: Fuel is a very costly commodity. To ensure adequate quality control and correct accountal of fuel oil, it is of utmost important that RCDs are adequately manned. The following general guide lines are prescribed:-

8.28.1 The man power requirement stipulated in Board's Lr. No.93/Fuel/282/3, dated 2/12/1993 has become inadequate due to present day increased work load at the RCDs due to change of mode of supply from Tank Wagons to RTTs as large number of activities are now required to be carried, which were not there earlier. As such, the following yardsticks should be followed for manning the RCDs:-

SN	Activity/Staff Category	Major (≥ 125 KL per day)	Medium (≥ 50 KL < 125 KL per day)	Minor (< 50 KL per day)
1.	RCD in-charge	1	1	1
2.	Shift Supervisor	4	4	4
3.	Fuel Issuer Team (* for one side Fuelling)			
a)	Skilled Staff	8	6	4
b)	Unskilled Staff	4	4	4
4)	Flowmeter operator (** for one flowmeter)	4	3	3
5)	Fuelling Pump Operator	4	3	3
6)	Pre decanting and dip measurement (*** for one shift operation)			
a)	Office Staff	1	1	1
b)	Skilled Staff	1	1	
c)	Unskilled Staff	2	1	1
7)	Decanting Staff (*** for one shift operation)			
a)	Skilled Staff	5	3	2
b)	Unskilled Staff	5	3	2
8)	Decanting Pump Operator	2	1	1
9)	Post decanting Checks (***for one shift operation)			
a)	Skilled Staff	1	1	1
b)	Unskilled Staff	2		-
10)	Staff for maintaining office records	5	4	3

* For two side fuelling this yardstick will become double.

** For two flowmeters this yardstick will become double.
*** For two shift operations, this yardstick will become double.
In addition, this yardstick may require upward revision, depending upon the local conditions: number of fuelling points, distance between two fuelling sides, number of RTTs decanted, etc. LR and RG is included in the above-mentioned yardsticks

8.28.2 **Quality Control:** One CMA should be there in the base shed for testing of fuel oil samples received from storage tanks and various fuelling points.

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8.28.3 However, Railways should gradually go in for system of payment for the fuel actually consumed from the fuelling point. Also, the operation, upkeep and safety of the fuelling point should be responsibility of the supplier.

8.29 Stock Verification:

8.29.1 Guidelines have been issued by Board vide letter no. 2006/fuel/282/5 pt dt 9-3-2010 (revised J.P.O Para -7 & 7.1) for periodic stock verification of fuel stock of RCDs.

8.29.2 As per these guidelines, stock verification has to be done four times in a year, out of which three times by divisional officers and once by Accounts Representative. Any shortfall noticed during these verifications should be written off, duly following the laid down procedure. Accordingly, book balance should be adjusted, including in case excess is noticed.

8.30 Computerization of RCD records and automatic relaying:

8.30.1 All office records being maintained at RCDs should be computerized and desired reports generated by computer programme.

8.30.2 The various information should be relayed to a secure website for viewing and record of Divisional and HQ officials.

8.30.3 This website should have the facility of access by various sheds for viewing the details of fuelling done in their locos at various RCDs.

Annexure-8.1

Nomograph for Volume and Gravity Corrections

The accompanying chart for estimating approximate volume correction factors and API gravities at 60^{o} F from observed temperatures and API gravities, in petroleum product measurement calculations, is based on ASTM-IP Petroleum Measurement Tables 5 and 6*****.
The intersection of horizontal and vertical lines drawn from points representing observed temperature and observed API gravity on the outside scales will be the point representing the API gravity at 60^{o}F and the volume correction factor to 60^{o}F. These values may be determined from the location of the point with respect to the diagonal curves for such values.

Example:
What is the volume and API gravity at 60^{o}F of 1000 gallons of oil of 37 API gravity at 90^{o} F.
Horizontal line AP is drawn between the 90^{o}F points on the observed temperature scales and vertical line CD is drawn between the 37 points on the observed API gravity scales. The point of

intersection of lines AP and CD falls within the quadrilateral bounded by volume correction factor lines of 0.986 and 0.988 and by 60^{o}F gravity lines 34 and 36.

By inspection the volume correction factor is estimated at 0.9866 and the API gravity at 60^{o}F is estimated to be 35. Therefore, at 60^{o}F the volume would be approximately 986.6 gal. of 35 API gravity .

*ASTM Designation D 1250 , Standard ASTM-IP Petroleum Measurement Tables.

………………………..Railway QUADRUPLICATE

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Form No.1 (only for TWs)

Serial No. ----------------------------------

Date : ---------------------------------------

Statement showing the wagon details for the quantity of HSD oil supplied ---------------------------------------

COS Order		Bill		Qty. billed for in (litres)	Loading Advice		Tank Wagon No./ Lorry	Invoice			Booked		Date receipt in full	Qty. as per measurement (Litres)	Remarks
No.	Date	No.	Date		No.	Date		No.	Date	Qty (Litres)	From	To			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

This should be prepared by the suppliers, separately for each bill and serially numbered for each consignee, The S.No. and date of this form should be indicated in the bill.

One copy to be sent to FA&CAO/ Stores..

Two copies to the consignee by Registered Post.

Columns 1 to 13 to be filled by the supplying Firm.

Columns 14,15 and 16 to be filled by the receiving RCD.

Signature of Supplier

Signature of RCD Official

Railway ----

Form No. 2

Monthly statement showing the enroute supplies in oil Tank Wagons measured in the presence of Traffic Representative

Date of receipt	Tank No. Lorry	Wagon no.	Invoice		Invoiced quantity	Booked From	Booked to	Qty. as per measurement	Difference between Col.5 & 8	Initial of	
			No	Date						Loco Representative	Representative
1	2		3	4	5	6	7	8	9	10	11

To be prepared in quadruplicate : Original and Duplicate to FA&CAO (Stores)
Triplicate to SM
Quadruplicate to Record.

Official in charge of RCD

……………………….Railway

Form No.3 (only for TWs)

HSD oil Wagon placement Memorandum

(to be returned to the Station Master at the time of release of wagons by Depot In-charge)

Serial No. -----------------------------------

Date : --------------------- Hour ----------------- Consignee---------------------------------

Owning Railway	BG Wagon number	MG wagon number	Tare weight	Carrying capacity litres	Rebooking Particulars						Actual Qty. as per invoice	Placed hour	Released hour	Tike taken	Remarks
					From	To	R.R		Invoice						
							No.	Date	No.	Date					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

------------------------------- Station Master

------------------------- RCD In-charge

------------------------------- Station

------------------------- Depot

Monthly statement showing the enroute supplies in oil Tank Wagons measured in the presence of Traffic Representative

Statement of Analysis of HSD Oil Sample

Railway. -----------------------------------

Month… year…

Sl. No	Station name in full	Sample and supply received from#	Supplier and supply received from*	Date		Colour comparison with 2% Pott. dichromate solution							Remarks
				Collected	Total		Flash pt. in °C @	Kinematic viscosity at 37.8° in cst	90% Distillation recovery temp. in °C	Carbon residue Rams batton (% by wt)	Total sulphur (% by wt.)	Pour Point °C	

TG.W – Tank Wagon, T.L. -Tank Lorry, U.G.S.T.- Under Ground Storage Tank, S.T.- Storage Tank, L.F-Loco Tank

*Refinery or bulk storage depot from which the supply is received may be given. The Railway Receipt will indicate the place from which the wagon has been dispatched

@ Abel's method should be used if flash point is lower than 49° C and PM method if it is higher than 49°C

Railway --- **Form no. 5**

Register of Oil Tank Wagons received and detail with at ------------------- during the month -----------------

Date of receipt	Individual No. of tank Wagons/ Lorries	Carrying capacity Litres	Measured Qty. Litres	Time of place Hrs. Mts	Time of release Hrs. Mts	Time of making over to traffic Hrs. Mts	Decanted storage Tank no.	Remarks	Initials of the representative of	
									Loco	Traffic
1	2	3	4	5	6	7	8	9	10	11

This should be prepared in Triplicate

Original to Record

Duplicate to Traffic Official

Triplicate to DFM ------------------------ Official In-charge of RCD

Railway **Form no. 6**

Issue Voucher for H.S.D. Oil

Serial No. ------------------------------- Date

Outgoing LP --------------------------------- Train no. ……………………………. Date ……………………………..

From --------------------------------- To--------------------------- Station -------------------------------

Incoming Train no.& Date -------------------------------------

Issued from Tank No. -----------------------

Loco Oil Tank Balance left by the incoming LP (litres)	Quantity of oil fuelled (litres)	Idling (Litres)	Shed movement (Litres)	Total quantity of oil in the loco oil tank prior to commencement of trip (excluding oil used for idling and shed movement)

Signature of the official-in-charge of issue Signature of the LP

This should be prepared in Triplicate: Original sent to DFM with Form no.6. Duplicate retained for record and the Triplicate to the outgoing LP

Railway ---- **Form no. 7**

Statement showing daily issue of HSD

Date…………………

Reference to issue voucher		Engine no.	Service	Train		Tank no. from which fuelled	Quantity fuelled in litres	Remarks
Date	No			Date	No			

Total | Stock

Summary of issues | Abstract | Tank No.

(a) Opening Balance

(b) Receipts during the days

(c) Total of (a) & (b)

(d) Issues during the day

(e) Closing balance for the day

To be prepared in Duplicate and one copy to DFM/-----------concerned along with Form no.6

Official In-charge of the RCD

Railway -- **Form no. 8 (only for TWs)**

Quadruplicate

Advice Note no----------------------- Date --------

From ----------------------------------- To FA&CAO

Issue Note for delivered HSD Oil Tank Wagon

The under mentioned HSD Oil Tank Wagons received from ------------ is rebooked to you on ---------------- and the particulars are as follow:-

R.R. No. & Date	Invoice Quantity	Booked from	Individual Tank Wagon No.	Rebooking Invoice		Invoiced quantity	Date of* arrival at destination	Accounted for Qty	Accounted in the period	Signature of official receiving the wagon.
				No.	Date					
1	2	3	4	5	6	7	8	9	10	11

* To be filled in at the destination station

To be prepared in Quadruplicate: Original to FA&CAO (Stores), Duplicate & Triplicate to the consignee concerned and Quadruplicate For office record

Signature of the Official In-charge of the RCD
(Rebooking the Wagon)

Railway **Form no. 9**

Monthly Statement of Missing Tank Wagons of HSD Oil

Tank Wagon No.	Missing Tank Wagon		Remarks	Tank Wagon reported missing but subsequently received					Remarks
	Invoice No. and Date	Qty. of oil in litres		Date of receipt	Tank Wagon No.	Reference to report as missing	Invoice Quantity in litres	Actual Qty. as per check	

No. ---------------------- Forwarded to FA & CAO (Stores), Fuel Branch , Headquarters office and CAO --------

Date ------------------- (to be prepared in 4 foils)

Signature of RCD-in-charge

Railway **Form no.10 (only for TWs)**

Name of the Firm ---------------------------------

Statement showing particulars of HSD oil Wagons received at --------------------- Depot during the period

From ---------------------- to --------------------

S. No	Date of receipt	Particulars of Wagon		Original Booking Particulars				Railway Receipt		Invoice		Re-booking particular		Remarks
		Owning Rly.	No.	Name of des-patching station	Actual quantity of HSD Oil as per invoice	Supply order No.	Forwarding Note No.	No	Date	No.	Date	Rebooking invoice	Particulars of Wagon if contents transshipped into WG wagons	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Total quantity ---- No. Date ----------------

To be prepared in quintuplicate : ------------- Station -----------

Forwarded to the DFM ------------- in duplicate (one for posting the priced Ledger and the other for lading of receipts with payments)

------------------ RCD in charge
----------------------- Depot

FA&CAO (Fuel) ---------------------------------
Fuel Branch, Head quarters office. ---------------------------------

Railway

Form no.11 (for Foreign Railway Locos)

Memo of High Speed Diesel Oil issued to LP of ---------------- Depot on --------------------

No	Engine Class	Train No.	HSD oil for the running engines litres	LP's Signature
1	2	3	4	5

Station -------------------------- No------------------------- Dated---------------------------
Forwarded to the DFM ---------------------------------- Division for disposal ----------------------------
-------- Subordinate in charge of Depot

Railway **Form no. 12**

Daily classified summary of issues of High Speed Diesel Oil for non-loco purposes at -----------

Depot for --

Issued to	Quantity issued in litres	Remarks
1	2	3
1. Shed Loco use 2. Pumping stations 3. Train Examiners 4. Repair & Maintenance 5. Other Departments 6. Foreign Railway Engines 7. Transfers to other depot 8. Private parties 9. Miscellaneous		
Total		

Note : In case of issue against cash payment or cash deposits, full particulars of remittance must be furnished in the remarks column. If the space in the remarks column is not sufficient for the purpose, the reverse of this form should be used.

--------------Subordinate in-charge
---------------RCD

Railway **Form no. 13**

Monthly schedule of issues for the month of ------------------------------- for -------- Depot issues to Locos

Date	Quantity issued in litres to locos	Quantity issued in litres to other than Loco purposes	Remarks
1	2	3	4
1. 2. 3. 4. 5. 6. 7. 8. 9. 10 and so on to 31			
Total			

Note : Daily posting should be made from the total of Loco issue notes (Form No. 10) and daily classified summary of issues for other than Loco purposes (Form no. 11)

Copy forwarded to DFM

Signature of RCD In-charge----------------------
RCD -----------------------------------
Railway

Form no. 14

Receipts **Tank Register** Issues

Tank No…………………………….. contents as per invoice of issue notes ---------------------- short or excess

Contents as per measurement ---------------------------

Date of receipt	Wagon no.		Invoice or Index No. & Date	Station From	In-voiced Quantity	Total daily receipt	Date of issue	Particulars of issues	Quantity of issues	Total issued daily	Balance on hand	Remarks
	BG	MG										
1	2	3	4	5	6	7	8	9	10	11	12	13

Signature of RCD In-charge----------
RCD -------------------------------------

……………………Railway

Form no. 15

Stock Ledger

Date	Daily receipt as per			Total Daily Receipt	Date	Daily issues				Total daily issue	Balance on hand
	Invoice No. or index statement	Transfer issue Notes	Without Advice			Home shed engines	Pump etc. Miscellaneous	Other shed engines	Other department & Rlys.		
1	2	3	4	5	6	7	8	9	10	11	12

Signature of RCD In-charge----------

…….Railway **Form no. 16 (Balance Sheet)**

Name of RCD …..

Monthly statement showing opening balance, receipts and issues for the month of ------------------------

S. No.	Location of installation	Opening Balance	Receipts	issues

Total-------------------------------------

No. Dated --------------------

To be prepared in triplicate Station -----------------

Divisional Accounts Office ----------------- RCD in charge

Divisional Fuel Branch ------------------ Depot

(C) Storage, Handling and Dispensing of Diesel lubricants

8.31 Characteristics of lubricants

The following are the main characteristics usually considered in the context of use of lubricants on diesel locos:-

8.31.1 **Viscosity:** This is the most important single property of lubricating oil. It is the fundamental characteristic having a bearing on the (a) ability of the oil to maintain a fluid film between bearing surfaces in spite of the pressure tending to squeeze it out (b) friction loss which may be expected on well-lubricated surfaces.

8.31.1.1 Obviously, reduction of fluid friction will lead to a proportional reduction in power consumption; hence the need to avoid excessive viscosity. Since rate of change of viscosity with temperature varies with different oils, it must be remembered that the significant figure is the viscosity at the operating temperature of the bearing surface. The testing for viscosity is customarily done at 37.7^{o}C (100^{o}F), 54.5^{o}C (130^{o}F) or 98.9^{o}C (210^{o}F). Viscosity at 37.7^{o}C is indicative of conditions such as when starting an engine after a long shut down.

8.31.1.2 As is well known, oils thin out rapidly when heated and thicken when cooled. If viscosity at two temperatures such as at 37.7^{o}C and 98.9^{o}C has been determined, viscosity at any other temperature can be determined from the Temperature – Viscosity chart.

8.31.2 Viscosity Index:

8.31.2.1 Since rate of change of viscosity with temperature varies considerably for various oils, having identical viscosities at any stated temperature, their viscosities will vary widely at all other temperatures. The term viscosity index (VI) refers to this phenomenon. Oils which show relatively small viscosity changes with changes in temperatures are said to have high VI. Those with large changes in viscosity are said to have low VI.

8.31.2.2 Viscosity index is of interest principally in oils employed in engines or other applications where they have to function at widely different temperatures and those which operate with widely varying loads. A high VI oil causes less starting resistance and at the same time maintains its body to an appreciable degree as the engine comes up to operating temperature.

8.31.3 Flash Points:

8.31.3.1 The ‘closed’ flash point is the temperature above which inflammable vapours are produced in an enclosed space above the oil. The open flash point is the temperature above which inflammable vapours are produced when the surface of the oil is exposed to the surrounding atmosphere. The fire point is the temperature above which the oil continues to burn in an open cup after ignition. In all these tests a naked flame is used to check inflammability. The exact value of the result obtained depends on the particular apparatus used, of which there are several kinds. In specification it is necessary to state which instrument is intended to be used.

8.31.3.2 Lubricating oils, usually, have closed flash points above 150^{o}C, in consequence; evaporation loss has little influence on oil consumption in an engine. Flash point has significance in relation to fire hazard. A flash point lower than normal indicates contamination of the oil with a more volatile material, such as diesel fuel in an engine.

8.31.4 **Cloud Point:** This is the temperature at which wax begins to crystallize from the oil. Below the cloud point, the oil does not behave as a normal liquid and its effective viscosity is higher than would be predicted from measurements made at higher temperatures.

8.31.5 **Pour Point:** This is the temperature below which it is impossible to pour the oil. The pour point is usually about 5^{o}C below the cloud point. The pour point of an oil should always be below the lowest temperature at which it is expected to start an engine. Under running conditions pour point has no significance.

8.31.6 **Carbon residue:** This is the solid residue obtained when the oil is heated to complete vaporization. It is more important for fuel oils than lubricating oils, except in the case of IC engines and some equipments where some or all of the oil is eventually burned where it may have a bearing on the amount of deposit formed. Carbon residue has little significance in relation to deposits on cylinders, pistons and cylinder heads, as the fuel and other factors play major parts. In two stroke engines, exhaust port deposits may be influenced by lubricating oil carbon residue, although even here the effects of the fuel are usually over-riding. Often enough, some of the best lubricating oils have high carbon residues. Carbon residue includes additive ash.

8.31.7 Insolubles :

8.31.7.1 Insolubles have significance in used lubricating oils. The insolubles consist of inorganic matter, carbonaceous matter and asphaltic matter. The asphaltic matter is soluble in benzene and this fraction is determined as separate percentage, by difference and is sometimes called percentage of asphaltenes. The residue left behind, after benzene extraction, is the inorganic and carbonaceous matter. The inorganic insolubles may include inorganic contaminants from external sources, and metals and metallic compounds from wear, corrosion and from decomposition of additives. They are determined as the sulphated ash from the Benzene insolubles.

8.31.7.2 ‘Insolubles’ give an indication of the degree of contamination that has occurred. It must be remembered that what is in the oil has not been left behind in the engine, and that dirty oil may indicate a clean engine. This is particularly so with detergent oils, which can hold high percentages of insolubles without precipitation.

8.31.8 Neutralization Number:

8.31.8.1 This is a measure of the alkali required to neutralize one gram of the oil. The higher the neutralization number, larger the acid content. New good quantity oil will contain no objectionable free acid and will usually have an acidity number of 0.1 or less (indicative of weak acids) but deteriorated, used oils may become very acidic.

8.31.8.2 Engine oils are fortified with alkaline additives to counteract acidity; while in use. The alkalinity is measured by neutralizing it with an acid during test and reporting the results in terms of equivalent quantity or KOH. This characteristic is called the ‘Total Base Number’. In course of service the TBN has a tendency to fall.

8.31.9 **Specific gravity:** This is the ratio of the weight of a given volume of oil to the weight of the same volume of water, both at a specified temperature. Specific gravity has no practical significance in lubrication but may be required for costing purposes; if oils are sold by weight, or for identification. In place of specific gravity, the gravity of an oil is also reported on an “API” scale.

8.31.10 **Ash content:** It is the percentage remaining from a weighed quantity of the oil, after combustion and subsequent heating to free it from carbon. Well refined, unused, straight mineral oils never contain more than a trace of ash. Oils containing additives have high ash content. The ash from used oils also contains iron and other metal particles, resulting from wear, together with any dirt that may have found its way into the system.

8.31.11 Evaporation Loss

The evaporation loss is of particular importance in engine lubrication where high temperatures occur and portion of oil can evaporate. High volatility can also lead to an increase in air pollution and an increase in piston deposits. This method is for the determination of evaporation loss of greases and oils as per ASTM D-972.

8.31.12 Foaming tendency

Rotary screw mechanical components have the potential to generate large amounts of foam if the lubricant used is not appropriately additized or synergistically balanced to prevent foam generation. The rotors and separator filter are the main potential. The rotors and sep. filter act as a mix-master blender and homogenizer, all in one. Add in the velocity, temperature, and pressure of the lubricant along with any extraneous contaminants that will chemically cause foam and you have the potential for one huge foam bath. Normally, the foam is seen in the slit glass of the sep. filter. Foam causes loss of lubrication and will eventually result in mechanical failure. Air-ends are expensive, so any lubricant with foam rating higher than “nil” should not be used in a rotary screw application.

8.31.13 Sulfur by x-ray fluorescence spectrometry

This test method provides rapid and precise measurement of total sulfur in petroleum products with minimum sample preparation. The quality of many petroleum products is related to the amount of sulfur present. Knowledge of sulfur concentration is necessary for processing purpose and directly related to the reduction of particulate emission.

8.31.14 Apparent viscosity of engine oils between -5 and -35 °c using cold cranking simulator

An electric motor drives a rotor that is closely fitted inside a stator. The space between rotor and stator is filled with oil. Test temperature is measured near the stator inner wall and maintained by regulated flow of refrigerated coolant through the stator. The speed of the rotor is calibrated as a function of viscosity. Test oil viscosity is determined from this calibration and the measured rotor speed. The CCS apparent viscosity of automotive engine oils co relates with low temperature cranking.

8.31.15 Load -Carrying capacity of Lubricating Oil (Four ball method)

This method is used for specific purposes, differentiates between lubricating oil having low, medium, and high level of extreme pressure properties. The results do not necessarily correlate with results from service.

8.32 Diesel Engine Lubricating oil Additives :

8.32.1 Lubricating oils derived from petroleum consist of a complex variety of hydrocarbons which vary in chemical and physical properties. Basically, lubricating oils differ from one another in respect of–

a. The nature of the crude from which they originate;
b. the method by which they are refined;
c. The types of the additives which they may contain.

8.32.2 The service conditions imposed on the oil are just as important in determining its performance as its inherent properties. The increasingly severe operating conditions resulting from higher and higher demands for power output per cylinder have led to the need for improved lubricating oils. To keep pace with these demands the refining methods have been improved. Solvent extraction methods have made a notable step forward, but there is a limit to what can be accomplished in this direction. Over refining defeat the very objective sought because it removes some of the polar constituents on which the lubricating properties depend and the oxidation inhibitant constituents are also depleted.

8.32.3 Today quality lubricating oils contain 'additives' oils. A large number of these additives have been developed with the object of improving one or the other property of oil and to impart to it certain desired characteristics, which were previously absent. The use of additives results in an improvement lubricant. It decreases the cost of refining and widens the scope of crude oil selection.

8.32.4 Additives in general are no substitutes for the quality of lubricating oil base stocks. Formulations are empirical and rigorous testing is carried out in order to ascertain the effectiveness of an additive in actual service, as well as to establish that it has no adverse effects on the functional properties of oil or the performance of various diesel engine components. Additives when incorporated in a finished product supplement its natural characteristics and improve its performance in existing applications or broaden its suability for other applications. The different classes of additives used in modern engine lubricants are given below:-

8.32.4.1 Anti oxidant: Anti oxidants are generally organic compounds having Sulphur, Nitrogen or Phosphorus such as Amines, Sulphides, etc. They may also contain metals like Barium and Zinc. These compounds prevent the formation of oxidation products like organic acids, sludge and varnish which are harmful to the proper functioning of a lubricant. They may act in two ways. (1) Terminate oil oxidation by breaking the reaction chains, (2) form a passivating film on the metal surface which acts as a catalyst during oxidation.

8.32.4.2 Anti wear: Anti wear agents are organic compounds having sulphur, nitrogen or phosphorus such as organic Sulphides, Phosphites, Thio phosphates or Sulphurised waxes. They prevent excessive wear of the metal surface and avoid corrosive attack on other metal surfaces in contact by forming a protective film on the metal surfaces. The formation of a chemical film on the metal also decreases its catalytic action during oil oxidation. Hence, some Anti wear agents are also anti oxidants.

8.32.4.3 Detergents: Detergents are normally organo-metallic compounds such as high molecular weight soaps of Barium, Calcium or Magnesium. They keep the metal surfaces clean by preventing any type of deposit formation. This is achieved by keeping the oxidation products of the oil in suspended state and their precipitation to form deposits is prevented.

8.32.4.4 Dispersant: Dispersants are also organo-metallic compounds such as Napthenates, Sulphonates, etc. The ashless type may contain any nitrogen in the form of Amides. Imides in combination with polymers. These compounds keep the potential sludge forming insolubles in suspension by preventing their agglomeration, and break the larger particles down into a finely divided 'colloidal' state.

8.32.4.5 Film Strength: Film strength agents are organic compounds of chlorine, phosphorus or sulphur such as chlorinated waxes, phosphates, lead soaps such as lead napthenate. They form a film on the metal surface which has a lower shear strength than the base metal thereby reducing friction. They prevent seizure of the contacting surfaces when the oil film is ruptured thus preventing galling or scoring of the surfaces.

8.32.4.6 Anti rust: Anti rust compounds may be sulphonates, Amines fatty oils, oxidize waxes, etc. They prevent rusting of metal parts by being preferentially absorbed on the metal surface and this film repels water and neutralizes corrosive acids.

8.32.4.7 Adhesive Agent: Adhesive agents are certain high molecular weight polymers which increase the adhesiveness of the lubricant to the metal surface. They provide a tackiness or stringiness property to the lubricant.

8.32.4.8 Special Compounds: This is a general class of materials and may consist of natural or synthetic fatty acids, either straight or sulphurised. They increase the slipperiness of the lubricant and provide a better resistance to water wash-off from the metal surfaces, forming a protective film.

8.32.4.9 V I Improver: Viscosity Index improvers are polymerized olefins or Iso-olefines mainly butylene polymers, or methacrylic acid polymers. They lower the rate of change of viscosity with temperature. These compounds are less affected by the temperature change than the oil and consequently raise the viscosity of the oil at 98.9^{o}C more in proportion than at 37.8^{o}C owing to the change in solubilities.

8.32.4.10 Pour point depressant: Pour point depressants are high molecular weight compounds such as wax alkylated napthlenes or phenols and their polymers or methacrylate polymers. They lower the pour point of oils by coating the wax crystals in the oil and preventing their growth or agglomeration.

8.32.4.11 Mild extreme pressure Agents: Mild EP agents are organic compounds like phosphates, Napthenates of Lead, alkyl thiophosphates, chlorinated waxes, etc. They form very tenacious films on metal surfaces which are far more active than in the case of anti wear agents and thus enable the surfaces to carry heavier loads. They also prevent contacting of surfaces after the oil film is returned.

8.32.4.12 Anti foam: Anti foam agents are normally silicone polymers which prevent the formation of a stable foam. These reduce the inter-facial tension so that small air bubbles collapse to form larger ones which separate out at a faster rate.

8.32.4.13 Emulsifiers: Emulsifiers are certain soaps of fatty acids, Sulphonic acids or Napthenic acids. They emulsify the oil with water and provide stable oil in water emulsion. They are essentially surface active chemical agents which reduce the interfacial tension between oil and water so that oil can exist in a finely dispersed state.

8.32.5 Contamination of lubricating oil in service and loss of additives:

8.32.5.1 Diesel engine lubricating oil continuously loses additives as well as becomes contaminated through use and its lubricating qualities become impaired. The degree of degradation of diesel engine lubricating oil varies with the length of service. This deterioration is also dependent upon -

a. The type of oil;
b. The nature and condition of the engine;
c. The operating variables and service conditions.

8.32.5.2 Loss of additives through lubricating oil filters is unavoidable. In diesel locos, some sort of filtering arrangement has to be incorporated in the lubricating oil system which limits the level of solid contamination. But when using detergent dispersant oils containing additives, filters that can remove exceedingly small particles cannot be used as these will remove a certain percentage of the additives also. The correct quality of filters as recommended for the diesel engine must, therefore, be used. This will ensure adequate filtration of the contaminating soot and dirt without undue depletion of additives.

8.32.5.3 Also important are contaminating materials formed as a result of deterioration of lubricating oil due to oxidation, polymerization and cracking of the constantly removed thin films of oil on the upper cylinder and piston surfaces during exposure to high cylinder temperatures. Considerable deterioration occurs by piston cooling oil contacting the high temperature surfaces of the piston crowns especially if the rate of oil flow through the piston cooling cavities is inadequate. High temperatures in engine crankcase or sump also promote oxidation of the fine mist of oil present in the crankcase.

8.32.5.4 Some contaminants can form carbonaceous deposits on piston surfaces and in piston ring grooves: some can concentrate on the cylinder walls and piston skirts in lacquer or vanish-like form; some can be deposited in crankcases or sumps or oil passages as sludges. The kinds of contaminants that can be present, their sources and their possible effects are tabulated below:

Contaminants	Sources	Possible results
Soluble and insoluble products of incomplete combustion, oxidation and deterioration.	Fuel oil and lubricating oil	Colour of lubricating oil darkens, viscosity of lubricating oil increases, lacquer deposits and sludge formed, resistance to oxidation lowered.
Sooty carbonaceous matter	Fuel oil	Lubricating oil becomes black. Viscosity of lubricating oil increases.

		Deposits.
Dust and dirt	Fuel oil & intake air	Abrasive wear of sliding surfaces and bearings deposits.
Metal particles	Engine wear rust and scale.	Abrasive wear. Speed up oxidation or lubricating oil. Deposits.
Fuel oil	Leaks in fuel pumps or piping, injection dribble, blow by and partial combustion	Dilutes crankcase oil reduces viscosity, lowers stability of lubricating oil, impairs lubricity.
Water	Condensation of blow by gases. Leaky jackets and leaky cooling heat exchangers.	Emulsions, sludge, corrosion due to combining with products of combustion. Lower resistance of lubricating oil to oxidation, Rusting.

8.33 Transmission Oils:

8.33.1 In hydraulic transmissions, oil is used as a power transmission medium (in the torque convertors and couplings). The same oil does all lubrication functions for various bearings and gears, etc. The transmission oil is, therefore, required to have properties both of a satisfactory hydraulic fluid required of hydro-dynamic systems and as a lubricant for bearings and gears.

8.33.2 A low viscosity type of oil is generally recommended for use in hydraulic transmissions, commensurate with requirements of lubrication, so that the transmission efficiency is the maximum. The oil must be a refined mineral oil of high quality with a viscosity index generally higher than 90. It must be adequately fortified with extreme pressure type of additives to ensure the required oil film even under heavy pressures. Addition of fatty oils or fatty acids is not permissible. The oil must contain anti corrosion additives and inhibitors to check oxidation and ageing. The oils should be totally noncorrosive to transmission components made of steel, cast iron, malleable cast iron, brass, copper aluminum, etc. The additives should remain uniformly dissolved or dispersed upto temperatures of the order of 150^{o}C or while they are in storage. Another basic requirement of transmission oils is that they should not foam at operating temperatures of upto about 120^{o}C – 130^{o}C and the air separation properties should be extensively good.

8.33.3 Apart from the general requirements, transmission oil must pass a severe test of its suitability as a gear lubricant. The FZG gear test is applied for this purpose, minimum specified is the 11th load range for scuffing load in this test, with a limit of maximum specific wear upto 10th load stage of 0.20 without any sign of corrosion.

8.33.4 Oils are evaluated for their suitability for use as transmission oils by strict laboratory tests followed by field trials. Brands considered suitable for different applications are approved by RDSO and the current approved brands are advised to all Railways from time to time.

8.33.5 Transmission oils are changed usually at scheduled intervals of one year. Some manufacturers advise smaller change intervals. Apart from the fixed time schedules, the condition of transmission oils should be left under check by laboratory tests.

8.34 Greases

8.34.1 Greases are semi-solids or solids at room temperature but provide fluid lubrication in the bearing. They are of two kinds:-

8.34.1.1 Some are oils, organic or mineral, that are more or less solid at room temperature. The term "grease' may also be applied to some lubricants that are really liquids, but of very high viscosity at normal temperatures.

8.34.1.2 The second types, soap greases, are the lubricating greases in the normally understood meaning of the word. They are defined by the American Society for Testing Materials as "a semi-solid combination of petroleum products and a soap or mixture of soaps, suitable for certain types of lubrication". They may vary from an almost liquid state to the consistency of hard soap, but they are all fluid lubricants, acting either by "bleeding" oil into the bearing or by softening under the heat and working of bearing and acting, in effect as a thick oil. The composition of most greases is 65 to 90 percent mineral oil, the rest soap. Extreme pressure or other additives, as used in liquid oils, may be incorporated, and solid "fillers" such as graphite are added in special cases. Nearly all greases soften very considerably when worked, but re-harden slowly on standing. This property is a very useful one in practice. In a properly grease-lubricated bearing, grease should be injected until it oozes out at the ends. This grease hardens and form a seal against the entry of dirt and moisture.

8.34.2 Greases are normally classified according to the type of soap used. The main types are as follows:-

8.34.2.1 **Lime-Base Grease (Cup Grease)**: Lime or calcium soap has been one of the most popular for grease –making purposes. It is insoluble in water, so that it may be used in very wet condition and even submerged. The texture is usually smooth and buttery, while the colour varies according to the type of oil used. A certain percentage of water is normally incorporated in the grease to obtain a smooth mixture of soap and oil, and if this water is driven off by heat, the oil and soap will separate, for this reason, such greases cannot be used continuously, at temperatures above 80^{o}C. These greases are used for general lubrication purposes such as plain shaft bearings and guideways.

8.34.2.2 **Sodium Base Grease:** Normal sodium base greases have a fibrous texture, but can be made smooth-textured, if desired. The fibrous texture is a natural characteristic of the grease and is not due to fibres of any foreign material, such as cotton. These greases can be used upto and beyond their melting point. The sodium soap used is soluble in water and sodium grease should, therefore, not be used where it may be washed away. The emulsified grease is still a good lubricant, however. Due to its high adhesive properties this type of grease is extensively used for bearings seldom attended to, such as automobile chassis bearings.

8.34.2.3 Mixed – Base Grease: This term is usually applied to a grease with a mixed sodium lime base. This is less fibrous than the straight sodium greases and is particularly suitable for the lubrication of ball and roller bearings. It also has an excellent temperature range, giving good lubrication from -40^{o}c to 120^{o}C or higher. The proportion of lime soap is normally very low, so that the characteristics are substantially those of a soda grease.

8.34.2.4 Brick Grease: This grease is a sodium base grease made by a different process from that used for the normal sodium greases and resembles hard soap in general appearance. It is used for heavy duty applications where oil lubrication is difficult or impossible, such as the driving journals of steam locos. Normally a bar or brick of grease is placed in contact with the journal and kept under pressure so that a steady supply of lubricant is maintained.

8.34.2.5 Lithium Base Grease: Lithium base greases, made with suitable natural petroleum and /or synthetic oils, may be used over a range of temperature from around – 70^{o}C to 150^{o}C. They are smooth and buttery in texture and do not harden or soften unduly over their temperature range. Lithium base grease is fairly water resistant. Its service life is usually long comparable with that of a good soda grease. It is suitable for antifriction bearing lubrication.

8.34.2.6 Aluminum Base Grease: This is like petroleum jelly in appearance. It is very adhesive to metals and is employed for automobile chassis lubrication and on cams, chains and oscillating surfaces to which other greases will not cling. It does not bleed readily and is not recommended for anti-friction bearing use.

8.34.2.7 Barium Base Grease: Resembles in appearance and characteristics a sodium or sodium calcium mixed base grease, except that the grease has no dropping point in the normal sense, remaining semi-solid until it fails due to high-temperature break-down or oxidation of the oil incorporated. It is very adhesive to metals, has good water resistance and can be used, with natural petroleum oil constituents at temperatures upto about 175^{o}C. It is suitable for anti-friction bearing use.

8.35 Characteristics of Lubricating Greases

8.35.1 Cone Penetration of lubricating greases

Grease consistency correlates to the firmness of the grease. Depending on the applications they're designed for, greases can range from semi fluid consistencies to almost solid. Care must be taken to select the correct consistency for the application. If the grease is too hard, it may not adequately flow to the areas in need of lubrication. If it is too soft, it may leak away from the desired area. Since consistency directly correlates to pump ability, equipment greased through a dispensing system may require grease representing a compromise between what is required for lubrication and what can be adequately pumped.

8.35.2 Drop point

Drop point is the temperature at which grease turns from semi-solid to liquid state. It is significant only in that an operating temperature above the dropping point may cause permanent thickener separation or alteration of grease properties. It is not necessarily a measure of the upper temperature limit of the grease

8.35.3 Oxidation stability

This is the ability of greases to resist a chemical reaction with oxygen. The reaction of grease with oxygen produces insoluble gum, sludge & deposits that cause sluggish operation, increased wear, and reduction of clearances. Prolong high temperature exposure accelerates oxidation of grease. Oxidation stability is expressed in terms of pressure drop over a given time period

8.35.4 Shear / Mechanical stability

Grease consistency may change as it is mechanically worked or sheared between wearing surfaces. Grease's ability to maintain its consistency when worked is its shear stability or mechanical stability. Unstable greases whose characteristics changes drastically in service can result in poor lubrication or other operational problems.

8.35.5 Load -Carrying capacity of Lubricating grease (Four ball method)

This method is used for specification purposes, differentiates between lubricating greases having low, medium, and high level of extreme pressure properties. The results do not necessarily correlate with results from service.

8.35.6 Rust preventive characteristics of lubricating greases (Emcor method)

This test method is used to assess the ability of grease to prevent corrosion in rolling bearings operated in the presence of distill water, sodium chloride, or synthetic sea water. It is used for development and specification purposes.

8.35.7 Oil separation from lubricating grease during storage

When lubricating grease separates oil, the remaining composition increases in consistency. This can affect the ability of the product to function as designed. This test method is not intended to predict oil separation tendencies of the grease under dynamic conditions.

8.35.8 Detection of Copper Corrosion from lubricating grease

This method measures the tendency of lubricating grease to corrode copper under specific static conditions. It may be of some value in predicting possible chemical attack on lubricated parts, such as bearings that contain copper or copper alloys. However, no correlations with actual field service, most of which are under dynamic conditions.

8.36 Storage, Handling and Dispensing of Lubricants in Running Sheds :

8.36.1 **General:** Even slight dirt and contamination will impair the lubricating quality of an oil or grease which will result in excessive wear, loss of power and early breakdown. The benefits to be derived by use of expensive oil or grease brands can be easily off-set by indifferent and incorrect storage or handling of lubricants.

Utmost care has to be exercised in handling and dispensing of lubricants which are the very life of diesel engines and loco components.

8.36.2 Storage and distribution of lube oil through Bulk Installations: Now-a-days most of the diesel loco sheds has got bulk lube Oil Installations, which remain under custody of Stores. Following procedure, broadly, may be followed for accountal of lube oil in such installations.

8.36.2.1 Main Tanks (horizontal/vertical) of suitably capacity, to hold at least two months requirement, shall be installed in the diesel loco shed.

8.36.2.2 These tanks shall be connected by a common receipt pipe line, with isolating valve for each tank.

8.36.2.3 These tanks shall have in-built level gauges to check lube oil balance or provision of measurement by dip rod.

8.36.2.4 These main tanks will be under the custody of stores.

8.36.2.5 After receipt of the Road tanker, quantity in the tanker shall be verified with the help of a calibrated dip rod, after placing the tanker on a level platform, before decanting.

8.36.2.6 The receipt quantity will be recorded in terms of gauge level/dip rod reading of the storage tank before and after decanting of road tanker. Further, any leftover quantity in the road tanker will also be collected and measured.

8.36.2.7 For the purpose of the acknowledging receipt, the quantity recorded in the tanker with the help of calibrated dip rod of the tanker will be treated as final. However, in case of abnormal difference between the reading by calibrated dip rod and in-built level gauge/dip rod of the main storage tanks, the matter will be investigated and accordingly corrective action taken.

8.36.2.8 A suitable capacity ancillary tank (sufficient for holding one week requirement) will be provided in the shed in which lube oil from main storage tank will be transferred, on placing a demand by the consignee. This tank will have provision for measurement of the quantity received with the help of a dip rod or through an in-built level gauge. This tank will remain under the custody of SSE/General of the shed.

8.36.2.9 The delivery side pipe line from the main storage tank shall be provided with a flowmeter for measurement of the issued quantity. A daily issue register shall be maintained recording the quantity issued and balance by the reading of level gauge, converted into quantity. A ledger card shall be maintained in the stores for stock balance i.e. (Opening balance, Receipt, Issues and Closing Balance).

8.36.2.10 The reading of flowmeter of main storage tanks will be considered final for the purpose of receipt in the ancillary tank by the SSE/General. However, in case of abnormal difference in the quantities shown by flowmeter reading of the main storage tank and dip rod/level gauge reading of the ancillary tank, the matter will be investigated and accordingly corrective action taken.

8.36.2.11 Issues to the loco will be done from the ancillary tank through a flowmeter. The balance in the ancillary tank shall be recorded by dip rod/level gauge. The quantities issues to locos will be maintained in a register date-wise with signature of the shift in-charge, i.e. (Opening balance, Receipt, Issues and Closing Balance).

8.36.3 Storage of oils received in Drums:

8.36.3.1 The drums should be stored preferably under proper cover.

8.36.3.2 If storage in the open is unavoidable, the following precautions should be taken:

a. Drums should be stored on their sides or bilges
b. Wooden dunnage should be used to keep them clear of the ground and to prevent rusting of the underside.
c. Drums should never be stacked directly on a surface containing clinker as this is particularly corrosive to metal.
d. The drums at each end of the stack must be securely wedged to prevent movement.
e. Drums can be stored either in a single layer or in tiers with wooden battens between the layers, but three layers is the maximum.
f. Drums of different brands of oils should be stored at separate places marked for each brand.

8.36.4 Storage of Smaller Packages :

8.36.4.1 Smaller packages of oils and greases are less resistant than large drums to the effect of weathering. These should never be left in the open and should be stored in a well covered place.

8.36.4.2 Package of different brands of lubricants should be stored separately at places marked for each brand.

8.36.5 Dimensioning of Lubricating Oils:

8.36.5.1 Out of the various oils used in a diesel loco, engine lubricating oil has the maximum and a sizeable consumption. This oil is issued for the following two purposes:

a. For renewing engine lubricating oil, which requires comparatively large quantities at a time.

b. For topping up, requiring a few litres each time.

8.36.5.2 **Renewing the Engine lubricating oil for large consumptions** : In sheds where locos in excess of 20% of one type are homed and where the consumption of a particular brand of oil is large enough to justify filling arrangements, to save time and labour the following method should be adopted :-

a. Engine lubricating oil should be stored in a rectangular tank (capacity 2500-5000 litres) installed at a suitable covered place. The tank should be painted from outside with the distinguishing colour and name of the oil brand written on it.

b. Tank should be made of steel and not galvanized iron as oil may react with zinc.

c. The bottom of the tank should be slightly sloping to allow easy cleaning.

d. The tank should have the following fittings:
   i. A gauge glass, calibrated in litres;
   ii. A vent at the top to take care of breathing;
   iii. A drain plug at the lowest level at the bottom;
   iv. A dust proof man-hole at the top; and
   v. An outlet pipe about one inch above the bottom.

e. The outlet pipe of the tank should be connected through an electric or hand pump to pipe lines having suitable stop cock arrangements and leading to various service platforms

f. The pipe lines at the platforms may be connected at two or three places (depending upon the number of locos to be accommodated on each platform) with oil resisting hoses having a nozzle and a shut off cock at the end. To protect the nozzles when not in use, from contamination with dust, they should be kept in closed cabinets erected on the platforms

g. For measuring the quantity of oil delivered to the engines, a meter should be fitted in the pipe line at the delivery point on each platform.

h. For transferring oil from the original barrels to the tank, a flexible pipe may be attached to the pump through a stop cock. By putting the end of this pipe in the barrels and shutting and opening proper stop cocks, the oil can be pumped into the tank.

8.36.5.3 **Renewing the Engine Lubricating Oil** (Alternative method for smaller consumptions): In sheds which have less than 20 locos or different makes of diesel engines using different brands of oils, so that the consumption of each brand of oil is small, the following can be adopted:-

a. One drum of each brand of engine oil should be kept on a light weight trolley (capable of being pulled by one man). To the drum a hand pump with an oil resistant hose and nozzle with a shut off cock should be attached.
b. Separate trollies should be used for each brand of engine oil.
c. The trollies should be painted with distinguishing colour and the brand of oil should be written over the trollies.
d. The drum mounted trollies should be kept at a neat and covered place when not in use.

   Note: Even in sheds which will have oil dispensing from a central tank, sometimes the renewing of engine oil may have to be done outside the shed, due to congestion in the shed or some other reason. For such eventualities one drum of engine oil with hand pump and other accessories (mentioned above) should be kept mounted on a trolley

8.36.6 Lubricants for topping up or for small consumptions:

8.36.6.1 For topping up or for small consumptions one drum of each brand of oil should be kept in the lubricants room under the charge of an attendant. The room should have such a flooring that the spilt oil can be easily removed. The room should be dust-proof, to the extent possible.

8.36.6.2 In this oil room, one drum of each brand of oil should be placed on a wooden or steel cradle.

8.36.6.3 The portion of the cradle under each drum should be painted with the distinguishing colour and name of the oil should be written on the wall just behind each drum.

8.36.6.4 The drums should be fitted with drum taps.

8.36.6.5 A metal tray or drip pan should be provided under each drum to avoid spilling of the oil. The oil dropped in the tray should never be used in the engines.

8.36.6.6 For each oil two or three measuring cans of capacity 2.5, 5 and 10 litres and having flap covers should be provided. The cans must also be painted form outside with distinguishing colour and the brand of the oil should be written on them. The cans meant for one oil must never be used for another oil.

8.36.6.7 When not in use, these cans should be hung over hooks provided on the cradle by the side of each drum. Oils should be issued to the fitters in these cans which when returned should be wiped from outside and hung at their proper places.

8.36.6.8 The funnels used for pouring oils in the engines should have flap covers and be fitted with wire mesh screens. They should also be painted from outside with distinguishing colour and name of oils written over them. Separate funnels should be provided for each brand of oil.

8.36.6.9 When not in use, these funnels should be kept on suitable stands by the side of a wall in the oil room. The funnel stands should also be painted with distinguishing colours.

8.36.6.10 If more than one brand of engine oil is used, in a shed, the filling points of the engines or any other suitable place, like that of a portion of cylinder block, opposite each engine room door, should be painted with the distinguishing colour of the brand of oil to be used on the particular diesel engine.

8.36.7 Greases:

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8.36.7.1 One drum or container of each brand of grease should be kept in the oil room. The drums should be kept standing and arranged in a row.

8.36.7.2 Smaller containers of greases should be kept at places marked for each on a rack which should be about 75 cms from the ground, in the oil room. The names of the greases should be written on the wall behind the respective packages.

8.36.7.3 For issuing greases two or three bucket type cans, capacity 2-2.5 kgs having flap covers should be provided for each brand of grease. The cans must be painted from outside with distinguishing colours, and names of the greases written on them. When not in use, these should be hung on hooks provided on the underside of the rack just under each grease package.

8.36.7.4 One large metal spoon preferably of stainless steel should be kept inside each drum or container for taking out grease from it.

8.36.7.5 One spring balance of about 7.5 - 10 kgs lbs. capacity should be provided in the oil room for weighing greases before issue. The spring balance should be kept on the rack at a proper place.

8.36.7.6 For dispensing greases, separate grease guns should be provided for each brand. A portion of the gun should be painted with the distinguishing colour and the brand of the grease written over it. The capacity and the type of guns required i.e. hand-operated, pneumatic or electric will depend upon the number of locos to be greased. The guns when not in use should be kept in the oil room at their proper places. The hand guns should be kept on the rack.

8.36.8 General Instructions :

8.36.8.1 All oil and grease drums and other containers must never be left with their lids off.

8.36.8.2 All oil dispensing equipments and oil room with its contents should be kept well cleaned and scrubbed. The grease guns, oil and grease cans and funnels, etc. should be given a wash once in a month with kerosene, and the kerosene must be fully removed before the cans, etc. are put to use again.

8.36.8.3 The oil storage tank should also be cleaned once in six months by flushing with kerosene and removing the same completely before re-filling.

8.36.8.4 Cotton wastes or woolen rags should never be used by those handling lubricants, as these tend to leave behind fibrous practices which eventually find their way into the diesel engines and impair circulation of oil.

8.36.8.5 Oil soaked rags should never be allowed to accumulate in the oil room, as they are liable to give rise to spontaneous combustion.

8.36.8.6 Fire extinguishing equipment should be provided inside as well as outside the oil room, in consultation with the fire fighting authorities.

8.36.8.7 Lubrication charts should be hung on the walls in the shed giving the type of lubricants and the parts of the locos in which they are used.

8.36.8.8 Each storage drum, tank, etc and the dispensing equipment should be painted according to the STANDARD colour scheme to avoid mixing of the lubricants.

8.36.8.9 A system of rotation should be used as a safeguard against the accumulation of old stock.

8.36.9 Storage of Used Engine Lubricating Oil :

8.36.9.1 Used engine lubricating oil removed from the diesel engine crankcases has many uses and as such it is necessary to store the used oil in satisfactory manner to avoid further contamination or deterioration during storage. Contamination during storage will affect the efficiency of the re-refining process, or make the oil unfit for such uses as axle lubrication, etc. Care should be taken for storage of used oil as given below:-

a. If more than one brand of lubricating oils are used in the shed, the drained oils should be kept separately. This is because the drained oils may be used once again after re-refining.
b. If used oil is stored in the original barrels, the bungs of the barrels should be tightened well to prevent ingress of rain water. The drums should be stored on their sides in the same way as for new oils.
c. Sometimes oil has to be drained out due to water contamination or excess fuel dilution. The drums having such used oil should be segregated and on them should be written “water contaminated” or “fuel diluted”. Such oil should never be issued for sensitive applications. This process of segregation will also increase the efficiency of the re-refining process.

8.37 Testing of used Engine Lubricating oils :

8.37.1 Engine crankcase oils deteriorate in service through a combination of various factors such as oxidation, additive depletion, contamination by blow by products of combustion and leakage in fuel and coolant systems, etc. The extent of deterioration is influenced by the mechanical condition of the engine, the operating conditions and the quality of the oil charge. One of the means of monitoring engine performance is through physio-chemical analysis of samples of the oil at regular interval in service.

8.37.2 Some of the test methods employed and their significance are given below:-

8.37.2.1 **Specific gravity:** Specific gravity lower than the original value indicates fuel dilution or addition of lighter oil as make up oil. Specific gravity higher than the original value indicates oxidation, increase of insoluble matter or addition of heavier oil as make up.

8.37.2.2 **Viscosity:** Viscosity of the oil is affected by both physical factor (i.e. contamination) and chemical factors (oxidation). Contamination by un-burnt fuel lower the viscosity while particular contaminants tend to increase it.

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Certain polymeric additives, e.g. some viscosity index improvers show a reduction of viscosity in service due to mechanical shearing of the polymer molecules. Oxidation of oil results in increase of viscosity but this is usually associated with increase in insoluble content and acidity of the oil

8.37.2.3 Flash Point: A drop in flash point of the oil in use indicates its contamination with the fuel either through scraping action of the rings of the un-burnt fuel condensed on the walls or through blow by. It is very difficult, from the measurements of flash point, to determine the extent of fuel dilution. However, certain broad limits can be set to safeguard against the ill effects of excessive dilution, on the basis of experience.

8.37.2.4 Sulphated Ash: No limit can be set on the total ash content. However, its qualitative and quantitative examination is very useful in predicting the mechanical condition of the engine.

8.37.2.5 Water: Water may enter the crankcase through a water leakage from the cooling system or due to the condensation as a result of operating the engine under unduly low temperature conditions. Water tends to increase the viscosity of the oil and may have an adverse effect on oxidation, may accelerate sludge formation and increase foaming tendency. It also has an adverse effect on the additives in the oil and may cause bearing failures. Presence of water can be determined by crackling test (qualitatively) and by distillation test (quantitatively)

8.37.2.6 Acidity (TAN): Oxidation and contamination with acidic combustion products contribute to the increase in the oil's acidity which is determined as "Total Acid Number (TAN). The part of the acidity that is derived from the strong acids (inorganic acids) is determined by titration against Pott. Hydroxide (Alcoholic) solution to an end point corresponding to pH4 , which is indicative of negligible presence of strong acids. Strong acids are harmful to the bearings and cause troublesome engine deposits.

8.37.2.7 TBN: TBN of the lube oil is a measure of the potential of the oil to neutralize strong acids such as mineral acids derived from sulphur, chlorine etc. The concentration of alkalinity is also used as a criterion of the effectiveness of the additives. Corrosive wear and rusting in engines caused particularly under low temperature operating conditions could be effectively combated by increased alkalinity which is generally introduced into the oil through the use of over-based Calcium / Barium sulphonate type of additives. High TBN oils are also found to minimize varnish and sludge deposits in the engine. The TBN should also be maintained at a certain minimum value. The oil should be changed when the TBN is equal to or less than the "fuel Sulphur content (% weight) + 0.1".

8.37.2.8 Oil Insolubles: The suspended and partly dissolved contaminating matter in the oil contributed by air borne dust, fuel carbon, highly carbonized materials from the degradation of oil fuel and additives, engine wear debris, oil soluble resinous matter, etc. is evaluated by the Pentane/Hexane and Benzene insoluble test. This information facilitates taking preventive steps before the insoluble reach a value high enough to interference with the proper functioning of the lubricant. Generally the following insoluble content, is not considered harmful

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for the diesel engines using higher detergency oils such as MIL-L-2104 B level oils:

a. Hexane/Pentane insoluble's - upto 3.5%
b. Toluene insoluble's - upto 2.5%
c. Resins - 0.5%

However, these limits have to be specified separately for each oil and the engine in which it is used.

8.37.2.9 Blotter Spot Test :

a. There is no dispersancy test in general use in laboratories and in this one instance "Blotter spot test" can provide information not obtainable from a routine laboratory examination. The test consists of depositing a drop of oil from the engine crankcase on a sheet of a specified type of filter paper. After a certain number of hours (depending upon the temperature of the oil and the entrained carbon particles) will have diffused into the pores of the filter paper. An examination of the oil spot shows:

   i. A central zone with light or dark centre called the drop core
   ii. A dark HALO surrounding the central zone (drop core)
   iii. A zone of diffusion outside the halo
   iv. A translucent area soaked with oil outside the diffusion zone.

b. The information is particularly useful when the blotter spot tests are carried out on a regular interval.
   i. Contamination with the insolubles (primarily combustion spot) is judged by the lightness or darkness of the Central Zone.
   ii. The lightness or darkness of the soot spot (Central Zone) is markedly affected by the dispersancy of the oil. An oil of poor dispersancy will deposit its soot burden on a much smaller area than will a highly dispersant oil.
   iii. The dispersancy is judged by the extent to which the oil carries its contaminant through the paper (the zone of diffusion). The decrease of disappearance of this zone indicates flocculation of the suspension and a fall in the detergency level of the oil (effectiveness of additives).
   iv. The presence of fuel oil in the lube oil is indicated by divergent and irregular drop core. The out zone is also comparatively dark.
   v. Water has the effect of imparting a clearly defined boundary to the Central Zone. The size of the drop halo is smaller than normal. The centre is heavy block.

8.37.2.10 pH Value: pH value of the oil gives a rough indication of the presence of Alkalinity/Acidity in the oil. A pH value of less than 4 indicates the presence of or formation of inorganic (strong) acids in the oil.

8.37.2.11 If the test results are to be used towards evolving better usage standards of lubricating oils, etc., it is imperative that proper records of the various checks carried out are maintained in a systematic fashion. This should be the responsibility of the Laboratory Superintendent who would keep the SSE/Diesel informed in regard to the lubricating oil changes, etc. It should also be ensured that a forecast of the various schedules to be carried out along with the dates and time thereof, is supplied to the Laboratory Superintendent, so that the samples are drawn at the proper time.

8.37.2.12 Spectrographic Analysis of Oil:

a. Spectrographic analysis of used crankcase oil is a valuable tool in providing warning about abnormal wear which may lead to major breakdown such as piston or bearing seizure. It does not, however, give prior indication of a sudden failure of any component due to fatigue. It may be said that spectrographic analysis of the used lube oil is analogous to the blood test of human body with a view to detect the abnormality of the system. The spectrographic analysis of the used crankcase oil helps in:
   i. Predicting the required maintenance.
   ii. Scheduling the overhauls, thus avoiding unexpected down time and thereby increasing the loco availability.
   iii. Preventing engine failure resulting from the incipient wear of engine components.

b. During calibration of spectrograph it should be ensured that temperature, humidity and other conditions in spectrograph labs are maintained as per the manufacturer's recommendations. The equipment shall be calibrated with the primary standard supplied by the manufacturer. Spectrographic analysis of used oil samples shall be done after calibrating the spectrograph against the fresh oil samples and adjusting the fresh oil values to zero. The correlation between wear elements and the engine condition is given in the table below:

Indication of elements & engine wear by spectrograph

S. No.	Element	Indication
1	Cu	Bushing wear
2	Pb	Main / Connecting rod, Turbocharger bearing wear
3	Sn	Main / Connecting rod, Turbocharger bearing wear
4	Fe	Bushing shaft wear, ring wear
5	Cr	Cylinder liner wear
6	Na	Water leakage
7	B	Water leakage
8	Al	Piston wear, Inefficient filtration
9	Si	Inefficient air filtration

8.37.2.13 Ferrography: Ferrography is a technique for analysing the particles present in fluids that indicate mechanical wear. It uses microscopic examination and was developed in the 1970s for predictive maintenance. It overcomes the large particle detection deficiencies of spectrographic analysis of oil. It has proved much more useful, as compared to spectrographic analysis of oil, in accurately predicting impending failures of components.

8.37.3 Procedure for Drawing Samples of Engine Lubricating Oils:

8.37.3.1 The value of any analysis carried out depends entirely on whether the sample provided for test is truly representative of the bulk oil in the crankcase. Too much emphasis, therefore, cannot be placed on the importance of correct

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sampling and it should only be undertaken by persons who are specially trained in it and with the proper equipment.

8.37.3.2 The proper equipment consists of a hand syringe with nozzle extended by a tube which when fully inserted from the dipstick hole or any other suitable opening from where the sample of oil is to be taken, reaches midway between the bottom of the sump of the crankcase and the oil level. The container into which the sample is to be taken should be capable of being cleaned quickly and properly. For cleaning the container neither water nor paraffin should be employed. The presence of water and the effect of paraffin on the flash point could lead to misleading results. The best method of cleaning the container is to rinse it thoroughly with new engine oil and allow it to drain.

8.37.3.3 The following points should be rigidly observed while taking sample:-

a. The oil must be hot and in a state of agitation. The sample should preferably be drawn while the engine is running or just after it is shut down.
b. Flush the syringe by filling and discharging it back into the sump twice, before drawing the final sample.
c. Use a clean and dry container for the sample and only fill it 2/3rd, so as to facilitate shaking of the oil prior to testing.
d. If a syringe cannot be used and the sample must be taken from a drain cock, allow at least twice the capacity of the drain pipe to discharge before taking the sample so as to avoid any possibility of stagnant oil being included in the sample.
e. The sampling operation MUST be carried out before the addition of topping-up oil.
f. For ease of identification, each container must be properly marked with loco number, date sample drawn, etc.

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Chapter 9

Safety & Environment

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9. SAFETY & ENVIRONMENT

9.1 Scope: This chapter covers-

9.1.1 Industrial safety as applicable to locos,

9.1.2 Industrial safety as applicable within the shed boundaries,

9.1.3 Environment Management in sheds.

9.2 Safety & Environment Management (SEM) Officer: Each shed will nominate one of the AMEs as Safety & Environment Management Officer. He will be responsible for ensuring compliance of the relevant legal requirements and coordinating with concerned State Government Authorities.

9.3 Industrial Safety: Each shed shall issue a safety manual which will have two parts: first one dealing with safety of locos (SL) and the second one dealing with safety at work place (SW).

9.4 Safety Manual dealing with safety of locos (SL)- will broadly cover:-

9.4.1 List of safety components of undertruck, underframe superstructure, both mechanical and electrical, which are required to be checked for working/intactness/availability, every time the loco goes out from the shed. An indicative list of such items is enclosed at **Annexure-9.1.**

9.4.2 List of safety precautions during maintenance of the locos. An indicative list of such precautions is enclosed at **Annexure-9.2.**

9.5 Safety Manual dealing with safety at work place (SW)- will broadly cover:-

9.5.1 List of specific areas affecting safety at Work Place, alongwith the precautions to be taken to ensure safety. An indicative list of such areas and precautions is enclosed at **Annexure-9.3.**

9.5.2 List of checks to be made for ensuring regular Maintenance of M&P, Infrastructure, Shunting, Working of Outside Persons, etc. which are likely to have bearing on safety. An indicative list of such checks is enclosed at **Annexures-9.3.1 to 9.3.14.**

9.5.3 Provision of Personal Protection (PP) Items with various categories of staff. An indicative list of such PP items is enclosed at **Annexure-9.4.**

9.5.4 Provision of fire fighting facilities in the shed. An indicative list of such facilities is enclosed at **Annexure-9.5.**

9.5.5 Emergency Response Plan which will detail the procedure to be adopted for handling various kind of emergencies/accidents. A sample plan is enclosed at **Annexure-9.6.**

9.5.6 Legal Provisions related to Safety at work place. A list of such provisions is enclosed at **Annexure-9.7.**

9.6 System of checking and record keeping of items- mentioned in **paras 9.4 and 9.5** should be in place. Frequency of check and to be done by whom should also be specified for each item to be checked/ensured. In the summary of various checks to be made in different areas, Register No. in which record of checks made of individual items should also be mentioned.

9.7 General Safety Areas

9.7.1 Crane rails and girders shall be certified for safety as per prescribed periodicity by representative of Engineering Department (BRI). In case engineering department is unable to comply this, it will be got certified through authorized outside agencies.

9.7.2 Lifting tackles and wire rope/slings shall be tested with clear cut defined periodicity. Sufficient Lifting tackles and wire ropes/slings shall be available so that lifting tackles and wire ropes/slings in good condition, duly tested, are only utilized.

9.7.3 Other lifting equipments shall be correctly used, periodically attended and tested, as per regulations in force on the railway.

9.7.4 Testing of lifting equipments and accessories shall be got done through authorized outside agencies.

9.7.5 Welding precautions shall be strongly inculcated in the minds of concerned staff.

9.7.6 The provisions regarding guarding felt drivers, securely fencing off rotating equipments, use of protective equipment & proper ventilation in handling solvents, acids, etc. should be scrupulously observed.

9.7.7 All outsourcing/contract staff working in shed premises shall follow the laid down safety instructions. All such staff should have “Work Permit” issued by the Shed in-charge.

9.7.8 Spillage of fuel, lubricants and sand while filling/topping up in locos should be prevented. Automated dispensing arrangements for this purpose should be used, to the maximum extent possible.

9.7.9 Good quality hand tools with proper grips shall be procured.

9.7.10 Operational safety in spotting, moving locos for servicing and repairs are the special responsibilities of the shed shunting supervisor. This is ensured by clearly demarcating areas and allotting one shunter per nominated area. Long experience has proved out this practice. No movement within the prescribed area is permitted except when the nominated shunter is operating the locos. Loco Pilots must be invariably guided by the nominated shunter of the area, when inside shed boundaries. In fact it is better that actual operation of the loco be entrusted to the nominated shunter.

9.7.11 It will be the duty of each section-in-charge to ensure that protective equipment and safe practices are observed within his section. For this purpose he will be carefully briefed through organized training courses so as to know what are the special precautions that he has to take.

9.7.12 The supervisor and some of his men should be trained in firefighting & first aid. Periodic refresher courses should be used to keep them in readiness.

9.7.13 Sufficient nos. of safety precautions/posters shall be displayed prominently in shed. Some sample safety precautions in different areas of working in shed are at **Annexures-9.3.1 to 9.3.14.** These are only illustrative and not exhaustive ones.

9.7.14 Unsafe working conditions should be completely eliminated. Tools, machinery and plants which help in reducing staff fatigue can be used to improve safety. These can be pneumatic, hydraulic and electrical tools for torquing, slackening, etc.

9.7.15 Material handling equipment like forklifts, battery operated platform trucks, hydraulic trolleys etc. should be maintained by following laid down maintenance schedules.

9.7.16 Points and crossings in shed area should be attended/renewed as per laid down periodicity. Electrically operated points in place of manually operated points should be provided.

9.7.17 Staff involved in safety related activities like: Welding, EOT crane operators, M&P maintainers, etc., should have competency certificate, issued by Authorized Agency.

9.7.18 **Indian Electricity Rules 1956:** Compliance to Indian Electricity Rules 1956 need to be ensured. Some of the vital requirements are:-

9.7.18.1 Certification of electrical installations in shed every five years.

9.7.18.2 Staff working on electrical installation to have Competency certificate

9.7.18.3 Measurement of IR of HV and LV circuits of electric installations.

9.7.18.4 Proper earthing of all electrical devices.

9.7.18.5 Checking of earthing devices of shed once in two years.

9.7.19 A safety review committee shall be formed consisting of: Officers, Supervisors, trade union representatives and interested staff. This review committee shall conduct a thorough inspection of shed floor once in a month and take corrective & preventive action for deficiencies noticed.

9.7.20 A multi-disciplinary team of JS/SS of Civil, Mechanical and Electrical departments should carry out checks and identify the actions to be taken for improving safety. The periodicity of such checks should be once in a year.

9.8 **Prevention of Fire:** With fire preventing units disbanded from most of the sheds, proper planning needs to be done for prevention of fire.

9.8.1 The SSE/General of Diesel Shed will be responsible for the provision, maintenance and operation of the fire prevention and firefighting equipment and organization in the Diesel sheds.

9.8.2 Proper network of approach roads, static tanks and hydrants at suitable locations shall be available. If not included in the original plan, these measures should be designed and completed as early as possible.

9.8.3 Sufficient water supply arrangements in Static Tanks & Hydrants shall be ensured.

9.8.4 Hoses for use in fire hydrants shall be provided near the hydrants. These hoses shall be housed in a box with glass front.

9.8.5 Fire extinguishers shall be conspicuously available at strategic points. Periodic maintenance, testing and refilling of Fire Extinguishers shall be ensured. The date of last inspection done and next due date shall be painted on inspected/ maintained fire extinguishers.

9.8.6 Adequate number of Fire Alarm boxes shall be provided at various locations of the shed.

9.8.7 A layout plan of the shed indicating availability of fire fighting facilities: fire extinguishers, sand buckets, Hydrants, Static tanks, fire alarm boxes, etc., shall be displayed at three prominent locations in the shed.

9.8.8 Proper record keeping of operational history, inspection and maintenance of fire extinguishers, working of water supply and pumping out arrangement in Static Tanks and of Hydrants provided in different places of shed shall be maintained.

9.8.9 Apart from the regular fire fighting staff of SSE/General, supervisors and a nucleus staff in every section should be trained to handle ‘ABC’ class fires. Regular refresher courses for such staff should also be arranged.

9.8.10 The SSE/General shall make periodic inspection of the premises to check correct working practices, particularly stocking of combustible materials and accordingly take corrective action, if required.

9.8.11 Fire extinguishers suitable for ‘BC’ Class equipment have to be provided on locos. Timely and correct maintenance of these fire extinguishers should be ensured by SSE/General.

9.8.12 The large stocks of combustibles such as HSD, oils, lubricants, solvents, etc., in a typical maintenance depot are specific responsibilities of the SSE/General. He should be fully associated in the construction stage and follow up through regular works progress to upgrade the stocking and handling facilities, as and when required.

9.8.13 Shed floors should be kept clean – free of oil/muck. Habit of spillage free handling of oil/grease on floor should be inculcated in the staff. This will not only improve work environment, but also curtail the chances of fire accidents.

9.8.14 All electrical fittings/Circuit breakers, etc., shall be checked as per schedule for avoiding any short circuits. The "electrical earthing" of shed should be checked as per schedule. No hanging or loose wires shall be allowed in the shed.

9.9 Safety Management System: Diesel sheds shall have integrated safety management system in line with provisions of OHSAS so that an assured safety management system is in place in the shed.

9.9.1 Identification and Control of Hazard: Diesel Sheds shall establish and maintain a system for ongoing identification of hazards, the assessment of risk and implementation of necessary control measures of various activities in Diesel Sheds to facilitate setting up of occupational health and safety targets.

9.9.1.1 While identifying the hazards not only the routine and non-routine activities shall be taken into consideration, but also identification of the hazardous activities of all personnel having access to the workplace shall be taken into account.

9.9.1.2 A cross functional team shall be used for identification of hazards. The team shall consider process flow diagram, select activity and use work activity information, its effect on safety and health of employees, requirements of relevant acts and reactive monitoring data to identify hazards.

9.9.1.3 The hazards are reviewed and the risk of each of these hazards is determined by estimating the likelihood and potential severity of harm. While estimating the likelihood of harm, the existing adequacy of control measures already implemented is considered.

9.9.1.4 Risks are identified and classified according to their estimated likelihood and potential severity of harm, as mentioned below:

a) Severity of risk will be assessed as follows:

Severity	Remarks
Slightly harmful	Injury of very minor nature where there is no incapacitation from work place.
Harmful	The cases of injury in which loss of man days takes place and/or permanent disability
Extremely harmful	The cases of fatal injury

b) Probability of occurrence is assessed as follows:

Probability	Remarks
Highly unlikely	There is no occurrence in the past and no such possibility in the future as well.
Unlikely	There are very few cases reported in the past
Likely	There are cases which have occurred in the past & there is likelihood of occurrence in the future also

c) The various risk levels are shown in the following table. These risk levels in form the basis for deciding whether improved controls are required and timetable for action. The outcome of risk assessment is treated as inventory of actions, in priority order, to devise, maintain or improve controls.

Risk Level	**Remarks**
Trivial	No action is required and documentary records need to be kept for data analysis.
Acceptable	No additional controls are required. Monitoring is required to ensure that the controls are maintained.
Moderate	Efforts may be made to reduce the risk, but the cost of prevention should be measured and limited. Risk reduction measures should be implemented within a definite time period.
Substantial	Work should not be started until the risk has been reduced. Considerable resources may have to be allocated to reduce risk. Where the risk involves work in progress, urgent action should be taken.
Unacceptable Risk	Work should not be started or continued until the risk has been reduced. The work has to remain prohibited until the risk is reduced. There is no consideration for limitation of resources.

9.9.1.5 Operational Control Procedures shall be implemented to control the significant risks. Management programme are drawn up to introduce time bound action plans to reduce risks and also to monitor the action plans.

9.9.1.6 Risk assessment provides input to facility requirements and identification of training needs.

9.9.1.7 **Control of Hazard:** For moderate risk levels, management programme are planned to reduce risk level in a definite time period. The result of this assessment is considered while setting up objectives. In case any new activity is added or the existing one is changed, it shall be taken into account and the risk assessment again done for this risk. The hazards associated with the same are identified and risks assessed. The process of risk assessment is carried out once in a year to assess the effectiveness of control measures and to see if the hazards and risks have been significantly controlled over the period.

9.9.2 **Monitoring and Measurement of OHSAS performance:** Diesel Shed shall establish and maintain a system for monitoring and measurement of OHSAS performance on a regular basis and following plan be followed:-

9.9.2.1 Procedure has been established which identifies the measures of performance to be measured and monitored.

9.9.2.2 Both quantitative and qualitative measures have been considered, where appropriate

9.9.2.3 Proactive measures of performance that monitor compliance of OHSAS arrangements through surveillance and inspection have been identified

9.9.2.4 Reactive measures of performance that monitor historical evidence of deficient health and safety performance have also been identified

9.9.2.5 Arrangements are defined to monitor OHSAS objectives. Ensuring that recording of data and results of monitoring and measurement sufficient to facilitate subsequent corrective and preventive action analysis have been defined in the procedure.

9.9.2.6 Proactive Monitoring:

a) Systematic inspection of workplace as per planned interval.

b) Systematic audit of workplace as per planned interval

c) Measurement of occupational parameters as defined in legal register

d) Health check up of employees engaged in hazardous activities

e) Periodic inspection/testing of lifting devices and air receivers

f) Review of OHSAS objectives, management programme and legislative requirements

g) Mock drills to asses efficacy of emergency preparedness

h) Addressing issues of occupational health and safety raised by staff

9.9.2.7 Reactive monitoring:

a) Monitoring of hazardous events including near miss.

b) Sickness absence-employee absence due to illness in identified hazard areas.

c) Internal audit findings

d) Inspection reports of regulatory body

e) Analysis and action

f) Regular safety check sheet inspection and annual safety audit and remedial action be taken and in case the need is felt, formal Corrective and Preventive Action is taken

9.9.3 Personal Safety

9.9.3.1 All persons working in Diesel Shed shall be provided with suitable protective clothing and safety equipment as per 'Schedule of safety equipment and protective clothing'

9.9.3.2 Training on safety, including fire fighting, and first-aid shall be provided to nominated persons periodically.

9.9.3.3 All staff working in Battery Section should be sent for regular medical check-ups and entries of such check- ups made in an exclusive register.

9.9.3.4 While attending the electrical breakdowns, all safety guidelines should be followed and 'permit to work' certificate taken.

9.9.3.5 All electricians should use properly insulated tools for attending electrical breakdowns.

9.9.4 **Accidents, Reporting and Solving Strategy:** Though running sheds do not work under the purview of the Factories Act, it is preferable to use the guide lines of this act for observing industrial safety. Following methodology shall be followed in Diesel Sheds:

9.9.4.1 The efforts made toward improving working environment shall aim at zero accident. There shall be well documented procedure: Emergency Response Plan, for handling accidents in shed.

9.9.4.2 Each case of accident shall be thoroughly investigated and corrective & preventive action shall be defined. Brief details of each accident including corrective & preventive action taken shall be recorded in separate "accident register".

9.9.4.3 Employees shall be involved and consulted in formulating accidents/incidents related procedures

9.9.4.4 Taking necessary action to mitigate any consequences arising from accident/incident.

9.9.4.5 Initiation of corrective and preventive action and implementation of the same

9.9.4.6 Shed in-charge shall regularly review the status of compliance of corrective & preventive action.

9.9.4.7 Monthly statement of accidents in shed shall be intimated to HQ through MCDO.

9.9.4.8 Review of corrective/preventive action for risk assessment

9.9.4.9 Monitoring of these actions for effectiveness

9.9.4.10 Defining methodology for identification, investigation and Corrective and Preventive action on non-conformities

9.9.4.11 Road accidents are normally handled by operating divisions. Their staff and inspector should be suitably trained for this purpose. However, in some cases assistance will be required from the Diesel Shed for which nominated inspector, supervisor and staff with required equipment can be sent out by shed, whenever required.

9.10 Environment Management: Each shed will have a Environment Manual which will broadly cover:-

9.10.1 Legal provisions related to Water, Air, Noise and Waste Disposal: A list of such provisions is given at **Annexure-9.7.** The list given is only indicative and may not include all or some of these may not be relevant at a particular time. Hence, this list shall be periodically (not less than once in a year) updated by the shed in-charge.

9.10.2 Waste water management system.

9.10.3 Air pollution control system

9.10.4 Noise Pollution control system

9.10.5 Waste Management Disposal System, specifically covering hazardous waste

9.10.6 Energy Conservation

9.11 Environment and Occupational Health and Safety Management Certification: Each shed will have certification of ISO:14001-Environment Management System (EMS) and ISO:18001- Occupational Health and Safety Management System (OHSAS)**.** This will help in:-

9.11.1 Ensuring safe and healthy working conditions in the shed,

9.11.2 Ensuring that legal and other requirement are identified and updated as applicable to the Environment and Occupational Health & Safety aspects of the activities, product and services of diesel shed.

9.12 Legal Register: Legal provisions related to safety and environment, pertaining to diesel shed activities, product and service, will be contained in a register called "Legal Register". It will mention:-

9.12.1 The relevant clause nos. of the environment and safety law and their brief relevance.

9.12.2 Regulatory limits of parameters

9.12.3 Responsibility and frequency of checks of compliance of various laws/parameters

9.12.4 This Legal Register shall be maintained by SSE/General or any other SSE nominated by Shed in-charge.

9.12.5 The legal register shall be periodically (not less than once in a year) updated by Shed in-charges.

9.12.6 Report on compliance of legal register shall be reviewed by Shed In-charges on Monthly basis and advised to HQ on Quarterly Basis along-with MCDO.

9.12.7 Some important legal requirements related to environment pollution are given at **Annexure-9.8.**

9.13 Waste Water Management:

9.13.1 Sheds utilize lot of water for shed cleaning, loco component cleaning, in coolant system of locos and for staff use. The importance of water need not be emphasized in a scenario where the water has become a precious resource. So, sheds should take all measures to conserve water. The conservation of water encompasses: efficiency of use, rain water harvesting and recycling of treated water.

9.13.2 To improve the efficiency of water usage, first there should be a measure of utilization. For this purpose, flow meters should be installed at various tapping points in the shed. It should be inculcated in the minds of supervisors and staff that water is a precious resource and it should be used judiciously.

9.13.3 Effluent Treatment Plant: Each Shed shall have an Effluent Treatment Plant which shall be able to treat all liquid discharges of the shed so that various environmental parameters remain within the legal permissible limits. Drainage from pits shall be connected to the drain where ETP plant shall be installed and checking of various parameters of ETP shall be regularly monitored. Storm water drains should be separate from pit drains, these should not be connected to ETP, instead they should have direct discharge to the main drain, leading the waste water discharge outside the shed.

9.13.4 The design of ETP should comply with the laid down norms of respective State Pollution Control Board.

9.13.5 System of Rain Water Harvesting which involves collection from the shed roof area and ground water recharging should be in place. It will create good amount of water resources within the shed premises. Effective help of state government officials should be obtained in this regard.

9.13.6 For effective rain water harvesting, the drainage of the shed should be well planned. Old sheds should re-work the internal drainage for better rain water harvesting. Better internal drainage system will also help in preventing flooding of bays and pits during heavy rains.

9.13.7 Reclaimed/rejected water from ETP/RO plants should be recycled and used for cleaning of loco/components, shed cleaning and gardening.

9.14 Air Pollution Control System:

9.14.1 Every shed shall have a incinerator to burn waste material like gaskets, lub oil filters, etc. This will help in reducing the unnecessary carrying of such waste to nominated waste dumps.

9.14.2 Incinerator design should comply with the laid down norms of respective State Pollution Control Board.

9.14.3 The air quality in the shed should be monitored at regular interval (Quarterly or as laid down by State Pollution Control Board) for specific parameters.

9.15 Noise Pollution Control System:

9.15.1 Sheds should take measures to reduce noise pollution in the shed premises. Main source of noise pollution are Load Box Testing of locos, Air Compressors & DG sets.

9.15.2 Load Box testing area should be away from main shed. Sound barriers in this area should be provided.

9.15.3 Air compressors and DG sets should have sound proof enclosures.

9.15.4 Noise level should be monitored at regular interval (Quarterly or as laid down by State Pollution Control Board) for specific parameters.

9.16 Waste Management: A planned waste management is key to safe working environment. Each shed shall make a matrix of various types of wastes, their quantity generated annually and appropriate action to be taken for their disposal so that the environmental laws, as applicable, are adhered to. Sample of a waste generation matrix is at **Annexure-9.9.** Following general guidelines shall be followed for waste disposal:-

9.16.1 At generation points, shop in-charges shall ensure that waste is segregated in different drums/pallets/bins.

9.16.2 Records of generation and dispatch of hazardous waste is kept in proper format.

9.16.3 During transportation of scrap from source to scrap yard/ refuse bin/ dump site care to be taken that there is no spillage/ mixing on the way.

9.16.4 Waste shall be discharged at nominated locations only.

9.16.5 Containers of chemicals, oil, etc. to be transported and stored with lid intact.

9.16.6 In order to avoid unintentional spillage of chemicals/oil/paints/thinner it should be ensured that there is no left over material in empty drums

9.16.7 Treatment of waste, wherever specified, to be ensured as per laid down guidelines

9.16.8 For items that are to be dumped in refuse bins, additional bins/drums/pallets may be used and kept on roadside adjacent to the refuse bins, if necessary, for collection of waste.

9.16.9 Pilot project for conversion of waste to energy can be taken up in certain sheds to see the efficacy and practical aspects.

9.17 Energy Conservation- Another important area that requires focus for environment improvement is energy conservation. Following steps should be taken for this purpose:-

9.17.1 Energy efficient electrical fittings should be utilized.

9.17.2 Renewable energy resources like solar water heaters, solar cells, tubular daylighting devices, etc. can be used for energy conservation.

9.17.3 One of the prime area of energy consumption is compressors. The efficiency of compressors should be improved by reducing leakages, using PID controllers (proportional–integral–derivative controller) and energy efficient nozzles. Instead of one large compressor feeding to the system, modular compressors for separate activities should be provided. This will help in switching on of only required number of compressors.

9.17.4 Unnecessary shunting activity in sheds should be avoided. Shunting plan should be so developed so as to ensure minimum movement.

9.17.5 Shutting of Locos idling in sheds should be ensured.

9.17.6 With on-board data loggers in locos, Self Load Box and Load Box test should be done only when essentially required.

9.17.7 Energy Audit of the shed should be got done once in a year from authorized agencies.

9.18 Miscellaneous:-

9.18.1 Every shed should have Consent for Establishment (CFE) and Consent for Operation (CFO) given by State Pollution Control Board, duly paying the prescribed fee.

9.18.2 Conditions, if any, stipulated in CFE/CFO should be complied with timely.

9.18.3 Annual Environment Audit report of shed should be submitted to State Pollution Control Board timely.

9.18.4 Boards displaying the CFE/CFO, conditions specified by SPCB for granting CFE/CFO and Main Parameters related to water, air and noise should be displayed prominently near the entrance of the shed.

9.18.5 Water cess charges should be paid regularly.

9.18.6 Sheds should go in for disposal of hazardous waste through agencies authorized by State Pollution Control Board for this purpose.

9.18.7 Operation of ETP and Incinerator should be outsourced.

9.19 Educating Staff–

9.19.1 Steps should be taken to educate staff by conducting competitions, seminars and by displaying various posters about Safety of locos, Safety at Work Place, Environment, Water, Air, Noise, Electricity utilization, etc.

9.19.2 Regular (not later than once in a month) safety review meetings at section level and supervisor level should be conducted in which safety and environmental issues should be discussed.

9.20 Green Cover- at least 30% of the shed area should be under green cover. Proper maintenance of the green cover through outsourcing should be ensured.

9.21 Periodic Audit:-

9.21.1 Periodic Audit: Both internal and external audits should be conducted to check the compliance of stipulation laid down for SL and SW and Environment Management.

9.21.2 Internal Audit should be conducted at the level of AME/Mechanical and AME/Electrical once in a Quarter and at the level of Sr.DME/DME once in six months.

9.21.3 External Audit should be conducted by a team of HQ/Other Shed officials once in a year.

9.22 Safety and Environment Management through Expert Auditors: The whole gamut of Safety and Environment Management is quite exhaustive and require concentrated and continuous efforts on part of shed management to ensure compliance. With dwindling manpower, both at officer and staff level, it shall not be possible to pay due attention to Safety and Environment Management by the shed management, without losing focus on core work of maintenance of locos. Also, the auditing requires lot of expertise to make it meaningful. Therefore, each shed should arrange external audit of Safety and Environment Management in sheds once in six months through auditors expert in this field. These auditors should inspect the shed and bring out non-conformities to the attention of shed management.

Annexure 9.1

INDICATIVE LIST OF SAFETY ITEMS/FITTINGS IN DIESEL LOCOS

S.No.	Description	Check for
1	Wheel profile	Root 6mm, Flange 3mm, Tread 6.5 mm
2	Loco side buffer bolts	Dull sound loose or missing bolts.
3	Cattle guard and Rail guard bolts	Dull sound loose or missing bolts.
4	CBC Retaining plate, ‘U’ clamps and bolts	Dull sound loose or missing bolts.
5	CBC Knuckle and lock pin	Wear Go / No Go Gauge
6	Brake pull rod safety brackets.	Missing and welding given up.
7	Equalizing beam Safety Brackets for WDM2/3A	Missing and welding given up
8	Equalizing beam Tie rod pins and cotters for WDM2/3A	Cotters for breakage and for proper splitting
9	Link pin and equalizers, cotters and washers for WDG3A/WDM3D	Cotters for breakage and for proper splitting
10	Link pin and equalizers Safety straps for WDG3A/WDM3D	Welding given up / missing
11	Brake tie bar and safety chain	Condition and for missing chain
12	Resilience pads split pins	Missing and proper splitting of pins
13	Gear case bolts	Dull sound loose or missing bolts and sealing
14	Nose cap bolts	Dull sound loose or missing bolts and sealing
15	Brake hanger bolts safety straps	Welding given up / Missing.
16	Axle box stay plate bolts and cover bolts	Dull sound loose or missing bolts
17	Vertical and horizontal damper bolts for WDG3A locos.	Loose or missing bolts
18	Both Trucks ‘U’ Bracket bolts	Loose or missing bolts
19	Air dryer and guard securing bolts	Loose or missing bolts
20	Main Reservoir holding strap and bolts	Intactness and loose or missing bolts
21	Fuel tank holding bolts	Loose or missing bolt
22	Brake power of loco	Apply power up to second notch in brakes applied condition, loco should not move
23	Super structure to bogie connecting ‘D’ shackles	Intactness and availability of split pins
24	Hand rails	Proper securing
25	Sand pipe brackets and bolts	Loose or missing bolts
26	Outer coil springs	Coils touching each other (due to being weak)
27	Critical locations for bogie frame	Cracks
28	Mounting arrangement of sand boxes.	Availability of bolts, brackets, welding
29	CBC	Working and locking of knuckle and availability of anti-creep protection

S.No.	Description	Check for
30	VCD	Working
31	Loco Brakes	Effectiveness (by observing movement on 1st Notch)
32	Dynamic Brakes	Working
33	Conjunction Brakes	Working
34	Parking Brakes of DEMUs and DHMUs	Availability and Working
35	TBUs of WDP1	Working
36	Hand Brake	Functioning
37	Flasher Light	Working and Automatic Switching ON
38	Headlight	Working and focusing, availability of spare bulb
39	Classification Lamp	Working (both red and white)
40	Window Wipers	Working
41	Horns	Working
42	Speedometer	Working (both)
43	Fire Extinguisher	Availability and Inspection
44	Wooden Wedges	Availability and Condition

Annexure- 9.2

LIST OF SAFETY PRECAUTIONS TO BE TAKEN DURING MAINTENANCE OF THE LOCOS

ELECTRICAL:

SN	Description
01	Ensure ECC connection wires junction box cover to be intact with no oil inside.
02	Ensure headlight connections are free from dirt and oil
03	TA/TG room should always be kept dry.
04	Ensure no oil leakages on electrical cables.
05	TG/TA gear case oil should be filled duly using funnel and also avoid over filling. Filling cap to be tightened properly.
06	Ensure TA/TG pit drains are free from obstructions.
07	Check regularly for IR values of power, control and power to control circuits and ensure minimum prescribed values are maintained.
08	Ensure no loose cable / wire joints and perished/damaged insulation of cables is there.
09	Wires/ cables of correct rating to be used.
10	Ensure good condition / fitment of Arc chutes.
11	Ensure calibration of safety relays, MCBs and safety valves as per prescribed norms.
12	Avoid overcharging of batteries and blockage of vent plug holes.
13	Ensure no oil, dirt/waste papers are allowed in the control compartment and also in the

SN	Description
	control panel, i.e., under the BKT and REV switches.
14	Ensure electrical junction boxes are oil tight.
15	Ensure that all traction motor and generator / alternator cables under the floor are properly secured in cleats and are thoroughly cleaned of all dirt, oil and grease. In no case, cables should be tied up with wires / ropes / cloth, etc.

MECHANICAL:

SN	Description
1.	Complete engine room should be kept dry.
2.	Check for tappet cover, sump and explosion door gasket joints for oil leakages.
3.	Ensure availability of Braided/Rubber hose as cover over Fuel oil cross over Pipe.
4.	Ensure no cracks on primary and secondary fuel oil filter housings.
5.	Check for rubbing of hoses and metallic pipes with other parts. If so, these should be properly clamped.
6.	Check exhaust manifold for signs of any exhaust gas leakages from bellow joints/manifold.
7.	In every schedule lube oil drain pipe dummy should be removed and should be properly fitted back after draining oil.
8.	Ensure radiator room is completely dry. Leakages, if any, should be arrested. Check lube oil pipe dressor couplings and flange joints for leakages. Lube oil drum cover should be properly tightened. Ensure legs and cover bolts of filter housing are not broken.
9.	4 Nos. of fire extinguishers fit in all respects are to be always available in the Drivers cab. They should be properly secured and located within easy reach of the loco pilot.
10.	Ensure compressor high pressure discharge pipe lines are covered with thermal insulating material. No oil should drip on insulation. If necessary, piping and joints should be suitably relocated.
11.	Ensure compressor pit is dry with no accumulation of oil and water. The drain pipe under floor should be of adequate length at bottom to avoid falling of drained oil / fuel on truck / TM or other under gear items.
12.	Ensure cleaning of oil, grease and muck, etc., in loco to avoid catching of fire.
13.	In every schedule brake cylinder piston travel and brake adjustment should be done in sequence correctly.
14.	Ensure that proper caps are secured on gear cases / suspension bearing oil sump, etc. In no case openings should be allowed to be covered with cloth.

Annexure- 9.3.1

SAFETY PRECAUTIONS FOR CRANE OPERATION

1. Ensure free movement of crane in longitudinal and transverse directions, functioning of controls and limit switches before starting the crane.
2. Do not keep loose objects in the crane to avoid accidental falling from crane.
3. Crane should never be over loaded beyond the safe working load capacity which should be prominently marked on the machine.
4. Brakes should be checked when a near capacity load is being lifted by actually lifting the load a few inches and switching off the controls.
5. If the brakes do not apply and the load comes down it should be repaired/set/adjusted first before lifting the load again.
6. The hook block should never be lowered below the point where,

   i) Less than two full wraps of rope remain on the hoisting drum or

   ii) It is about to touch the floor.

   Ensure the lower limit is adjusted accordingly.
7. The cranes should be centered over the load such that the hoisting ropes are vertical. It should not be used for angular lifting or pulling a load.
8. Before shifting the load it should be lifted high enough to clear all obstructions on the floor.
9. Know and obey the signals from supervisor/slinger while operating the EOT crane.
10. Controls should be operated smoothly to avoid abrupt, jerky movements.
11. Personnel in the immediate area should be cleared off when the load is being lifted and moved.
12. Look out in the direction of movement of moving loads to avoid accidents.
13. The bell provided should be operated to alert the staff about crane movement.
14. “STOP” the crane operation when in “DOUBT” about the health of the crane.
15. A suspended load should never be left un-attended.
16. Station the crane near the ladder.
17. “DO NOT” walk along the crane rails
18. SWITCH OFF the crane before leaving the crane.
19. SWITCH OFF main power supply when the crane is not in use.
20. Do not open fuse boxes and electrical controls for repairs without proper authority.
21. The crane should be electrically isolated and the main switch should be locked or tagged and fuses removed before inspection, repairing, cleaning/lubricating etc., where an accidental start of the Crane may result in a severe accident. (Refer to electrical isolation and tagging)
22. When two EOT cranes available on one line, gantry or rail safety devices functioning should be ensured which sounds a warning or cuts off the electricity supply to crane movement so that collision between the two cranes can be avoided.

23. Check whether any maintenance schedule of crane is overdue. If so, immediately inform the concerned supervisor.
24. Always keep the crane clean and tidy.

Annexure- 9.3.2

SAFETY PRECAUTIONS FOR USE AND EXAMINATION OF ESSENTIAL LIFTING ACCESSORIES

1. Ensure that load being lifted is within the limit of safe working load of respective lifting machine or tackle, wire rope
2. Ensure that lifting chains, ropes being used are not overdue testing and are free from any visible defect.
3. Ensure lifting tackle is free from any visible defect.
4. Wear Protective Clothing, Helmets and shoes compulsorily while working with lifting machines
5. The crane should be centered over the load such that the hoisting ropes are vertical. It should not be used for angular lifting or pulling a load.
6. Ensure that loco lifting by jacks is done at prescribed place
7. Before use, ensure that locking device of loco lifting jacks is in working order
8. Ensure that loco lifting jacks are placed at the prescribed location.
9. Ensure that loco lifting jacks are placed firmly on floor
10. Ensure that lifting arm of loco lifting jack is free from visible defect

Annexure- 9.3.3

SAFETY PRECAUTIONS FOR ELECTRIC ARC WELDING

1. Wear protective cloth during welding operation.
2. Use nose mask for protection against welding fumes.
3. Avoid contact with any metallic element which carries voltage without proper insulation.
4. Properly earth the negative terminal nearer to the work place. Do not resort to loose connection on the earth terminal.
5. When not working, remove the electrode from holder and switch off the machine.
6. Holder should be kept in such a way that it does not make any contact with persons or conducting objects.
7. Ensure holder is fully insulated and electrical connections are tight.
8. Keep welding cables, holders and other accessories neat and dry.
9. Wear helmets or head screens, goggles, safety shoes and protective clothing for all welding operations.

10. Do not carry out welding on un-cleaned drums, containers, tanks which are used for combustible materials.
11. Do not stand in the wet place while welding.
12. Ensure air vents in welding transformers are not covered.
13. Ensure welding transformer is properly earthed.
14. Ensure full oil levels in the transformer.
15. Ensure all fuses are of correct size and quality.
16. Use right electrodes for the task in case of doubt, confirm from the lab.
17. Welding and gas cutting should not be carried out when spraying of ORION and Kerosene is going on electrical rotating machines to improve IR Value.
18. Store/preheat the electrode in the portable ovens.
19. Never look at the flash without safety goggles even for an instant.

Annexure – 9.3.4

SAFETY PRECAUTIONS FOR WELDING OF FUEL TANKS

1. Drain the fuel oil completely from the fuel oil tank.
2. Fill the fuel oil tank with water.
3. Keep both the fuel oil filling caps in open condition for escape of any gases generated during welding.
4. Do not keep any inflammable material in the fuel oil tank welding area.
5. Keep sufficient sand near the welding area.
6. Keep at least 4 nos. fire extinguishers near the fuel tank welding area.
7. Ensure that a senior supervisor is available during welding.
8. Use all protective gears like apron, goggles, gloves during welding.
9. Do not weld fuel tanks during night time, unless specifically approved by the competent authority.

Annexure-9.3.5

SAFETY PRECAUTIONS FOR GAS CUTTING AND GAS WELDING

1. Know the safety precautions while cutting/welding with gas.
2. Wear protective clothing while on work.
3. Wear hand gloves while working on gas welding equipment.
4. Wear safety shoes and safety goggles while working on gas welding equipment.
5. Check condition of torch and regulator. If not in good condition, replace them with good equipment.
6. Set the regulator to correct pressure.

7. Do not use faulty/leaky regulators.
8. Check hose pipes for condition and leakages. Replace leaky/cracked hose pipes.
9. Check the cutting tip/nozzle and clean them, if they are not good.
10. Use Acetylene cylinder in vertical position.
11. Use correct spanner and spindle key for opening/closing of cylinder valves.
12. Cylinder should be away from inflammable substances.
13. Use Oxygen cylinder horizontally.
14. Don't expose the cylinders to heat.
15. Ensure oil or grease not present near the cylinders.
16. Shut the cylinder valves when not working.
17. Use gas mask while gas cutting on battery boxes without fail.
18. Ensure availability of bucket full of water and fire extinguishers for ready use near to the work spot.
19. Use only spark lighter to torch (not match box)
20. Light the blow pipe properly.
21. Do not attempt to mix gases in the cylinder.
22. Welding and gas cutting should not be carried out when spraying of ORION and Kerosene is going on electrical rotating machines to improve IR Value

Annexure-9.3.6

SAFETY PRECAUTIONS FOR MAINTENANCE OF PRESSURE VESSELS

1. Check availability of last test date of pressure vessel within due date.
2. Check availability of safety valve in pressure vessel and its working.
3. Check the working of pressure gauge mounted on the pressure vessel for its working.
4. Check maximum safe working pressure painted on the vessel.
5. Do not operate any pressure vessel without the above information

Annexure-9.3.7

SAFETY PRECAUTIONS FOR WORKING ON DIESEL LOCO IN OHE TERRITORY

1. Do not climb on top of the loco when the loco is located below the OHE (over head electrical) wires.
2. Do not bring any loco spare or tool near to the OHE wires.
3. In case of urgency, ensure before climbing the loco that the overhead equipment is dead or earthed and permit-to-work is issued by competent authority.
4. Inform the competent authority after completion of work.

Annexure-9.3.8

SAFETY PRECAUTIONS FOR SHUNTING ACTIVITIES /SHUNTER

1. Do shunting only under instruction of official authorized by Sr.DME/DME(D).
2. Ensure that no person/persons are attending to loco before taking up shunting.
3. Ensure proper brake power in the shunting loco.
4. Ensure availability of wedges/skids before starting shunting.
5. Check the operation of walkie – talkie sets before shunting.
6. Check the loco horns by operating.
7. Ensure proper coupling of locos before movement.
8. Whistle and take round of loco before shunting, especially check pit under the loco.
9. Blow whistle frequently while carrying out shunting.
10. Do not exceed maximum speed of 8 KMPH while shunting.
11. Always be in sober condition before carrying out shunting.
12. Don’t pass over the points without ensuring their correct setting.
13. Ensure Pointsman is available with red and green flags for day working.
14. Ensure that a torch is also available with Pointsman for night working.
15. Ensure Points man Wear helmet, safety shoes and hand gloves during shunting.
16. No loose shunting should be carried out inside the shed.
17. Ensure track is clear of all obstructions in shunting path.
18. After completion of shunting, ensure its securing with wedges / hand brakes/ parking brake and stop boards.

Annexure-9.3.9

SAFETY PRECAUTIONS FOR ELECTRICAL SAFETY IN SHEDS

1. Do not keep unwanted material near the electrical switch board.
2. Call the authorized person for any electrical repair.
3. In case of electrical short circuit, put off the electrical switch.
4. Do not use water on fire due to electrical short circuit.
5. Use electrical insulating gloves in case of emergency.
6. Use proper plug and sockets for small electrical equipments like drills and grinders.
7. Do not use damaged flexible cable for small tools.
8. Counsel your colleagues on the above instructions.

Annexure – 9.3.10

SAFETY PRECAUTIONS IN USAGE OF HEAVY M&P

1. Clear the machine before starting the work from metal cuttings and chips.
2. Only properly trained persons should work on the machines.
3. Ensure proper lubrication of the job and the machine during its working.
4. Keep the coolant pump in working if it is required.
5. Do not disturb or damage the protective guard for the motor and other equipments.
6. Ensure that the belt guard is in place.
7. Switch off the machine and put off the power when not in use.

Annexure – 9.3.11

SAFETY PRECAUTIONS FOR FIRE PREVENTION AND CONTROL

1. Do not lit fire inside the shed premises including open area and yard.
2. If necessity arises, approval of competent authority to be obtained for lighting the fire after taking all precautionary measures.
3. Keep away all inflammable materials from the vicinity of fire, sparks.
4. Released material such as oil soaked cotton waste, rubber items, wood, packing material from the shed which can cause fire should be segregated and disposed off under controlled environment.
5. Removed lube oil and fuel oil filters should be stacked at nominated place away from normal working area where there is no possibility of catching fire.
6. “NO SMOKING” instructions should be strictly complied with.
7. Acquire knowledge of using fire extinguishers.
8. Be aware of location of fire extinguishers.
9. In case of any fire accident, immediately inform the control to put on the siren and whistle/shout to warn the employees nearby fire spot.
10. Do not use water for putting off the electrical fire.
11. In case of fire, remove the loco and the other inflammable material from the vicinity of fire.
12. Ensure that fire is properly put off before moving near to the spot.

Annexure – 9.3.12

SAFETY PRECAUTIONS FOR LEAD ACID/VRLA BATTERIES

1. Do not pour water into acid while preparing electrolyte for filling in batteries
2. Mix acid into the water step by step and observe the electrolyte temperature

3. Battery connections must be checked for tightness.
4. Keep the batteries free from dirt and dust.
5. Wear safety goggles, gloves, safety shoes, nose masks and protective clothes.
6. Take precaution while loading and unloading the batteries.
7. Ensure first-aid, fire extinguishers are provided for emergency.
8. Use petroleum jelly on the terminals.
9. Do not use metal container for handling electrolyte.

Annexure-9.3.13

SAFETY PRECAUTIONS FOR USE OF LPG GAS SYSTEMS

1. Maintenance of installation of LPG manifold should be done by authorized persons.
2. Lock the gas manifold room. Room to be opened only by authorized persons.
3. Keep the room clean and well ventilated.
4. Only gas cylinders and fire extinguishers should be kept in the room.
5. Paste 'NO SMOKING' Labels outside the room at prominent locations.
6. Do not allow naked flame or any other source of the fire inside or near the room.
7. Display contact phone numbers of distributor of LPG and fire brigade at prominent locations.
8. Ensure safety protection cap in place.
9. Check leakage from valve by applying soap solution.
10. Close isolation valve before connection and disconnection of cylinder.
11. Don't drag, roll or drop the cylinders.
12. Close the LPG cylinder connection when the work is completed.

Annexure – 9.3.14

GENERAL PRECAUTIONS TO BE TAKEN FOR SAFETY

1. Do not spill oil on shed floor, cat walks, ramps, pits.
2. Do not throw waste materials on shed floor, cat walks, ramps and pits.
3. Do not damage the shed floor by throwing heavy items.
4. Do not allow water to stagnate
5. Do not throw waste materials like cotton waste, papers and block the drainage.
6. Always wear protective clothes, helmets and shoes while working.
7. Wipe the floor immediately after spilling of lubricant/oil.
8. Replenish first-aid box and keep it easily accessible.
9. Do not be too casual while handling any equipment.
10. Never handle loose electrical cables.

11. Do not allow trespassers into the shed which is a PROHIBITED area
12. Avoid walking under/near working crane, while walking through the shed bays
13. Be on lookout for shunting movement while crossing tracks inside shed
14. While cranking ensure that no person is working on the loco
15. Do not scatter tools and material at the work spot
16. Take prescribed precautions while checking HT IR of locos

Annexure- 9.4

PERSONAL PROTECTIVE EQUIPMENTS

SN	Description of Protective Equipment	Quantity/ person	Frequency of change/renewal	Category of Staff required to be provided
1.	Helmets	Two	Yearly	All staff of shed
2.	Leather Hand Gloves	2 pairs	Quarterly	All technicians and unskilled
3.	Safety shoes	2 pairs	Half yearly	All staff of shed
4.	Ear Plugs	2 pairs	Quarterly	Supervisors, Technicians and Unskilled staff involved in Load Box Testing of Locos
5.	Welding Gloves	2 pairs	Quarterly	All welders
6.	Welding Goggles	2 pairs	Half Yearly	All welders
7.	Safety belts	2 pairs	Yearly	All staff working at height
8.	Line Testers	Two	Half Yearly	All electricians working for maintenance of shed power supply
9.	Rubber shoes	2 pairs	Half yearly	All shunting staff and shed cleaning staff
10.	Protective apron /coveralls	2	Half Yearly	All staff of shed

Annexure- 9.5

FIRE FIGHTING FACILITIES IN THE SHED

SN.	Description of equipment/facility	Requirement in numbers		
		<100	≥100 <175	≥175
1.	Stored Pressure type DCP type fire extinguishers of 6Kg for Class: BC fires to IS:15683 (to be provided at suitable locations in bays- above & below maintenance platforms, store rooms, scrap yard, office, etc.)	40	72	100
2.	Fire hydrants	6	8	10
3.	Hoses of adequate length for use in fire hydrants (to be housed in a box with Glass front and located near to fire hydrants).	6	8	10
4.	Static tanks	1	2	3
5.	Sand buckets	36	48	60
6.	Fire Alarms four numbers to be provided in each bay, two numbers on each floor of shed building, two numbers in each ward, etc (This number can be suitably increased as per shed layout and need).			

Annexure- 9.6

EMERGENCY RESPONSE PLAN

1. A booklet defining action to be taken in case of any accident/emergency: person to be contacted and duties of various persons in different types of emergencies, on the pattern of Disaster Management Plan being issued by divisions for handling train accidents and other natural calamities, shall be prepared by each shed.

2. Important Phone Nos. of fire brigade, hospital, police, etc. shall be prominently displayed in the control office.

Annexure- 9.7

LEGAL PROVISIONS

S. No	Act / Rule
1.	The Water (Prevention and Control of Pollution) Act, 1974, amendment 1988 and Rules, 1975, amendment 2011
2.	The Water (Prevention and Control of Pollution) Cess Act, 1977, amendment 2003 and Cess Rules, 1978, amendment 1992
3.	The Air (Prevention and Control of Pollution) Act, 1981, amendment 1987 and Rules, 1982
4	The Noise Pollution (Control and Regulation) Rule,2000
5.	Hazardous wastes (Management & Handling) Rules, 2008 and third Amendment Rules, 2010
6.	The Environment (Protection) Act 1986, amendment 1991 and Rules 1986
7.	The Factories Act, 1948 (for guidance only)

S. No	Act / Rule
8.	Battery management and Handling Rules, 2001
9.	Indian Electricity Act, 2003 and Indian Electricity Rules, 1956
10.	The Ozone Depleting Substances (Regulation and Control) Rule,2000
11.	Contract Labour (Regulation and Abolition) Act, 1970 and Rules, 1971

Annexure- 9.8

Legal requirements as per Consent/Authorization/Licenses and other Statutory Rules and Regulations

(Conditions given in Sr.No. 1 & 2 are on the basis of Consent given to DLW/BSB)

1.	**The Water (Prevention and Control of Pollution) Act, 1974**	
	Condition 2	Separate Collection of Process and domestic effluent.
	Condition 3	Treated water should have: BOD < 30 mg /ltr, TSS < 100 mg/ltr., amongst other requirements
	Condition 12	Solid waste to be segregated and disposed off to ensure 1) Inactive material to be disposed off in landfills. 2) Controlled burning of combustible organic waste. 3) Bio-degradable material to be composted.
	Condition 15	If the quantities discharged or parameters are in excess of prescribed standard, the information to be sent to the Pollution Control Board.
	Condition 17	Sampling and testing of effluents to be done as per IS: 2488 at least once in 3 months and report sent to the Pollution Board.
	Condition 20	Application for renewal of consent to be filed at least 30 days before its expiry.
	Clause 1	Implementation report of water consent to be sent within one month.
	Clause 2	Water meter reading of water supply source to be sent every month.
	Clause 3	Reading of water meter near ETP to be sent every month & calibration chart to be sent time to time.
	Clause 7	ETP to be operated effectively to ensure that discharges are within prescribed standard.
	Clause 9	Tree plantation- Report to be sent quarterly
	Clause 14	Log book of chemicals consumed to be maintained
2.	**The Air (Prevention and Control of Pollution) Act, 1981**	
	Clause 1	Implementation report of air consent to be sent within one month.
	Clause3	Test report of flue gas emission and ambient air quality to be sent within one month
	Clause 4	Operation of wet scrubber should be as per the std norms of SPCB
	Clause 5	Layout plan, design etc. of treatment unit etc. to be sent within 1 month
	Clause 6	Quality of ambient air as per the std. of SPCB norms
	Clause 8	Consent is applicable only for present production capacity & emission.
	Clause 11	Ensure implementation of Water Cess Act of 1977
	Clause 12	Ensure to send environmental statements within time.
	Clause 13	Ensure water harvesting as per instructions of GOI.
3.	**The Noise Pollution (Regulation and Control) Rules, 2000**	
	a)	The noise levels in any area/zone shall not exceed the ambient air quality standards in respect of noise as specified in the Schedule. (75 dB(A)Leq in day time and 70 during night time)
	b)	Periodic monitoring of noise levels in various parts of the shed should be done and reported to SPCB, as required.
4.	**The Hazardous Wastes (Management, Handling and Transboundary Movement)**	

	Rules, 2008	
	a)	Ensuring that no adverse impact on the air, soil & water including ground water.
	b)	The person authorised shall not rent, lend, sell, transfer or otherwise transport the hazardous Waste without the prior approval of SPCB.
	c)	An Application for the renewal of Authorization shall be made in Form 1
	d)	File return in prescribed Form 3 & 4 along with compliance report of the consent
	e)	For movement of hazardous waste “Transport Emergency (TREM) Card” must be issued by Occupier in Form 11
	f)	Marking of hazardous containers should be done as per Form 12
	g)	Hazardous Waste Manifest- should be issued by occupier in six copies as per Form 13
	h)	Any accident’s complete details on form-14 must be sent to board at the earliest.
	i)	A report on complete details of waste oil reclamation and handling and storage facilities for waste oil to be sent to SPCB (as applicable)
	j)	Sludge from ETP to be stored in temporary storage facility. Not to be disposed off on land or in any water body.
	k)	Waste oil disposal must be to authorized re-processors

Annexure- 9.9

WASTE GENERATION MATRIX

A. HAZARDOUS WASTE

SN	Type of waste	Treatment if any	Collection area	Method of Disposal	Precautions
1	Filters and filter material having organic liquids on them	To be packed in HDPE bags	Collection area for incinerable waste	Incineration	Collection area to be concrete paves to avoid seepage of oil in ground
2	Waste lubricating oil	Collected in drums	Identified Location	To be sold to SPCB approved recyclers only	Avoid spillage on kuchha ground
3	Waste Asbestos gloves, rope, cloth, sheets	Gloves, rope, cloths, to be packed in HDPE bags	Collection area for hazardous waste	To authorized Hazardous Waste Handlers	Till disposed, to be kept securely
4	Waste oil soaked jute and saw dust	To be packed in HDPE bags	Collection area for incinerable waste	Incineration	Avoid scattering on kuchha ground
5	Waste tubes/ containers of adhesives	To be packed in HDPE bags	Collection area for hazardous waste	To authorized Hazardous Waste Handlers	Till disposed, to be kept securely
6	Waste from incineration unit	To be packed in HDPE bags	Collection area for hazardous waste	To authorized Hazardous Waste Handlers	Avoid scattering on kuchha ground
7	Waste Plastics, V-belts, etc.	To be packed in HDPE bags	Collection area for hazardous waste	To authorized Hazardous Waste Handlers	Till disposed, to be kept securely

B. Solid waste disposed on DS-8

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S. No.	Type of waste	Treatment, if any	Precautions
1	Steel and cast iron boring and turning	To be compacted by a baling machine	
2	Damaged/obsolete/rejected/broken/ worn-out components, pallets, wire ropes, chains, machine parts, discarded tools, used steel shots, off-cuts of steel plates, sheets, pipes, tubes, sections, bearings	-	To be kept securely
3	Wooden packing material	-	To be kept away from fire prone areas
4	Empty containers of paint, thinner, primer, trichloroethylene	To be kept in isolated area with open lid to dry-up. To be punctured thereafter.	Efforts to be made to use maximum quantity from the container
5	Empty containers of acids, alkali and other chemicals	Neutralize as per laid down procedure	Avoid splashing and contact with skin and eye.
6	Empty containers/ drums of POL items	-	To be cleaned by scrap merchant
7	Scrap batteries	Acid to be drained and neutralized as per laid procedure	To be disposed to dealer authorized by MOEF/SPCB

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Chapter 10

Outsourcing & Contract Management

10. OUTSOURCING AND CONTRACT MANAGEMENT

10.1 Scope: This chapter covers-

10.1.1 Activities to be outsourced in diesel loco sheds

10.1.2 Contract Management

10.2 Importance of Outsourcing:

10.2.1 Now-a-days it has become very costly to hire manpower, cost of procuring the spares & inventory carryover has become quite high and technological complexities in locos have increased. Further, with increase in production of locos, holding of locos in existing sheds is likely to go up substantially in the near future. Increased holding of sheds will further widen the gap between available sanction and manpower requirement as per benchmark/yardsticks. Therefore, outsourcing of identified activities will be imperative to bridge the gap and maintain increased holding of the locos. Already, maintenance of a number of assemblies such as: MBCS, MCBG, Air Dryers, PTLOC, ABB Turbo supercharger, TCC, etc. are being done through OEM. This concept needs to be proliferated further by picking up assemblies which are technologically advanced or involve high man-hours for maintenance/overhauling or require stocking of multiple types of spares duet o non interchangeability of subcomponents in assemblies of different OEMs.

10.2.2 Now-a-days locos, both of Alco family and EMD family, being manufactured have high end technology like Microprocessor Excitation and Propulsion Control system, Microcontroller Based Governors, PTLOCs, IGBT, DC link, TCC, CCB, etc. Many, of these high end technology systems are very complex and they are driven by proprietary softwares which keep on getting upgraded and their trouble shooting requires in-depth knowledge. Also, many of these assemblies have unique parts which can be supplied only by OEM. Hence, for ensuring maintenance of these systems, it becomes essential to give AMC/Overhauling of such systems/assemblies to OEMs, which will include not only the regular check up and trouble shooting, but also incorporation of various upgrades, supply of spare parts of assured quality, etc.

10.3 Activities to be outsourced: Following activities have been identified in Diesel Loco sheds which can be outsourced as per local conditions and requirement of the shed:-

10.3.1 General Activities for Diesel Loco Shed

10.3.1.1 Cleaning and housekeeping (including Gardening) in Shed Premises
10.3.1.2 Cleaning of Locos
10.3.1.3 Cleaning of Loco Components
10.3.1.4 Supply and filling up Sand in Locos
10.3.1.5 Maintenance of Fire Extinguishers
10.3.1.6 Painting of Locos
10.3.1.7 Stripping of Locos during heavy schedule

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10.3.1.8 Scrap and Waste Disposal (including hazardous waste)
10.3.1.9 Operation and Maintenance of ETP
10.3.1.10 Operation and Maintenance of Incinerator
10.3.1.11 Transportation of Material by Road Trucks
10.3.1.12 Maintenance of M&P
10.3.1.13 Maintenance of Engineering Infrastructure (including buildings and track)
10.3.1.14 Maintenance of electrical fittings, switches, wiring/cable, etc.
10.3.1.15 Security of Shed Premises

10.3.2 Specific Activities for Alco Loco Shed

10.3.2.1 Maintenance and Overhauling of Compressors through OEM
10.3.2.2 Maintenance and Overhauling of MEPs through OEM
10.3.2.3 Maintenance and Overhauling of MCBGs/WW Governors through OEM
10.3.2.4 Overhauling of PTLOCs through OEM
10.3.2.5 Reclamation and Overhauling of Bogies
10.3.2.6 Overhauling of Moatti Filters through OEM
10.3.2.7 Reclamation and Overhauling of High Efficiency Turbo Super Chargers through OEM
10.3.2.8 Overhauling of Air Brake Valves through OEM
10.3.2.9 Maintenance and Overhauling of Air Dryers through OEM
10.3.2.10 Maintenance and Overhauling of CCB through OEM
10.3.2.11 Maintenance and Overhauling of Traction Alternators through OEM
10.3.2.12 Maintenance and Overhauling of Traction Motors through OEM
10.3.2.13 Maintenance and Overhauling of Auxiliary Rotating Machines/Motors through OEM
10.3.2.14 Overhauling of Power Pack of locos
10.3.2.15 Overhauling of Engine Assemblies (cylinder heads, FIPs, Injectors, Water Pump, Lub Oil Pump, etc.)
10.3.2.16 Overhauling of RTTM blowers through OEM
10.3.2.17 Overhauling of loco accessories (FTTM blowers, ECC, Right Angle Gear Box, Radiator Fan, Radiators, etc.)

10.3.3 Specific Activities for EMD Loco Shed

10.3.3.1 Maintenance and Overhauling of Compressors through OEM
10.3.3.2 Maintenance and Overhauling of TCCs through OEM
10.3.3.3 Maintenance and Overhauling of MCBGs/WW Governors through OEM
10.3.3.4 Overhauling of Lube Oil Coolers through OEM
10.3.3.5 Reclamation and Overhauling of Bogies
10.3.3.6 Reclamation and Overhauling of Turbo super chargers through OEM
10.3.3.7 Maintenance and Overhauling of Air Dryers through OEM
10.3.3.8 Maintenance and Overhauling of CCB through OEM
10.3.3.9 Maintenance and Overhauling of Traction Alternators through OEM
10.3.3.10 Maintenance and Overhauling of Traction Motors through OEM
10.3.3.11 Maintenance and Overhauling of Auxiliary Rotating Machines/Motors through OEM
10.3.3.12 Overhauling of Power Pack of locos
10.3.3.13 Overhauling of Engine Assemblies (Power Assembly, Unit Injectors, Water Pump, Lube Oil Pump, etc.)
10.3.3.14 Overhauling of RTTM blowers through OEM

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10.3.3.15 Overhauling of loco accessories (Radiator Fan, Radiators, etc.)

10.4 Contract Management

10.4.1 Normal contracting is a lengthy and complex process as lot of variables are involved in this. Shed officials do not have much expertise in dealing with tenders. But, as mentioned above, with proliferation of outsourcing the contracting is bound to increase manifold. Hence, it is important that shed officials remain aware of the nitty-grities of tendering and contract management. In this regard reference to Chapter on “Tenders and Contract Management” of New Mechanical Code, under issue, may be made to get more details on this subject.

10.4.2 At the same time, it is a fact that most of the specific activities of maintenance/overhauling of loco assemblies/system through OEM are of Pan- India nature. Hence, Rate contract for such maintenance/overhauling shall be finalized by Centralized Agencies like DLW/DLMW/ICF, or other agencies as nominated by Board. This will greatly help in ensuring uniformity of rates and other terms and conditions. Also, since volume will be higher, better price and terms & conditions can be negotiated with the OEM, who will find it easier to deal with one agency for contract finalization.

10.4.3 Such Rate Contracts for AMCs/Overhauling Contract should be for a period of at least 2-3 years.

10.4.4 Such Rate Contracts should be operated by Shed in-charges after getting administrative approval and sanction from CME/CMPE (for proposals of total value prescribed in the SOP) with their associate finance concurrence. Administrative approval/sanction by CME/CMPE shall be given duly considering the need for operation of rate contract, keeping in view the local conditions.

10.4.5 Each shed shall have a dedicated “Contract Management Cell” for processing and managing the contracts.

10.4.6 Contracts shall be based on the concept of minimum acceptable performance level of availability / reliability. Suitable penalty clauses shall be built into the contract in case of violation / non-achievement of the specified performance level.

10.4.7 In the system of service contract, the user (PU, a workshop or a diesel shed, for example) enters into a running contract with a service provider who refurbishes sub-assemblies or major parts for the Railways. The system is based on statistical average for refurbishment rather than on measurements of the work content in individual pieces. The contractor is expected to carry out refurbishment of assemblies given to him at fixed contract prices regardless of the actual work content in each piece. A model on these lines exists in DMW which awards works contracts for rehabilitation / refurbishing of ABB turbochargers.

10.4.7.1 In such contracts the benefit to the Railways is that it gets sub-assemblies repaired at fixed prices. It is noteworthy that the refurbished sub-assemblies come with warranty as new. It is upto the contractor to either refurbish the sub-assembly thoroughly or in some cases replace it with a new one. As far as Railways are concerned, the quality and reliability is identical in both cases.

10.4.7.2 The benefit to the contractor would be that he gets order for an assured quantity and often for a period of 2-3 years. He would, therefore, be motivated to invest in equipment and systems in his plant. The OEM of the sub-assembly is a natural candidate for such contracts though it may not be necessary in all cases.

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10.4.8 Sufficient unit exchange spares must be maintained by sheds so that sufficient quantities can be offered for overhauling and repair through outsourcing.

10.4.9 A unified computerized contract management system should be developed for close monitoring and accounting of outsourcing activity. There should be online bill submission and clearance for transparency. Also the performance and penalties of the contractors can be displayed online on diesel portal – so that effective monitoring can take place.

10.4.10 All outsourcing contracts should preferably be comprehensive, including cost of parts to be changed, both must and condition basis, so that benefit by reduction in inventory and procurement cost of material can be realized.

10.4.11 The activities outsourced by various sheds, other than those being operated on Centralized Rate Contracts, should be hosted on a common diesel portal. This will help in dissemination of information and comparison of prices for maintenance/overhauling of various activities and as well help in quick adoption of same by other sheds. This will help in achieving synergy amongst sheds, saving of time and efforts of others.

10.4.12 Outsourcing activity is meant for value addition and cost cutting in maintenance. Therefore, the advantages accrued by such outsourcing should be documented for monitoring the efficacy of the activity.

10.5 Important Points to be considered in Contract Management

10.5.1 Proposal Stage:

10.5.1.1 Justification should contain the requirement to outsource and savings to Railways by Outsourcing.

10.5.1.2 Proposal should be very clear in scope of work which needs to be outsourced.

10.5.1.3 The cost analysis should be done on the basis of open market rates, minimum wages to labour, and previous rates for similar or same contracts.

10.5.1.4 Detailed estimate should contain the costing of each individual item.

10.5.1.5 Sanction of competent authority as per SOP to the detailed estimate.

10.5.1.6 Adding of items not in the estimate at the proposal stage is very difficult once the concurrence from Finance and sanction of Executive Officer has been obtained.

10.5.2 Tendering Stage:

10.5.2.1 Prepare Tender schedule carefully

a) Think how would you carry out the work if the contract was given to you as a private person. The exact step by step procedure for carrying out any activity in the contract should be clearly understood and preferably written down in background papers. The scope of work for contractor should then be clearly defined in the tender document.

b) Think what is the expectation of Railways from the contract and what assistance will be given by Railways and what items, manpower, etc., will be under the scope of contractor. It should be clearly specified whether the supporting infrastructure required, supply of consumables, any other facility/material required will fall in scope of contractor or Railways? If the onus is on Railways to supply/provide; cost (if any) and method of cost recovery should be clearly mentioned.

c) Ideally, General Conditions of Contract should be left unchanged/untampered.

10.5.2.2 Specific requirements for a particular contract such as what work exactly is to be done, how it should be done, how the resources will be arranged, how the measurement of work will be done, what action can be taken by Railways in case of default, etc., should be listed out in detail under Special Conditions of Contract and added to the GCC separately.

10.5.2.3 The final result expected should be clearly mentioned. It should also be clearly mentioned:

a) Who will measure the result? (i.e. nominate with clear designation at suitable level- SSE, SE, JE etc)

b) Where and when will the results be measured? (i.e. location and at what stage of work completion)

c) How will the results be measured? (i.e. what are the tools/equipments required for testing the quality as well as quantity of the work done and what procedure will be followed?)

d) What shall be acceptable limit in terms of quality? (Once method of measuring quality is defined, the limits for accepting/rejecting the work should also be mentioned to avoid any ambiguity)

10.5.2.4 In most cases, a certain methodology/procedure for carrying out an activity is desired. In such cases, the methodology/procedure to be followed by the contractor for the particular activity should be clearly spelt out in the tender schedule.

10.5.2.5 Once procedure to be followed by contractor is laid down, verification is required to ensure that no shortcuts are being adopted by the contractor. To verify this, the following aspects should be clearly spelt out in tender schedule:

10.5.2.6 If the procedure calls for use of some specific consumables/materials, the specifications for that consumable/material should be clearly defined.

10.5.2.7 The frequency of testing (to verify whether material being used conforms to laid down standards) should be defined.

10.5.2.8 Who shall carry out such verification, where and how should also be clearly defined. [e.g. if a particular primer has been specified to be used in a painting activity-

a) The testing for primer coat thickness can be done only before application of paint.

b) The material composition can be found only by lab test.

c) The sample needs to be collected from a sealed tin from the lot which is in use for primer application.

d) The sample shall be collected on daily/weekly/fortnightly/monthly, etc., basis.

e) The sample shall be collected by CMS(lab)/SSE(Paint)/SE(Paint)/someone else should be clear.

f) The details of sample collected, results of sample testing etc should be recorded in a register/kept on file by CMS(lab)/SSE(Paint)/SE(Paint)/ Someone else should be clear.

g) The purchase bills with lot numbers are required to verify that primer has been purchased only from approved source (if approved source condition has been kept in tender).

h) The purchase bill verification will be done by whom? Where it will be recorded and the result will be sent to whom to ensure penal action (in case of deviation) should be clearly mentioned.]

10.5.2.9 If some parameters can be checked only at certain stage before completion of the work, provision for stage inspection should be kept in agreement. The frequency and person to carry out stage inspection should be clearly mentioned.

10.5.2.10 If some particular parameter(s) can be verified only visually, such parameters should be unambiguously specified in the schedule itself.

10.5.2.11 Clear responsibility (designation-wise) for keeping the records of such inspections/verifications should be laid down.

10.5.2.12 Also action to be taken in case any non-conformity is noticed during such inspections should be clear. (e.g. in a cleaning contract, the cleaning may be done satisfactorily, but the number of broomsticks procured and used may be less than specified in the contract. In such case, the penalty for not procuring/using the specified number of broomsticks should be clearly mentioned).

10.5.2.13 Add a clause saying that in case of conflict, Special Conditions will prevail.

10.5.2.14 Add any other relevant information to the contract document which can have an impact on execution of the contract.

10.5.2.15 Give at least 30 days notice from the date of publishing.

a) In case of urgency the notice period can be curtailed to 21 days.

b) Issue corrigendum if any corrections required in the published tender schedule.

10.5.2.16 Do not make changes in the conditions after tender has been opened.

10.5.3 Finalization Stage:

10.5.3.1 Get verification of documents, certificates, etc., from the issuing party done and keep on record.

10.5.3.2 During finalization of tender, ensure all the points that are in the mind of the committee are written in the discussion and put up to accepting authority.

10.5.3.3 Accepting authority can record his/her own reasons and direct the TC to review their decision again or can change the decision directly.

10.5.3.4 If agreed, the AA can simply accept TC recommendations.

10.5.4 Execution stage:

10.5.4.1 Ensure that person who is measuring the work is aware of all contract provisions.

10.5.4.2 Ensure that he/she is monitoring the provision as stipulated and record is kept of all such monitoring.

10.5.4.3 Records of action taken should also be kept wherever defaults are noticed.

10.5.4.4 Railway is considered as Principal Employer and all the obligations towards labour which is done by Contractor is ultimately Railway’s responsibility as per various labour Acts.

10.5.4.5 As per para 1313 of Engineering Code, Gazetted Officers should personally check at least 20% of the work done in money terms. For this purpose-

a) The responsible officer should be clearly nominated in the agreement and provision for the prescribed test checks by Officers’ should be kept as a contract clause.

b) Such checks cover the final work done in its entirety as per contract and therefore Officer should do stage inspections (if any) and verification of records also.

c) The Officer has to personally satisfy himself that the work has been done as per contract specifications and should not depend on checks by proxy.

d) The records of such checks by officers should be maintained separately apart from entries in the measurement book.

10.5.4.6 The person preparing and signing it is in essence certifying that he/she has ensured 100% of the work done and is satisfied.

10.6 Compliance of Contract Labour Act: It is important to comply with the important major provisions to be complied with by the principle employer for engaging contract labour and by the contractor as per Contract Labour (Regulation and Abolition) Act, 1970 an Rules, 1971.

10.6.1 Following is the list of major provisions for compliance by Principle Employer

10.6.1.1 Registration of establishment

10.6.1.2 Renewal of registration whenever a new contractor is added.

10.6.1.3 Ensuring availability of valid license to the contractor in case the No. of labors are more than 20.

10.6.1.4 Ensuring payment of wages to the contract labor as per the wage period.

10.6.1.5 Ensuring payment of wages as per the minimum wages act issued from time to time.

10.6.1.6 Ensuring statutory deductions like PF & ESI as per the law.

10.6.1.7 Ensure deposition of deductions made from the wages to the appropriate authorities.

10.6.1.8 Ensuring welfare & health of contract labors.

10.6.1.9 Ensuring grievance redresses machinery including imposition of penalties

10.6.1.10 Ensuring surprise inspection of the contract labors, adherence to the provision of the act.

10.6.1.11 Ensuring the maintenance of records as per the act both by principle employer as well as contractor.

10.6.1.12 Records to be maintained by Principal Employer:

a) Form I- Application for Registration of Establishments Employing Contract Labour

b) Form II- Certificate of Registration
c) Form III- Register of Establishments
d) Form V- Form of Certificate by Principal Employer
e) Form VIB- Notice of Commencement / Completion of Contract Work
f) Form VIII- Application for Temporary Registration of Establishments Employing Contract Labour
g) Form IX- Temporary Certificate of Registration
h) Form XII- Register of Contractors
i) Form XXV- Annual Return of Principal Employer to be sent to the Registering Officer

10.6.2 Following is the list of major provisions for compliance by the Contractor:

10.6.2.1 Form IV-Application for License
10.6.2.2 Form VA- Application for Adjustment of Security Deposit
10.6.2.3 Form VI- Government of India Office of Licensing Officer (License Certificate)
10.6.2.4 Form VIA- Notice of Commencement / Completion of Contract Work
10.6.2.5 Form VII- Application for Renewal Of License
10.6.2.6 Form X- Application for Temporary License
10.6.2.7 Form XI- Office of the Licensing Officer
10.6.2.8 Form XIII- Register of Workmen Employed by Contractor
10.6.2.9 Form XIV- Employment Card
10.6.2.10 Form XV- Service Certificate
10.6.2.11 Form XVI- Muster Roll
10.6.2.12 Form XVII- Register of Wages
10.6.2.13 Form XVIII- Form Register of Wages - Cum- Muster Roll
10.6.2.14 Form XIX- Wage Slip
10.6.2.15 Form XX- Register of Deductions for Damage or Loss
10.6.2.16 Form XXI- Register of Fines
10.6.2.17 Form XXII- Register of Advances
10.6.2.18 Form XXIII- Register of Overtime
10.6.2.19 Form XXIV- Return to be sent by the Contractor to the Licensing Officer

10.6.3 Shed in-charges should ensure that these provisions are fully complied with.

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Chapter 11

Cost & Expenditure Control

11. COST & EXPENDITURE CONTROL-1

11.1 Importance of Cost & Expenditure Control:

11.1.1 Railways are the principal mode of transport in the country. The adequacy, efficient maintenance and optimal functioning of the fleet of Rolling Stock are, therefore, the pre-requisites to the effective role of Railways as a Public Carrier. In a shed, locomotive management is a crucial function in the quest for efficiency and profitability in operations.

11.1.2 For 2011-2012, the Plan outlay of Indian Railways was Rs. 1, 01,760.98 crore. Of this, the outlay on rolling stock was Rs. 30,560.22 crore (30.03 per cent) of which the outlay on locomotives was Rs. 12,630.27 crore (41.33 per cent). Thus, prudent financial management of assets is a much desired necessity.

11.2 Financing of Railway's Plan Expenditure: The Railway's plan expenditure is financed from: Out of the budgetary support received from the General Exchequer, internally generated resources and market borrowings through IRFC, loans raised specifically for Railway purposes i.e. Specific Debts.

11.3 Demands for grants:

The proposals of Railways in respect of amount required to meet the expenditure of the year is submitted in the form of Demands to the Parliament and on receipt of vote of Parliament is known as the Grant. The budget presented to Parliament contains the following demands-

Demand No.	Description of Demand
1	Railway Board
2	Miscellaneous Expenditure (General)- consisting of Research, Audit and Misc. Charges
3	General Superintendence& services (Abstract 'A')
4	Repairs and Maintenance of Way and Works(Abstract 'B')
5	Repairs and Maintenance of Motive Powers(Abstract 'C')
6	Repairs and Maintenance of Carriage and Wagons. (Abstract 'D')
7	Repairs and Maintenance of Plants and Equipment. (Abstract 'E')
8	Operating Expenses Rolling Stock and Equipment (Abstract 'F')
9	Operating Expenses Traffic (Abstract 'G')
10	Operating Expenses Fuel (Abstract 'H')
11	Staff Welfare & Amenities, Medical (Abstract 'J')
12	Misc. working expenses, RPF payments (Abstract 'K')
13	PF, Pension & other retirement benefits.(Abstract 'L'), N-Suspense
14	Appropriation to Funds (Abstract 'M')

Demand No.	Description of Demand
15	Dividend to Genl. Revenue, repayment to loans
16	Asset Acquisition and Replacement

11.4 **<u>Plan Heads under Demand No 16</u>**: Investments for creation, acquisition and replacement of assets on the Railways are processed under various plan heads under Demand 16. The plan heads which have a direct bearing in the sheds and workshops are as below-

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Plan Head	Description
21	Rolling stock
41	Machinery and Plant
42	Workshops including production units

11.4.1 **<u>Rolling Stock Programme (RSP)-Plan Head-21:</u>**

Rolling Stock Programme is of two types: Bulk RSP - which is sanctioned by Railway Board for the entire Railway or more than one Railway and Itemized RSP- which is sanctioned for the individual Zonal Railways on the basis of the proposals sent by the respective Zonal Railways.

11.4.1.1 **Bulk RSP:** Requirements in a Rolling Stock programme are derived as a follow up of the five year plans and indicate the projected requirements of rolling stock like diesel locos, wagons, coaches, etc. which need to be manufactured or indented to meet the projected targets. RSP is generally dealt at the Railway Board's level. It also include midlife rehabilitation, modernization/upgradation of rolling stock and Unit Exchange spares requirement.

11.4.1.2 **Itemized RSP:** The itemized rolling stock programme can also contain such capital spares for rolling stock costing more than the limit specified for an item which are to be manufactured/procured by Zonal Railways themselves. This programme also caters to major modifications to be carried out on the rolling stock. e.g. sanction of upgraded compressors, bogie frames, etc. IRSP proposals are framed by individual sheds, vetted by associate finance and submitted to respective HODs of Zonal Railway HQ. At Zonal Railway HQ the proposals received are scrutinized and submitted to FA&CAO(S&W) for concurrence after obtaining approval of CME. The consolidated concurred proposals are submitted to Board by CWE, who is coordinating officer in HQ, after obtaining sanction of GM. The proposals should reach Board by 15^{th} September of the year, which precedes the year to which the programme relates. At Railway Board's level these proposals are scrutinized, finance concurrence and approval of competent authority taken. The approved proposals are reflected in the Pink Book of the subject year.

11.4.2 **<u>Machinery and Plant (M&P) Programme- Plan Head-41:</u>**

For carrying out maintenance work successfully it is important that sheds have all the necessary Machinery & Plant. The M&P program is dealt at two levels: Board and Zone. Items costing more than 10 lakhs each for Zonal Railway and 30 lakhs each for PUs and above and all road vehicles, irrespective of their cost, have to be submitted to Railway Board for sanction. For items costing less than 10 lakhs (with the exception of few items costing more than 10 lakhs like in-motion weigh bridges which can also be processed at Zonal Level, as specified from time to time by Railway Board), proposal is to be processed at Zonal Level.

11.4.2.1 **M&P proposals at Board Level**: All such proposals are sent by unit in-charges with associated finance concurrence to CME(Plg.). After CME's approval and HQ finance concurrence, the proposals are submitted to Railway Board by CME(Plg.) for sanction through M&P portal. For M&P proposals costing Rs.1 crore and above, prior approval of Railway Board is necessary. The M&P at Board's level costing above Rs.2.5 crores is published in the Pink Book and for less than Rs.2.5 crores a separate list is issued by DME(PU), Rly Board. Normally, for M&P above Rs.30 lakhs and few specific machines below Rs.30 lakhs (as per list notified by COFMOW), the procurement is done by COFMOW. However, in some particular cases the Zonal Railway may seek dispensation for procurement through COFMOW, giving due justification for doing so.

11.4.2.2 **M&P proposals at Zonal Level (Lump Sum M&P-LSMP):** All such proposals are sent by unit in-charges with associated finance concurrence to CME/ CME(Plg.). CME is the nodal in-charge for all Departments to sanction M&P items within the ceiling limit conveyed by Railway Board. After review of the submitted proposals and discussion with concerned PHODs/HODs, CME sanctions the proposals, which are published in Law Book.

11.4.2.3 The utilization and allotment of funds for various items in M&P is also coordinated by CME/CME(Plg.).

11.4.2.4 M&P proposals can be initiated under DRF, Capital, DF-III or OLWR allocations.

11.4.3 <u>Workshops and Sheds-Plan Head -42</u>

Investments in maintenance /infrastructure buildings in a shed are made under plan head 42. CME is the nodal officer for all proposals under plan head 42 from all departments. The proposals under Plan Head 42 are sanctioned at three levels, as under:

(i) Board level which is sanctioned by Railway Board (Preliminary Works Program-PWP)

(ii) Zonal level (Lump Sum Works Program- LSWP) which is sanctioned by GM for works costing upto Rs. 1 Crore

(iii) Divisional Level (Lump Sum Works Program- LSWP) which is sanctioned by DRM for works costing upto Rs. 5 lakhs

11.4.3.1 **Works under PWP:** For works under PWP, proposals are to be submitted by field units with associated finance concurrence and DRM approval to CME/CME(Plg.). Afterwards, the proposals are reviewed by CME and important proposals are shortlisted. Prior approval of Board is required for works costing more than Rs.5 crores. Afterwards, a meeting is held by GM with all PHODs for shortlisting of new works for onward submission to Railway Board, with finance concurrence, for sanction. This list of sanctioned works is published in Pink Book.

11.4.3.2 **Works under Zonal LSWP:** For works under Zonal LSWP, proposals are to be submitted by field units with associated finance concurrence and DRM approval to CME/CME(Plg.). Afterwards, the proposals are reviewed by CME and important proposals are shortlisted. Afterwards, a meeting is held by GM with all PHODs for sanction of new works in which only the shortlisted proposals are discussed and important ones are sanctioned, with finance concurrence, within the ceiling limit conveyed by Railway Board. This list of sanctioned works is published in law book.

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11.4.3.3 **Works under Divisional LSWP:** For works under divisional LSWP, proposals are to be submitted by field units to Sr.DEN(Co). Afterwards, the proposals are reviewed by DRM and important proposals are shortlisted. Afterwards, a meeting is held by DRM with all Branch Officers for sanction of new works in which only the shortlisted proposals are discussed and important ones are sanctioned, after finance concurrence, within the ceiling limit conveyed by Railway Board. The list of such sanctioned works is published in LSWP booklet published by the division.

11.5 Expenditure under revenue Demand No.4B-431: This is the expenditure unit for charging the expenditure towards repair, upkeep and maintenance of Workshops, Diesel sheds, Coaching depots, Stores depot. Adequate use of funds under this demand should be made for keeping the field units in good fettle.

11.6 <u>Different Stages of Budget:</u>

Stage -1	**Original Grant:** Distribution of Funds by the Railway Board-The Grants as voted by the Parliament and the appropriation for the charged expenditure as sanctioned by the President are distributed by the Railway Board among the railway administrations and other authorities subordinate to them, as soon as possible, after the Budget is sanctioned. The sums so distributed are called "Allotments" and the orders by means of which the allotments are made are called "Budget Orders". The allotments made out of funds voted by the Parliament are shown as "Voted" and those fixed by President are shown as "Charged". The Budget Orders are accompanied by the final issue of "Demands for Grants" and “Works, Machinery and Rolling Stock Programme" containing the detailed distribution of the Budget allotment made to the railway administrations for working expenses and Capital, Depreciation Reserve Fund, Development Fund, Open Line Works (Revenue) and Accident Compensation, Safety and Passenger Amenities Fund expenditure. The Budget allotment made to a railway administration is intended to cover all charges, including the liabilities for past years, to be paid during the year or to be adjusted in the accounts for it. It shall be operative until the close of the financial year.
Stage -II	**August Review**: in the month of August- Railway Administration should review their expenditure in August to see whether any modifications are

	necessary in the allotments placed at their disposal. The review in respect of each grant should be submitted, to the Railway Board in form No. F-383 so as to reach them not later than 1st September each year.
Stage-III	**Revised Estimate:** in the month of November (plus budget estimate for the next year)-This statement should be realistically prepared and requirements of funds projected carefully taking into account the likely supply date. In other words projection should be made only for those items which are expected to be received/commissioned before 31st March. It also gives a half yearly trend on utilization of the allotted budget. Any surrender/excess requirement should be reflected now. The revised estimate for the current year and the budget-estimate for the next year should be fixed after taking into account the expenditure of the previous year and comparing the expenditure during the first seven months of the year with the corresponding period of the previous year. Explanation of variations -A brief narrative explanation should be given of the causes (with amounts involved in each case) of substantial differences between the figures adopted for the revised estimate of the current year and (i) the actuals of the previous year, and (ii) budget allotment for the current year. Similar explanation should be given for differences between the figures of the budget estimate of the ensuing year and the revised estimate of the current year. Large variations which compensate each other should also be indicated. When the expenditure anticipated in the last five months of the year is disproportionate as compared with (i) the first seven months of the year or (ii) the corresponding period of the previous year, reasons for the disproportionate expenditure should be given in the revised estimate. Special and non-recurring items of expenditure in a year should show a corresponding saving in the following year. Likewise, when transfers are made from one demand to another.
Stage-IV	**Final Modification**: in the month of February-The Railway Board should be furnished, for each grant separately, so as to reach them not later than the 21st February each year, statements showing the additional allotments required (both voted and charged) or surrenders to be made, during the current financial year under each head of appropriation, as prescribed in the budget orders, and requiring the sanction of the President. The variations between the final modified allotments required and the revised estimates as fixed by the Board should in all cases be supported by adequate explanations of the reasons for the demand or surrender. This will give an even more realistic utilization of funds allotted and based on this statement 'Final Grant' will be allotted to the Railways. FM is projected in such a way that it almost corresponds to the actuals booked for that year and would have little or no variation.
Stage-V	**Final Review:** The railways should, however, continue to review the budgetary position further after submission of the Final Modification statements and any modification that may be considered necessary as a result of new factors visualized and the further review of budgetary position should be advised telegraphically to the Board so as to reach

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	them before the 20th March of the year, to enable the President to accord sanction to them, where possible, so that the Railway Administrations may sanction in time, before the 31st March of the year, any re-appropriations to cover the anticipated excess over allotments.
Stage -VI	**Appropriation Bill** -Pursuant to Article 114 (1) of the Constitution, after the Demands for Grants have been voted by the Lok Sabha, there shall be introduced a Bill to provide for the Appropriation out of the Consolidated Fund of India of all money required to meet the grants so made by the Lok Sabha and the expenditure, if any, charged on the Consolidated Fund of India, but not exceeding in any case the amount shown in the Statement previously laid before the Parliament. The Appropriation Bill as passed by the Parliament and assented to by the President forms the basis for budgetary allocation to the Railways.

11.7 Head of Allocation in Budget

Engineering code elaborates on the various stages of investment planning, Works programme and Budgeting. Broadly, expenditure for works of mechanical department is booked under different heads as below-

11.7.1 Allocation-Capital

Works that yield a ROR of 14% and above are charged under CAP. Since funds are borrowed from open market, utmost care needs to be taken to ensure that the returns are obtained.

11.7.2 Allocation-DRF

Works initiated for replacing old assets after completion of their codal life are charged against DRF.

11.7.3 Allocation-Development Fund

Works which are for developing/ augmenting of some existing facilities is proposed under DF. There are four subheads under DF. Mechanical department works generally fall under DF-III.

11.7.4 Allocation-OLWR

These are called open line works and are under Revenue. Small/petty works costing upto Rs.10 lakhs come under OLWR.

11.7.5 Control over Expenditure

11.7.5.1 The expenditure on Railways is either Capital or Revenue in nature. The control over expenditure incurred over these heads involves two aspects:

a) Control with reference to Sanctions i.e. Delegation of powers to GM and others & Canons of financial propriety.

b) Control over actual expenditure incurred/booked in the books of Railways-In order to keep watch on the expenditure incurred on revenue heads, it is monitored through maintenance of Revenue Allocation Register, duly recording the transactions for each abstract(A to M) so as to inform the spending authorities the progress of expenditure against the allotments.

c) As far as Works expenditure is concerned, the control over expenditure under Grant 16 is exercised through the Works Registers where the running comparison between the actual expenditure and budgetary allotments and between actual expenditure and estimated cost of work as shown in Pink book is monitored.

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d) Control over stores transactions are managed through Fund Register and Expenditure register.

e) Apart from above, FA&CAO also reviews the progress of expenditure in respect of Working Expenses, Capital, DRF, DF, SRSF through monthly reviews and the same is apprised to GM in the shape of financial review for the whole Railway

11.7.5.2 After close of financial year's account, the statements prepared by the Railway administrations for each grant are submitted to Public Accounts Committee through Railway Board, comparing the figures of actual expenditure with that of Grants voted by the Parliament and appropriations sanctioned by the President and also comparison of actual expenditure with that of Final Grants, explaining the variations of Excess/ savings beyond the permissible limits, are known as Appropriation Accounts.

11.7.5.3 The overall objective of this exercise is to keep watch over the progress of expenditure and earnings and to monitor Govt. ways & means with due diligence on budgetary support & pace of expenditure by observance of rules & policy decisions taken for planning, implementation, execution and management of Railway earnings and expenditure at appropriate level, maintaining the growth of economy & development with limited means of public money judiciously.

11.8 Classification of Expenditure

11.8.1 The revenue working expenses of Railways are classified into 13 abstracts each with separate minor heads. The minor heads are divided into main heads, sub-heads and detailed heads. Classification upto the detailed head represents the activity. This structure also incorporates a two digits code to represent object of expenditure incurred, such as salary. The revised classification system envisage an alpha numeric coding scheme comprising of the components indicating abstract of expenditure, activity of work and object of the expenditure, respectively as under

CLASSIFICATION OF REVENUE EXPENDITURE		
Demand No. 5-Abstract 'C' Repairs and Maintenance of Motive Power		
Minor Heads	**Sub-Heads**	**Detailed Heads**
100 Establishment in	110 Officers and office establishment	111 Officers-Mechanical. 112 Officers-Ferry services.

CLASSIFICATION OF REVENUE EXPENDITURE		
Demand No. 5-Abstract 'C' Repairs and Maintenance of Motive Power		
Minor Heads	**Sub-Heads**	**Detailed Heads**
offices.	(Mechanical).	113 Administrative Office Establishment-Steam 114 Administrative Office Establishment-Diesel 115 Administrative Office Establishment-Ferry
	120 Supervisory staff and their office staff (Mechanical)	121 Subordinate supervisory staff-Steam. 122 Subordinate supervisory staff-(Diesel). 123 Office staff-Steam. 124 Office staff-(Diesel) 125 Subordinate supervisory staff-Ferry. 126 Office staff-Ferry.
	130 Contingent and Laboratory expenses (Mechanical)	130 Same.
	140 Officers and office Establishment (Electrical)	141 Officers (Workshop). 142 Officers (Open Line). 143 Office Establishment (Workshop). 144 Office Establishment (Open Line).
	150 Supervisory staff and their office staff (Electrical)	151 Supervisory staff (Workshop). 152 Supervisory staff (Open line). 153 Office staff (Workshop). 154 Office staff (Open Line).
	160 Contingent expenses (Electrical)	160 Same.
		Diesel Electrics
300 Diesel Locomotives	310 Running repairs in sheds.	311 Body bogie and brake rigging. 312 Traction motors and other electrical rotating machines. 313 Engine. 314 Compressors and exhausters.
		Diesel Hydraulics-
		315 As in 311. 316 Transmission equipment. 317 As in 313. 318 As in 314.
	320 Running repairs done in workshops for sheds.	321 to 328 as in 311 to 318.
	330 Periodic overhauls.	331 to 338 as in 311 to 318.
	340 Intermediate overhauls	341 to 348 as in 311 to 318.

CLASSIFICATION OF REVENUE EXPENDITURE		
Demand No. 5-Abstract 'C' Repairs and Maintenance of Motive Power		
Minor Heads	**Sub-Heads**	**Detailed Heads**
	350 Special repairs.	351 to 358 as in 311 to 318.
	360 Other repairs	361 Control, cables and other running repairs-Diesel Electrics. 362 Control and cables and other running repairs done in workshop for sheds-Diesel Electrics. 363 Control and cables and other repairs-Periodical overhaul- Diesel Electrics. 364 Control and cables and other repairs-for intermediate overhaul-Diesel Electrics. 365-368 Same as 361 to 364 for Diesel Hydraulics.
	370 Miscellaneous charges including adjustments.	371 to 374 Diesel Electrics-Same as for 272 to 275. 375 to 378 Diesel Hydraulics-Same as for 272 to 275.

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11.8.2 Other Demand Heads for booking of Expenditure in Diesel Loco/DEMU sheds

11.8.2.1 **Demand No. 6 D-** all expenditure related to maintenance of DEMU is to be booked in this Demand head.

11.8.2.2 **Demand No.7 E-** all expenditure related to maintenance of M&P is to be booked in this Demand head.

11.8.2.3 **Demand No.8 F-** all expenditure related to operation of Diesel Locos like Lubricants, Brake Blocks, etc. (items whose consumption is directly related to quantum of running of locos) is to be booked in this Demand head.

11.8.2.4 **Demand No.10 H-** all expenditure incurred on fuelling of locos for running is to be booked in this Demand head.

11.8.2.5 **Demand No.12 K-** all expenditure related to miscellaneous working expenses (i.e. cost of training of staff, etc) is to be booked in this Demand head.

11.8.3 Primary Units for Booking of Expenditure

11.8.3.1 Different primary units have been assigned for booking of various types of expenditure in diesel sheds, as under:

Primary Unit	Description	Primary Unit	Description
PU 01	Pay	PU 22	Office utilities
PU 02	Dearness Allowance (DA)	PU 23	Rental for cable equipment other than data processing
PU 03	P.L.B (Productivity Linked Bonus)	PU 24	Printing and stationery including publications

Primary Unit	Description	Primary Unit	Description
PU 04	House Rent Allowance	PU 27	Stock items
PU 07	Transport Allowance	PU 28	Direct purchase (Non-stock items)
PU 11	Over Time	PU 32	Contractual payments
PU 12	Night Duty Allowance	PU 33	Transfer of Debits/Credits (from Workshops, PUs, etc.)
PU 14	Honorarium	PU 34	POH wages
PU 15	Transfer Allowance	PU 35	Material for POH
PU 16	Travelling Allowance	PU 36	Excise Duty
PU 20	Leave Encashment	PU 37	Customs
PU 42	MACP Arrears	PU 38	Sales Tax
PU 43	DA Arrears	PU 41	VAT
PU 44	Miscellaneous arrears	PU 50	Procurement of computers
PU 18	Office expenditure	PU 51	Consumables for computers
PU 19	Phones	PU 99	Miscellaneous expenses
PU 21	Advertisements		

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11.8.4 **Final Allocation for Booking of expenditure:**

Final allocation for booking of expenditure consist of: Demand No. (first two digits), Detailed Head (three digits) and Primary Unit (two digits) e.g. 05-312-28.

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Chapter 12

Reliability Centered Maintenance

12 RELIABILITY CENTERED MAINTENANCE

12.1 Concept of Reliability Centered Maintenance:

Reliability Centered Maintenance (RCM) can be defined as "an approach to maintenance that combines reactive, preventive, predictive, and proactive maintenance practices and strategies to maximize the time (life) during which an equipment functions in the required manner." RCM strives to create an optimal mix of an intuitive approach and a rigorous statistical approach to decide as to how to maintain an asset.

12.2 Reactive Maintenance:

Reactive maintenance is referred to by many different names viz: breakdown maintenance, repair, fix-when-fail, and run-to-failure (RTF) maintenance. When applying this maintenance strategy, a component receives maintenance (e.g. repair or replacement) only when the deterioration of the component's condition causes a functional failure. The major disadvantage of reactive maintenance is unexpected and unscheduled downtime. If a component fails and repair parts are not available, delays ensue while the parts are arranged. If these parts are urgently required, a premium for expedited delivery would need to be paid. If the failed part is no longer manufactured or stocked, more drastic and expensive actions are required to restore Locos like cannibalization of component from another loco or using an alternate component which may sometimes not meet the requirement. However, it can be effective if used selectively and performed as a conscious decision based on the results of an RCM analysis which compares the risk of failure with the cost of the maintenance required to mitigate that risk and cost of failure.

12.3 Preventive Maintenance (PM):

PM consists of regularly scheduled inspection, adjustments, cleaning, lubrication, parts replacement, calibration, and repair of components and equipment. PM is also referred to as time-driven or calendar-based maintenance. It is performed without regard to equipment condition or degree of use. PM schedules periodic inspection and maintenance at pre-defined intervals (intervals based on time, operating hours) in an attempt to reduce equipment failures for susceptible equipment. Depending on the intervals set, PM can result in a significant increase in inspections and routine maintenance; however, it would reduce the seriousness and frequency of unplanned failures for components with defined, age-related wear patterns. Failure rate or its reciprocal, Mean-Time-Between-Failure (MTBF), is often used as a guide to establish the interval at which the maintenance tasks should be performed. The major weakness in using such measurements to establish task periodicities is that failure rate data helps to determine only the average failure rate whereas in reality failures are equally likely to occur at random times and with a frequency unrelated to the average failure rate. Thus, sometimes selecting a specific time to conduct periodic maintenance for a component which has a random failure pattern is quite difficult.

12.4 Condition Monitoring (CM):

Condition monitoring, also known as predictive maintenance, uses nonintrusive testing techniques, visual inspection, and performance data to assess components' condition. It replaces arbitrarily timed maintenance tasks with maintenance scheduled only when warranted by condition. A continuing analysis of component condition monitoring data allows planning and scheduling of maintenance or repairs in advance of catastrophic and functional failure e.g. the use of Remmlot feedback to schedule maintenance activities, spectrographic analysis being conducted in sheds for lubricating oil to predict wear patterns of bearings, etc.

12.5 Proactive Maintenance:

A proactive maintenance program is the capstone of RCM philosophy. It provides a logical culmination to other types of maintenance approaches described above (reactive, preventive, or predictive). Proactive maintenance improves maintenance through better design, installation, maintenance procedures, workmanship and scheduling.

Proactive maintenance is characterized by the following attributes:

- ❖ Maintaining a feedback loop from shed to designers, in an attempt to ensure that design mistakes made in the past are not repeated in future designs.
- ❖ Viewing maintenance and supporting functions from a life-cycle cost perspective. (This perspective may show that cutting maintenance activities to save money in the short term often costs more money in the long term)
- ❖ Constantly re-evaluating established maintenance procedures in an effort to improve them and ensure that they are being applied in the proper mix.

12.6 RCM Analysis:

RCM analysis carefully considers the following questions:

- What does the system or equipment do?
- What functional failures are likely to occur?
- What are the likely consequences of these functional failures?
- What can be done to prevent these functional failures?

To implement RCM, it is imperative that the maintenance personnel think about the components provided on a loco in terms of its function. That means thinking about components in terms of systems, subsystems, and subcomponents.

12.7 Principles of RCM:

The primary principles of RCM are:

12.7.1 <u>RCM is concerned with maintaining System Functionality</u>- RCM seeks to preserve system or equipment function, not just to maintain a piece of machinery's operability for operability's sake. It should be noted that a common strategy is to maintain system function through equipment redundancy. Though equipment redundancy improves functional reliability but increases system life cycle cost (due to increased first cost of installing the redundant equipment). The increased life cycle cost of installing redundant equipment often eliminates its redundancy cost as an RCM method of providing system reliability.

12.7.2 RCM is System Focused- It is more concerned with maintaining system function than individual component function. The question asked continually is: "Can this system still provide its primary function if a component fails?" (In this example, if the answer is "yes," then the component is allowed to run to failure)

12.7.3 RCM is Reliability Centered- RCM treats failure statistics in an actual manner. The relationship between operating age and failures experienced is important. RCM is not overly concerned with simple failure rate; it seeks to know the conditional probability of failure at specific ages (the probability that failure will occur in each piece of equipment).

12.7.4 RCM Recognizes Design Limitations. -The objective of RCM is to maintain the inherent reliability of the system function. A maintenance program can only maintain the level of reliability inherent in the system design; no amount of maintenance can overcome poor design. This makes it imperative that maintenance knowledge be fed back to designers to improve the next design. RCM recognizes that there is a difference between perceived design life (what the designer thinks the life of the system is) and actual design life.

12.7.5 RCM is Driven by Safety First, then Economics. -Safety must be maintained at any cost; it always comes first in any maintenance task. Hence, the cost of maintaining safe working conditions is not calculated as a cost of RCM. Once safety on the job is ensured, RCM assigns costs to all other activities.

12.7.6 RCM Defines Failure as an Unsatisfactory Condition- Here failure is defined as a loss of acceptable product/service quality level or failure is defined as a function of not being maintained.

12.7.7 RCM Tasks Must Produce a Tangible Result. - The tasks performed must be shown to reduce the number of failures or at least to reduce the impact of damage due to failure.

12.7.8 RCM Recognizes Four Maintenance Categories and Uses Logic Tree to Screen Maintenance Tasks- This approach ensures consistency in determining how to perform maintenance on all types of facility equipment. Each piece of equipment is assigned to one of four categories:

12.7.8.1 Run-to-Failure - Under an RCM program, run-to-failure is a conscious decision reached after analysis of what facility function(s) would be affected by system failure versus the (life cycle) cost of preventing failure.

12.7.8.2 Calendar-Based Maintenance (PM) - This is the most basic approach. It schedules tasks based on the time since that task was last performed. It is the type of maintenance most often performed in Preventive Maintenance programs.

12.7.8.3 Condition Monitoring (CM) - This maintenance is performed based on predictivetesting and inspection. Real-time data is gathered and analyzed as a way to determine when a piece of equipment requires maintenance.

12.7.8.4 Proactive Maintenance - Efforts in this area of a maintenance program are aimedat applying the lessons learnt from past maintenance experience to future situations. This includes writing better specifications, precision rebuild, failed part analysis, and root-cause failure analysis.

12.8 RCM is an Ongoing Process-

This is one of the most important characteristics of RCM. No maintenance procedure can escape review. Maintenance personnel gather data from the successes/failures achieved and feed this data back to improve future maintenance procedures and design of new systems. This feedback loop is an essential part of the RCM process. This includes: changing old equipment specifications that have been proven inadequate or incorrect, rebuilding worn/failed equipment to better resist failures, performing failed-part analysis, and performing root-cause failure analysis.

12.9 The RCM Process-

The basic steps in developing a formal RCM analysis are:

12.9.1 Define the major systems and components. The user defines the systems. Where systems are extremely complex and this complexity makes analysis difficult, the user may opt to define subsystems as a means of organizing the problem into manageable pieces.

12.9.2 For each system, define all "functions" of that system.

12.9.3 For each of those functions, define the possible "functional failures" that could occur (i.e., what could go wrong that would prevent the system function from occurring).

12.9.4 For each functional failure, define all possible "failure modes" (i.e., each equipment failure which could be the cause of a functional failure).

12.9.5 For each failure mode, state whether it would be due to improper operation, improper maintenance, or both.

12.10 RCM Benefits:

12.10.1 **<u>Reliability-</u>** The primary benefit of RCM is to improve equipment reliability. This improvement comes through constant reappraisal of the existing maintenance program and improved communication between maintenance supervisors/shed, maintenance mechanics, designers, and equipment manufacturers. This improved communication creates a feedback loop from the maintenance staff/shed in the field all the way to the equipment manufacturers.

12.10.2 **<u>Cost</u>**- Due to the initial investment required to obtain the technological tools, training, equipment condition baselines, a new RCM program typically results in a short-term increase in maintenance costs .The increase is relatively short-lived. The cost of reactive maintenance decreases as failures are prevented and preventive maintenance tasks are replaced by condition monitoring. The net effect is reduction of reactive maintenance and a reduction in total maintenance costs.

12.10.3 **Scheduling**- The ability of a condition monitoring program to forecast certain maintenance activities provides time for planning, obtaining replacement parts, making the necessary logistical arrangements (i.e., notifying occupants of equipment downtime) before the maintenance is executed. RCM reduces the unnecessary maintenance performed by a calendar-based preventive maintenance program, which tends to err consistently on the "safe" side in determining time intervals between maintenance tasks.

12.10.4 **Equipment/Parts Replacement**- It obtains the maximum use from the equipment. With RCM, equipment replacement is based on equipment condition, not on calendar. This condition based approach to maintenance extends the life of the facility and its equipment.

12.10.5 **Efficiency/Productivity**- Safety is the primary concern of RCM. The second most important concern is cost-effectiveness. Cost-effectiveness takes into consideration priority or mission criticality and then matches a level of cost appropriate to that priority. The flexibility of the RCM approach to maintenance ensures that the proper type of maintenance is performed when it is needed. Maintenance that is not cost-effective is identified and not performed.

In summary, the multi-faceted RCM approach promotes the most efficient use of resources. Equipment is maintained as required by its characteristics and the consequences of its failures.

12.11 RCM on a Life Cycle

RCM must be considered throughout the life cycle of a component if it is to achieve maximum effectiveness. The four recognized major phases of an equipment's life cycle are:

- Planning
- Design
- Manufacture
- Operations and Maintenance.

Planning and Design stages contribute to the maximum costs in a components life cycle cost.

12.12 Use of Reliability Centered Maintenance by RDSO:

12.12.1 As stated earlier, data collection of failures of the components with reasons thereof, is the core activity of the Reliability Centered Maintenance. For this purpose, RDSO has made a four digit codification of component failures as per which users (Zonal Railways) have to submit information of components failures regularly to

RDSO. On the basis of this information received, analysis is done and RDSO publishes a Quarterly Report in which action to be taken for improving reliability is defined. This four digit codification is explained in brief for both, Alco and HHP locos below:-

12.12.2 Diesel Loco Defect Codification for Management Information System for ALCO locos issued vide Report No.MP-1406/87 (Revision-02) of October-2010-This codification system has been developed to facilitate collection of information from Railways about defects in Alco Diesel Locos. The data as received from zonal railways is analyzed to identify deficiencies in design stage, manufacturing and maintenance system of loco and to strategize the proposed areas for improvement. A complete cycle of feedback helps to improve reliability in the loco with appropriate inputs planned at various stages of the life cycle. The system calls for reporting on the following parameters-

S.No	Parameter Number	Description
1	**1**	Zonal Railway details have to be filled in
2	**2**	Diesel Shed details have to be filled in
3	**3**	Type of Loco viz.WDM2,WDM3D etc. has to be filled in
4	**4**	Loco number has to be filled in
5	**5**	Date of occurrence of defect has to be advised
6	**6**	Whether design change is required or not, has to be indicated. Say ‘Yes’, ‘No’ or ‘-’ indicating that Railway has no comment to offer
7	**7**	Whether Manufacturing method needs improvement, has to be indicated Say ‘Yes’, ‘No’ or ‘-’ indicating that Railway has no comment to offer
8	**8**	Whether Maintenance system needs improvement, has to be indicated Say ‘Yes’, ‘No’ or ‘-’ indicating that Railway has no comment to offer
9	**9**	This defect codification is to be used to identify the four Digit code for the defects’ location and its nature 1st digit indicates the main assembly involved. 2nd digit indicates the sub assembly involved 3rd digit indicates the sub assembly/component specified by first two digits. 4th digit indicates the nature of defect on the sub assembly/component specified by first three digits.
10	**10**	Remarks, if any, to be given

12.12.3 **Diesel Loco Defect Codification for Management Information System for HHP locos issued vide Report No.MP.MISC.270 (Revision-00) of March-2011**-This codification system has been developed to facilitate collection of information from Railways about defects in HHP Diesel Locos. The data as received from zonal railways is analyzed to identify deficiencies in design stage, manufacturing and maintenance system of loco and to strategize the proposed areas for improvement.

Complete cycle of feedback helps to improve reliability in the loco with appropriate inputs planned at various stages of the life cycle. The system calls for reporting on the following parameters-

S.No	Parameter Number	Description
1	**1**	Zonal Railway details have to be filled in
2	**2**	Diesel Shed details have to be filled in
3	**3**	Type of Loco viz. WDG4, WDP4, WDP4B, WDP4D, etc., has to be filled in
4	**4**	Loco number has to be filled in
5	**5**	Date of occurrence of defect has to be advised
6	**6**	Whether design change is required or not, has to be indicated. Say ‘Yes’, ‘No’ or ‘-’ indicating that Railway has no comment to offer
7	**7**	Whether Manufacturing method needs improvement, has to be indicated Say ‘Yes’, ‘No’ or ‘-’ indicating that Railway has no comment to offer
8	**8**	Whether Maintenance system needs improvement, has to be indicated Say ‘Yes’, ‘No’ or ‘-’ indicating that Railway has no comment to offer
9	**9**	This defect codification is used to identify the four Alphabet code for the defects’ location and its nature 1st Alphabet indicates the main assembly involved. 2nd Alphabet indicates the sub assembly involved 3rd Alphabet indicates the sub assembly/component specified by first two alphabets. 4th Alphabet indicates the nature of defect on the sub assembly/component specified by first three alphabets.
10	**10**	Remarks, if any, to be given

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Chapter 13

Technological Advancements

13. TECHNOLOGICAL ADVANCEMENTS

13.1 Induction of Diesel Locos on Indian Railways after Independence-Chronology

13.1.1 1950-1960: Introduction of Diesel Traction

13.1.1.1 WDM1: Diesel traction was introduced on the Indian Railways with the import of ALCO locos in 1957. These were classified as WDM1. The salient features are:

- Year introduced: 1957
- Bogie configuration: Co-Co
- Axle load: 18.6t
- 1950 bhp, 12-cylinder 4-stroke turbo super charged diesel engine
- Maximum Tractive Effort: 27.9t
- Maximum Speed: 104 kmph
- DC-DC transmission
- Single cab design

13.1.2 1960-1970

13.1.2.1 WDM2: Following WDM1 was the WDM2 class of loco, which was introduced in 1962. Forty of these locos were imported as kits which were assembled at the Diesel Loco Works, Varanasi, which was setup for manufacturing these locos under a transfer of technology agreement**.**

The WDM2 was mass produced and become the workhorse for the Indian Railways. Many improvements and innovations were made on this class of loco for performance enhancement over the years.

The salient features are:

- Year introduced: 1962
- Bogie configuration: Co-Co
- Axle load: 18.8t
- 2600 bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- DC-DC transmission
- Maximum Tractive Effort: 30.45t
- Maximum Speed: 120 kmph
- Single cab design

13.1.2.2 **WDM2A & WDM2B:** These are the technical variants of WDM2.

a) **WDM2A:** WDM2s rebuilt to feature Air Brakes. The initial ones had dual brakes.

b) WDM2B: WDM2s having Air Brakes as standard equipment. Only some were classified so.

13.1.2.3 **WDM4:** Indian Railways also purchased General Motors, Electro-Motive Division locos in the year 1962 which were classified as WDM4. A total of 72 units were bought. GM-EMD did not agree to a transfer of technology, effectively stopping further proliferation of this class of locos.

WDM-4

- Year introduced: 1962
- Bogie configuration: Co-Co
- Axle load: 18.8t
- 2600bhp, 16-cylinder 2-stroke turbo super charged diesel engine
- DC-DC transmission
- Maximum Tractive Effort: 28.2t
- Maximum Speed: 120 kmph
- Single cab design

13.1.2.4 **WDM3:** Only 8 Locos were imported from M/s Henschel. They were having hydraulic transmission.

- Year introduced: 1970
- Bogie configuration: B-B
- 2300bhp, Mercedes Diesel Engine
- Diesel Hydraulic transmission
- Maximum Tractive Effort: 22t
- Maximum Speed: 120 kmph
- Single cab design

13.1.2.5 WDM5: No Loco was designated as WDM5 on Indian Railways

13.1.3 1980-1990

13.1.3.1 WDM6: DLW built just two of these locos, which have a short centre-cab with a long hood and a short hood.

WDM-6

- Year introduced: 1982
- Bogie configuration: Bo-Bo
- Axle load: 17.3 t
- 1350bhp, 6-cylinder, inline 4-stroke turbo super charged diesel engine
- Transmission: DC-DC
- Maximum Tractive Effort: 19.2t
- Maximum Speed: 75 kmph
- Single cab design

13.1.3.2 WDM7: Fifteen of these locos were built by DLW from June 1987 to 1989. These Locos were designed for branch-line duties.

- Year introduced: 1987
- Bogie configuration: Co-Co
- Axle load: 16t
- 2000bhp, 16-cylinder, inline 4-stroke turbo super charged diesel engine
- Transmission: DC/DC & AC/DC
- Maximum Tractive Effort: 25.9t
- Maximum Speed: 105 kmph
- Single cab design

13.1.4 1990-2000: This decade saw introduction of many variants of Alco locos and introduction of AC-AC traction locos, which was a big technological leap.

13.1.4.1 **WDM3A:** The WDM3A was just a reincarnation of the old ALCO with a modified engine with output of 3100 hp. These were initially classified as WDM2C, but later on changed to WDM3A in line with the new classification scheme issued by Railway Board vide letter No 2000/M(L)/466/44/8 (NC) dated 14.03.2002.

- Year introduced: 1994
- Bogie configuration: Co-Co
- Axle load: 18.8t
- 3100bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- AC-DC transmission
- Maximum Tractive Effort: 30.5t
- Maximum Speed: 120 kmph
- Single cab design

13.1.4.2 WDP1: Introduced for branch line passenger service.

- Year introduced: 1995
- Bogie configuration: Bo-Bo
- Axle load: 20t
- 2300bhp, 12-cylinder 4-stroke turbo super charged diesel engine
- AC/DC transmission
- Maximum Tractive Effort: 20t
- Maximum Speed: 120 kmph
- Single cab design

13.1.4.3 WDP3A: Passenger loco for main line service. Only 69 locos were manufactured.

- Year introduced: 1998
- Bogie configuration: Co-Co
- Axle load: 19.5t
- 3100bhp, 16-cylinder, 4-stroke turbo super charged diesel engine
- AC/DC transmission
- Maximum Tractive Effort: 29.2t
- Maximum Speed: 160 kmph
- Dual Cab design

13.1.4.4 **WDG3A:** This Loco was developed in response to problems noted with the WDM-2, such as ride quality, lateral oscillations, and poor traction with heavy loads. These were initially classified as WDG2C, but later on changed to WDG3A in line with the new classification scheme issued by Railway Board vide letter No 2000/M(L)/466/44/8 (NC) dated 14.03.2002

- Year introduced: 1995-96
- Bogie configuration: Co-Co
- Axle load: 20.5t
- 3100bhp, 16-cylinder, 4-stroke turbo super charged diesel engine
- AC/DC transmission
- Maximum Tractive Effort: 40.6t
- Maximum Speed: 100 kmph
- Single cab design

13.1.4.5 **WDG4:** The three phase AC traction control systems on diesel locos was introduced during this decade. 21 locos were imported. For mass production, Indian Railways entered into a transfer of technology agreement with General Motors-Electromotive Division for these 4000hp diesel locos which were put into production at Diesel Loco Works, Varanasi.

The WDG4 class of loco was first to enter service. The salient features are:

- Year Introduced: 1999
- Bogie configuration: Co-Co
- Axle load: 21t
- 4000hp, 16-cylinder 2-stroke turbo super charged diesel engine
- AC-AC transmission
- Maximum Tractive Effort: 51t
- Maximum Speed: 120 kmph
- Single cab design

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13.1.5 **2000-2010:** This decade saw many technological jumps. Some of the important ones are described briefly in the paragraphs below.

13.1.5.1 **WDP4:** Three phase traction was introduced for passenger locos in the form of WDP4 locos, the salient features are:

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- Year Introduced: 2001
- Bogie configuration: Bo1-1Bo
- Axle load: 19.5t
- 4000hp, 16-cylinder 2-stroke turbo super charged diesel engine
- AC-AC transmission
- Maximum Tractive Effort: 27t
- Maximum Speed: 160 kmph
- Single cab design

13.1.5.2 **WDM3B:** This Loco is Upgraded, higher-power versions of the WDM-3A loco. Only 23 locos were manufactured.

- Year introduced: 2005
- Bogie configuration: Co-Co
- Axle load: 19.5 t
- 3100bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- AC-DC transmission
- Maximum Tractive Effort: 38.6 t
- Maximum Speed: 120 kmph
- Single cab design

13.1.5.3 **WDM3C:** This Loco is Upgraded, higher-power versions of the WDM-3A loco. Only 54 locos were manufactured.

- Year introduced: 2002
- Bogie configuration: Co-Co
- Axle load:18.8 t
- 3300bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- AC-DC transmission
- Maximum Tractive Effort: 30.5 t
- Maximum Speed: 120 kmph
- Single cab design

13.1.5.4 WDM3D: This Loco is Upgraded, higher-power versions of the WDM-3A loco. Manufactured initially by DLW, then DLMW and later on both by DLMW & Parel Workshop of C.Rly.

- Year introduced: 2003
- Bogie configuration: Co-Co
- Axle load: 19.5t
- 3300bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- AC-DC transmission
- Maximum Tractive Effort: 36.0t
- Maximum Speed: 120 kmph
- Single cab design

13.1.5.5 **WDM3E:** This is a 3500hp loco developed by DLW in 2008, based on the WDM-3D design. It has a high-adhesion bogie ('HAHS'). Only 8 locos were manufactured.

WDM-3E

- Year introduced: 2008
- Bogie configuration: Co-Co
- Axle load: 19.7 t
- 3500bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- AC-DC transmission
- Maximum Tractive Effort: 38.6t
- Maximum Speed: 105 kmph
- Single cab design

13.1.5.6 WDM3F: This is a 3600hp loco developed by DLW, based on the WDM-3D design. These are having GE MBCS and GE electrics. It has a high-adhesion bogie ('HAHS' bogie). No longer in production.

- Year introduced: 2008
- Bogie configuration: Co-Co
- Axle load: 20t
- 3600bhp, 16-cylinder 4-stroke turbo super charged diesel engine
- AC-DC transmission
- Maximum Tractive Effort: 38.5t
- Maximum Speed: 120 kmph
- Single cab design

13.1.5.7 WDP4B: To meet the growing requirements of handling longer passenger trains, the WDP4 locos were modified into the WDP4B. The salient features are:

- Year Introduced: 2007
- Bogie configuration: Co-Co
- Axle load: 20.5t
- 4000hp, 16-cylinder 2-stroke turbo super charged diesel engine
- AC-AC transmission
- Maximum Tractive Effort: 27t
- Maximum Speed: 160 kmph
- Single cab design

13.1.5.8 WDP4D: To improve speed potential of the passenger locos in both directions of travel and to provide a more comfortable cab, the WDP4 platform was modified into a dual cab design and classified as WDP4D. The salient features are:

WDP-4D

- Year Introduced: 2010
- Bogie configuration: Co-Co
- Axle load: 20.5t
- 4000hp, 16-cylinder 2-stroke turbo super charged diesel engine
- AC-AC transmission
- Maximum Tractive Effort: 27t
- Maximum Speed: 160 kmph
- Dual cab design

13.1.6 2010- 2013

13.1.6.1 WDG5: To meet the requirements of hauling heavier freight trains at higher speeds the WDG5 class of loco has been developed with the joint efforts of Indian Railways and EMD. The salient features are:

WDG-5

- Year Introduced: 2012
- Bogie configuration: Co-Co
- Axle load: 22.5t
- 5500hp, 20-cylinder 2-stroke turbo super charged diesel engine
- AC-AC transmission
- Maximum Tractive Effort: 56t
- Maximum Speed: 120 kmph
- Single cab design

13.1.6.2 WDG4D: To improve speed potential of the goods locos in both directions of travel and to provide a more comfortable cab, the WDG4 platform was modified into a dual cab design and classified as WDG4D. The salient features are:

- Year Introduced: 2013
- Bogie configuration: Co-Co
- Axle load: 21.0t
- 4500hp, 16-cylinder 2-stroke turbo super charged diesel engine
- AC-AC transmission
- Maximum Tractive Effort: 540 KN
- Maximum Speed: 80 kmph
- Dual cab design

13.1.6.3 WDM2G (Multigenset loco): Fuel cost is the single biggest factor determining the operation cost and to meet the requirements of hauling freight trains with low fuel consumption the WDM2G Multigenset class of loco has been developed. First loco manufactured by DLMW/PTA. The salient features are:

- Year Introduced: 2013
- Bogie configuration: Co-Co
- Axle load: 18.8t
- 2400hp, 3 Gen-sets of 800 hp, each with 6-cylinder Cummins QSK-19, N-Gen II
- AC-DC transmission
- Maximum Tractive Effort: 37.20t
- Maximum Speed: 105 kmph
- Single cab design

13.2 Technological Advancements- A brief write up is given below for understanding as to what has happened in past and what is happening on the technological front at present in Motive Power and Engine Development Directorate of RDSO.

13.2.1 Motive Power Directorate

13.2.1.1 Pertaining to Alco Family Locos

SN	Description	Use Since
1.	**Micro-processor based control system:** Indian Railway had modernized the ALCO locomotive by fitment of Microprocessor based excitation & control system. The introduction of Microprocessor Control System in ALCO Locomotives fetched benefits like improved train operation safety, improved locomotive operational characteristics, reduced maintenance, flexibility to adopt new features.	2002-03
2.	**Plate type LO cooler:** Plate type lube oil coolers are compact, have higher reliability and efficiency as this design consists of alternate layers of thin and gasketted plates with hot and cold fluids flowing between alternate plates offering greater heat transfer against shell and tube type cooler. Guidelines for overhauling of Plate Type Lube Oil Cooler (PTLOC) being used on Indian Railways DE (Alco type) locos was published vide RDSO Instruction bulletin. No. MP.IB.ES.01.07.08.	2001-02
3.	**Mechanically Bonded Radiator:** For improved reliability and longer life, mechanically bonded radiators were planned for use on WDG2 & WDM3D locos. Mechanically bonded radiators use seamless tubes, which are mechanically bonded with header, whereas in conventional radiators, rolled tubes are soldered with the header, which is less reliable as compared to mechanical expansion.	2002
4.	**Air Dryer:** This removes moisture from compressed air resulting in improved life and reliability of brake valves and other electro –pneumatic equipment.	1998
5.	**Alternator-mounted rectifier on alternator assembly type 10102EV:** This project was taken up with a view to improve the layout of locos as the rectifier occupies substantial space. WDM3D locos are equipped with this design.	
6.	**Improved insulation scheme for traction motors:** With a view to improving the reliability of the TM, traction motors with modified insulation scheme incorporating flexible wrapping tape instead of Kapton mica wrapper, ceramic packing instead of Nomex and glass mica paper instead of conventional glass mica with flakes and associated insulating materials introduced	
7.	**Panel-mounted brakes for air brake locos:** This improves reliability and facilitates maintenance. Compact panel-mounted brakes for air brake locos with auxiliary dual brake panel: Compact type panel mounting brakes with three plate's design, which do not have external jumper have been provided for superior maintainability and reliability. In addition, an auxiliary panel for the dual brake system has also been provided to help maintainability.	
8.	**Inconel exhaust valves:** For improved reliability and longer life, exhaust valves of inconel material and inlet valves of 21 -4N material with thick neck (30 Degrees seat angle) have been introduced. The valve seat insert of Exhaust and Air makes interchangeable with 251 plus cyl. head and conventional cyl. Head (ALCO). The interference for Inconel exhaust valve seat insert in both the cases i.e conventional as well as 251 plus cylinder head assembly has been made similar.	
9.	**251+ cylinder heads:** 251 + cylinder heads have thin wall section which enables better heat transfer. Other design modifications include increased no of cores, use of frost plugs, etc, resulting in better performance. Modification of M/s Cooper Corporation, Satara make 251 plus cylinder head to improved its reliability was published vide MP.IB.EN.12.78.09.	1997
10.	**Fluonlex cables for TMs:** Fluonlex cables have higher flexibility & thermal rating as compared to conventional EPR/CSP & Nylon-braided PCP cables in use on lead & brush gear-connector application. A very high temperature rating, 150ºC or above and outstanding flexibility are the advantages of these cables. Although successful on Hitachi motor, their application on diesel locos has been limited due to economy considerations, as cables are very expensive. As these are one time cables for traction motors, RDSO has recommended these cables Vide instruction bulletin no MP.IB.EM.03.04.08 for all type of traction motors and the specification has been upgraded.	
11.	**Rectifier with built-in blower (92 days sch.):** For improved reliability and also reduced ducting in the under frame, rectifiers with in-built blower have been fitted on WDG2 locos. Instruction	

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SN	Description	Use Since
	bulletin NO. MP.IB.EM – 01.04.07 Dated 12-03-2007 was published by RDSO.	
12.	**Low maintenance battery (92 days sch.):** DLW in association with EXIDE, India has developed low maintenance battery which requires topping up after 92 days against 15 days for conventional battery. Instruction bulletin no. MP. IB. EC.01.02.05 (rev.01), Dec. 2008 published by RDSO for maintenance of batteries.	
13.	**E-beam cables:**E-beam irradiation used in traction cables provides better insulation and mechanical strength. These cables are able to withstand higher temperature which allows higher current in the same cross section of conductor leading to considerable saving in copper and weight. These cables are resistant to oil, last longer. Advantages of E-beam cross-linked and Fluonlex cables are : 5.4.1 Reduced insulation thickness 5.4.2 Reduced space & weight requirement 5.4.3 Reduced heat content of the system 5.4.4 Higher temperature rating 5.4.5 Increased current rating 5.4.6 Increased cable life 5.4.7 Reduced conductor size and weight 5.4.8 Higher mechanical strength 5.4.9 Reduced bending radius & increased flexibility 5.4.10 Reduced space requirement 5.4.11 Improved cable layout 5.4.12 Higher resistance to oil 5.4.13 Flame retardant 5.4.14 Low smoke inversion 5.4.15 Increased flexibility	
14.	**Twin beam halogen headlight:** Locos are being fitted with these headlights. Guidelines for Procurement of halogen bulbs for twin beam headlight for D. E locos purchased from different sources and Procedure for beam alignment of twin beam headlight was published vide Instruction bulletin no. MP.IB.EC.01.08.06 date: 27-12-06	
15.	**Higher speed LO & water pumps:** Low LO pressure to a great extent and water pressure to a lesser extent have been an outstanding problem with ALCO locos. Failure to achieve the specified minimum lube oil pressure on idle at elevated temperatures and on sudden notch down condition has been leading to shut down of locos. It has been decided to change the gear ratio of the lube and water pump gear train. To standardize, the overhauling periodicity of modified lube oil pump (Herringbone type gear) fitted on Alco type diesel electric locos was published vide RDSO Instruction Bulletin No. MP.IB.ES.08.66.09.	
16.	**Aesthetically & ergonomically designed driver's cab with suitable amenities:** After successful implementation of the basic ergonomically designed driver's cab with desk type master controller, a critical review of the complaints, and more importantly the requirements of a modern driving station, was done and a large number of features were conceptualized. Some of the important features are improved cab structure with noise proofing, redesigned partition door, improved locks, superior lights, superior gauges, amenities etc. Retro fitment of Driver's Cab in ALCO diesel locos with FRP Interiors was published vide RDSO Modification Sheet No. MP.MOD.LD-02.35.10, (Rev 0.00), Dated 06.07.2010.	
17.	**Stiffer unit camshaft:** Larger dia. cam lobes can withstand higher stresses thereby resulting in higher camshaft life. In this design, one cam segment is meant for one cylinder and can be attended separately. Each segment, therefore, can be removed and replaced easily by simply removing the fuel pump support of that location. Valve timing adjustments of the adjacent cylinders are not disturbed. In conventional design, whole camshaft assembly has to be necessarily removed from the free end which takes too much time. Expected life of the camshaft is more than conventional one. The concept of unit cam shaft, its advantages and the procedure of fitment was published vide RDSO Instruction Bulletin No MP.IB-EN-04.21.00 Complete switch over to Stiffer Unit Camshaft (SUCS) on 3100 hp locos and use of modified components in SUCS to increase the reliability was published vide RDSO Modification No. MP.MOD.EN.08.36.09	
18.	**E-beam irradiated air brake kit gaskets, O-rings and diaphragms:** New generation Rubber Part Kits for Air Brake systems by E-beam radiation curing technique introduced	
19.	**AC motor for fuel pump & crankcase:** In view of the inherent problems of bush holder & commutator in DC motors, it has been decided to use AC fuel pump and Crankcase motor(s) with	

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SN	Description	Use Since
	built-in inverter. Use of hybrid bearings 6304-2RSL3/ HC5C3S0WT and radial shaft seal CR 20X45X7 HMS5V in AC Crank Case Exhauster motor to improve reliability and performance was published vide RDSO Modification no. MP-MOD-EM-11-64-10 (Rev-00) May-10. Implementation of auto reset feature & increase in starting torque in AC Fuel Pump Motor developed by M/s Signotron (India) Pvt Ltd. Kolkata was published vide RDSO Modification no . MP.MOD.EM.01.07.08 (Rev-00) Sept, 08	
20.	**Improved Fast and Flexible couplings:** The failures on fast couplings reported are due to breakage of the coupling from the weld. The design has been modified to one piece integral centrifugal coupling and this design has been successful with the no. of failures reported going down drastically. Other failure reported due to breakage of fast coupling bolts etc., also have been tackled. The failures reported on flexible couplings are due to deformation/degradation of the rubber elements. The design has been modified to Nitrile rubber.	
21.	**Improved abrasion-resistant flexible hoses with crimped end fittings:** For improved performance of flexible hoses, use of flexible hoses with crimped end fittings at various locations used on ALCO type DE Locos was published vide RDSO Modification No. MP-MOD-ES-03-08-10	
22.	**High capacity buffers:** To bring the capacity in line with those used on coaching stock, design of high capacity buffers has been developed.	
23.	**Moatti type LO filter:** These filters do not employ any replaceable elements and therefore do not require any maintenance. In addition, the filtration efficiency is considerably higher. Report on Evaluation of Moatti self-cleaning filter for lube oil filtration of diesel locos was published vide RDSO publication No. MP. Misc 133 (Rev-00), Aug 2002)	2004
24.	**Mycalex brush holder pins:** Mycalex type brush holder pin are used successfully on GE machines with total elimination of IR problem. This design has been implemented with very encouraging results due to fewer problems during monsoon. Provision of Mycalex (Glass Bonded Mica) type brush holder arms on traction machines was published vide RDSO Modification sheet no. MP-MOD-EM-05-25-00 and Instruction bulletin No. MP.IB.EM.04.06.02	
25.	**LED type flasher light:** RDSO has conducted a comparative study of conventional, Xenon and LED type flasher lights and concluded that the LED type light is the best suited for our application. Specification was published vide RDSO Spec No. ELRS/SPEC/FLASHER LIGHT/0017 SEPT 04. Study on flasher light was published vide RDSO Publication No. MP.Misc-127 April’2002.	
26.	**Non-asbestos arc-chutes:** At present the arc chutes on contactors provided on locos are fabricated from plates made of asbestos based material, which, being brittle, these arc chutes tend to break during transit/handling. The problem gets aggravated during monsoon season when the asbestos absorbs moisture and loses its mechanical and electrical strength. Moreover, asbestos based insulating material has been banned worldwide due to health hazards. Moulded arc chutes have, therefore, been developed based on non-asbestos based material having better mechanical and electrical properties. These are based on non-asbestos glass fitted polymer resin bonded composition. Specification and test programme of non-asbestos, non-hygroscopic arc chutes for EP/EM contactors of diesel electric locos was published vide RDSO Specification No. MP.0.23.02.01 Dec-99 (Rev-00) (Amendment No.1)	
27.	**Modified low loss low maintenance cooling water system:** RDSO had conducted a study to improve the cooling water system with a view to reducing losses in the system and augmenting the heat removal characteristics. It has been decided to implement good features of the proposed design and also borrow superior piping/clamping practice from GM locos, including improvements like forged pipe unions/elbows to upgrade the system in respect of pressure loss and maintainability. A comprehensive report on Up-gradations made in water-cooling system of ALCO Locos was published vide MP.Misc-223 Nov’2009	
28.	**Relocated LED type marker Lights and GM type MU receptacles:** The incandescent lamps marker lights , which suffered from low life (further reduced due to vibrations), have been replaced by LED type marker lights which is solid state type, comprising of cluster of power light emitting diodes. It consists of sets of red and white LED's in such configuration that it provides a good reliability and failure of one LED shall not result in the failure of the light. The location of this light, along with the location and design MU receptacle, has been modified for superior aesthetics and reliability. Markers light specification was published vide RDSO Specification No. ELPS/MARKER/LIG/01	
29.	**High efficiency FTMBs with backward curved blades:** With the switchover to self-cooled rectifiers, it is possible to change the design of the FTMB suitably towards higher efficiency as	

SN	Description	Use Since
	the total cooling air requirement has gone down. RDSO specification No. MP.2400.11 (Rev-02) Feb 09 issued incorporating low capacity 9500 CFM FTTM blower	
30.	**Case-carburized shot-peened gear/ pinion:** Introduction of case carburizing TM gear & pinions and shot peened root on WDG3A was mooted due to some reports of failure due to bending as well contact fatigue. With these pinions, the problem has been eliminated.	
31.	**Open grain cylinder liners:** With a view to reduce lube oil consumption and enhance service life, these have been introduced.	2003
32.	**Modified bogie for WDM3D/WDG3 series without weight compensation arrangement:** Based on the problems reported by sheds on this bogie, many short term improvements have already been provided on the high adhesion bogie. As a long term improvement, this type of bogie has been developed without the compensating and equalizing arrangement for microprocessor based locos as all the long standing problems with equalizing/compensating beams are eliminated, the loss in adhesion made up due to superior wheel slip control. Another feature in this design is provision of CRU, instead of conventional cyl. roller bearings on journals for improved reliability & reduced maintenance.	
33.	**Light Wt. TMs with roller susp. brg (92 days sch.):** Light weight traction motors with roller suspension bearing for extended maintenance schedules, reduced axle loads and lower un-sprung masses has been provided, thus increasing the speed potential of the passenger locos and making them more track friendly.	
34.	**Rivetless bearings for traction motor pinion-end:** The reliability of the pinion end bearings of TM's has improved greatly with rivetless cage bearings.	
35.	**Improved fuel tank for WDG3A locos:** The detachable fuel tank of suffers from the following defects: 1. No provision of manhole leading to difficulties in cleaning, especially near suction pipe. 2. Different sizes for suction & return pipes making interchange difficult in case of any problem. 3. No provision of mesh near entry of fuel. 4. Draining difficult due to provision of dummy plug. 5.Glow rod has a tendency to become dirty and therefore unreadable These aspects have been taken care of in an intermediate design, providing GM type level gauge with a separate glass tube, which is not only a superior design but has better aesthetics & visibility and replacement is also easy.	
36.	**Vibration-free LO centrifuge with standardized location & mounting:** Tests at Pune diesel shed showed that in case lube oil centrifuge is used on the loco, it increases the life of lube oil filters by three times. The indirect benefits are longer life of piston, piston rings, liners, engine bearings etc. Location of the centrifuge has been standardized near R1 & R2 location of the engine, requiring modification to a door and pipelines etc. RDSO had issued spec. No. MP.0.2600-9, (Rev-03) May, 2005 and maintenance inspection vide report no. MP.MI-28.(Rev-00), Aug 2007.Subsequently this item was transferred to DLW as per instruction of Railway Board letter no. 2002/M(L)/466/ 402/dated 08/09/2006	2005
37.	**Single bolt design steel cap piston:** In view of the problems of leakage of gases past six bolt design, single bolt design pistons were developed.	
38.	**TM 4907 with roller suspension Bearing (92 days sch.):** This project was conceived for improved reliability and extended maintenance schedules.	
39.	**Upgraded compressor for enhanced schedule interval and overhauling:** The upgradation proposed envisages increased life of cylinder, piston rings, pistons, crankshaft, main bearings and LO pump. The upgraded compressors are designed for 92-day schedule and 36 months overhaul.	
40.	**Longer life primary & secondary FO filter (92 days sch):** The filter change for these filters is required only after 92 days. The casting design has been modified to seamless pipe type casting to avoid cracks.	
41.	**Nylatron bushings and liners for bogies:** Nylatron is a thermoplastic material used extensively on EMD locos in the bushings and line ring of bogies as it is strong & wear-resistant. Its use is likely to help in increasing periodicity of bogie maintenance. This concept has been extended on WDG2/WDM3D bogies also.	
42.	**Modified & relocated LO strainer:** The LO strainer was relocated to facilitate removal of large after coolers.	
43.	**Rubber cable cleats:** The wooden cable cleats used on locos today are of poor quality and design. So, it has been decided to switch over to rubber cleats on all locations as already used on traction motors.	
44.	**GM type fastons instead of conventional TBs:** The conventional TBs provided in the control	

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SN	Description	Use Since
	stand are unwieldy and prone to failure. To begin with, these have been replaced on WDM3Ds by fastons of the type used on GM locos.	
45.	**Provision of dynamic braking on WDP2 locos:** WDP2s have not been provided with DBRs because of space constraints on this full-width, loco. In view of inherent advantages of dynamic braking, it was decided to try out roof mounted DBRs within the loco MMD with natural cooling	
46.	**Modified LO and FO filer housings:** In view of problem of leakage of lube oil from the bottom of LO filter housing due to development of crack of welding between the shell and the bottom plate, the housing has redesigned with dish type bottom with change over from fillet weld to butt weld joint. RDSO had issued Instruction Bulletin No. MP.IB.EN.07.52.09 for change of design flat bottom to dish bottom type LO filter assembly.	
47.	**Modified low maintenance brake system piping:** It has been decided to implement good features of the GM loco brake system. The improvements would include features like elimination of mitre joints & modification to forged unions/elbows to eliminate the problems related with poor welds and joints, reduced threaded joints, relocation of reservoirs, improved clamping etc. and the overall design should improve reliability as well as maintainability.	
48.	**Modified air duct boot (without reinforced fabric):** Air duct boot is, at present, made from rubber reinforced with fabric. There are persistent quality problems with the present design as the dimensional control of the product is not satisfactory. Air duct Boot without using reinforced fabric has been developed. Air duct boot without reinforced fabric has been developed as per specification no. MP.0.2400.22 (Rev-01), 2006 issued.	
49.	**Thermal insulation for exhaust manifold:** Thermal Insulation for Exhaust Manifold was first used on 3100 hp, full-width, dual cab, WDP2 loco primarily with the purpose of reducing temperatures in the engine room thus making the loco more user-friendly.	
50.	**Improved high-cap SS slip ring alternator- 10102 DW :** This type of alternator was developed by BHEL in association with RDSO/DLW with increased conductor cross section, less steel slip ring, external neutral connection and strengthened gear case. These alternators are regularly being fitted on all new builds at DLW.	
51.	**Improved cable conduiting, sleeving and heat shrinkable tubings :** The cable conduits used on GM locos, both flexible and rigid, employ end fittings, which totally obviate the possibility of any oil or dirt ingress inside the conduits. The flexible conduit covering material is of an improved elastomer.	
52.	**Modification to WDP2 bogies:** Difficulty is faced by DLW and Railways during fitment of guide link on WDP2 locos. The bogies have other features which render it poorer in respect of maintainability and reliability like breakage of secondary springs. The matter was studied by DLW/RDSO in detail and a modified design has been developed by RDSO, incorporating features from ABB bogie.	
53.	**Notch separation on E type controls:** The existing E type controls are not amenable to notch-wise adjustment of power. Since large-scale deployment of microprocessor based systems is likely to take some more time, it was decided to take a project to upgrade the E type system itself for incorporation of notch wise adjustments.	
54.	**GM type headlight, cab, exterior and engine room lights:** These fittings for GM loco, except the headlight lamp, have been indigenized and it is proposed to introduce the same on ALCO locos also.	
55.	**Modified LO Piping:** For improving reliability and maintainability, modified lube oil piping has been introduced on WDG2 locos. The piping had many features, which have been adopted although some features like bellow couplings did not succeed and pressure drop problem was not solved.	
56.	**Modified under frame for WDG2 locos:** Following major complaints existed on the under frame of WDG2 locos: 1. Higher vibrations in the radiator room of WDG2s, which in turn arises as the floor is not secured to longitudinal member. The arrangement of stiffeners required to be modified 2.Common engine & TA trough remains filled with leak off oil and the air drawn by the alternator/FTMB carries this oil and the same required separating out by a partition 3.Oil enters into the resilient pad of TM no. 4 causing frequent problems on pad as well as TM cables despite undertaking modifications suggested by DLW. The drain of the sump is an L pipe, which gets choked and oil drops directly on TM no. 4. The system needed to be modified by eliminating the L pipe with one sloped tray and a vertical discharge pipe covering all the drain pipes of A/C sump & engine trough secured to the under frame. 4. Inadequate air outlets for alternator, requiring the outlet through the frame to be enlarged.	

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SN	Description	Use Since
	5. Lengthening of the alternator trough required to facilitate removal of the alternator. All these aspects have been taken care of in a new intermediate design implemented from April 02	
57.	**Pressurized control cubicle:** Control compartments for WDP2 locos were provided with improved layout and sealing arrangement for pressurization for improving maintainability and reliability, including avoiding ingress of dust which causes malfunctioning of electric devices. All WDP2 locos are fitted with this type of control compt.	
58.	**Higher stall current on WDG2s:** WDG2 loco is designed with the starting and despatchable adhesion numbers generally commensurate with each other. It was, however, seen in the rating & performance trials done by RDSO that the bogie has excelled the expectations and there is a scope to modify the electrical limit as well as increase the gear ratio. A gear/pinion set with a gear ratio 17:73 has been designed by RDSO. Stall current test at higher settings have also been done for both alternator and motor. This should help in reducing cases of stalling and enhancing its starting capability further.	
59.	**New look modified superstructure for WDG2 locos:** A project to reduce the weight of the superstructure by using less number of vertical door posts while strengthening the doors by providing diagonal stiffeners. Although the concept was good, this design was not successful as the users faced severe problems in examination/maintenance of component like cylinder heads, compressor & main bearings. The design was discontinued and a fresh design taken in hand with a view to providing superior interface to the maintainers while retaining the good features of the concept. Special care is being taken to improve the layout and approach to equipment such that the maintainability related problems on locos fitted with GE turbochargers are eliminated.	
60.	**Micro-controller based engine governor:** Micro Controller based Governor is intended to provide a reliable, economical and maintenance friendly alternative to the hydraulic governor	
61.	**Introduction of high-efficiency turbochargers:** For increasing the schedule periodicity of Turbo superchargers, increased boost air pressure and reduced Exhaust Gas Temperature, ABB VTC-304, Napier, ABB TPR-61, GE Single and Double Discharge and Hispaon-Suizo were introduced in fro 1990s onwards.	2002-03
62.	**Double helix type FIPs:** The existing FIPs are designed for optimum fuel performance on the full load. Double helix type FIP has provision of two helical grooves on the plunger, instead of only one as in the existing design, which ensures that the fuel timings can be manipulated to suit optimum fuel performance.	
63.	**Remote Monitoring and Management of loco and trains (REMMLOT) :** This system will enable the on line transfer of locomotive data like Locomotive health data, Fault Data with data packs, life time counters data, trip data counters and GPS Location information which will be very useful for sheds for failure analysis and preventive maintenance of the locomotive. The system will also have a Locomotive and Train management system, which will have LRMS communication module, database Management system, Web application Server, Application software etc. The same will enable to retrieve various reports like locomotive health status, fault records on a loco, list of Alert messages, GPS location of loco/ train etc	2009
64.	**Auxiliary Power Unit (APU) :** Analysis of the locomotive data has shown that most of the run time of the goods trains is spent IDLING for want of line clear signals on the station & yards for prolonged periods of time. While a diesel engine is idling at 400 RPM, the diesel engine consumes roughly 25 to 30 litres of diesel oil per hour. The diesel locomotive performs two functions while idling at stand still; the compressor maintains Main Reservoir pressure and the alternator charges the locomotive batteries. These two functions do not require much power; however as the full diesel engine runs to cater this requirement, the energy consumed is very large. To cater to the above requirement APU system has been developed as per RDSO Spec. MP-0-2400-62-Rev-00- Sept-09. During APU mode, Locomotive engine will be shutdown & APU engine will start working which in turn consumes very less fuel i.e. 5 litres per hours.	2009
65.	**H type couplers:** Traditionally the freight wagons were fitted with E-type centre buffer couplers whereas coaching stocks were fitted with screw couplers. To meet the requirement of running longer trains, IR adopted 'H' type centre buffer couplers which has advantages of higher working load and of anti-climbing feature.	
66.	**3RV Kit:** Excessive ring groove wear in the pistons was found a burning issue in the pistons of *5* RV. Three-ring version with modified profile of piston crown and modified skirt design to suit three rings and no constriction liner with sleeve and fire ring was suggested as a long-term measure to overcome excessive ring groove wear	2007
67.	**Brush Less Eddy Current Clutch:** The brushless technology eddy current clutches are more	2008-09

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SN	Description	Use Since
	rugged and less maintenance prone due to the inherent advantage of lesser air gap between drum & pole (which eliminates need of copper cooling on drum) & the static yoke (which eliminate the need of slip ring/carbon brushes).	
68.	**Forced Cooled Roof Mounted DBR Hatch Assembly:** The roof mounted forced cooled DBR hatch assembly (EMD technology) is capable to withstand 650ºC temperature and high shock/vibration levels in service in order to facilitate the self-load feature with full GHP.	2005
69.	**Microprocessor Based Fire Alerter System:** To prevent fire accidents on Diesel Electric locomotives, the loco is will have a suitable Fire Alerter System for fire detection and alarm. After fire detection, the signal will be provided by FAS through relay logic to microprocessor system for performing the activities like shutdown of engine, brake application by actuation of VCD magnet valve. Eight Nos. flame sensor mounted in expresser / engine room & alternator room at suitable places. The sensor shall detect the fire by ultraviolet ray detection system. One prototype of fire Alert systems with feature to integrate with control system for loco shutdown and fitted on Loco No 13377 & dispatch to diesel shed SCR/Gooty on dated.25.09.07. This fire alert system is also integrated with the loco control system to automatically shutdown the locomotive after 15 second of detection of fire, so that lube and fuel pumping is stopped to contain the spread of fire.	2007
70.	**Common 'S' shaped Wheel manufactured by DSP:** The S-shaped wheels have much higher heat sustaining capability which is one of the important contributory factor for wheel failures due to gauge widening & thermal cracks during repeatedly application of brakes at regular intervals on gradient sections.	
71.	**Single Brake Block per Wheel design:** Existing ALCO locomotive are having clasp type rigging design with two brake blocks for each wheel. In this arrangement 'L' type composite brake block are used. DLW build loco no. WDG3A-13221 has been turned out with single brake Block per wheel design.	
72.	**HHP type master controller:** Driving comfort is improved due to provision of EMD type compact control console. These control consoles have got a comfortable leg space, easy driving access for master controller, A-9, SA-9, indication switches, etc.	

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13.1.1.1 Pertaining to HHP Family Locos

SN	Description	Use Since
1.	**Use of IGBT:** The HHP Locos prior to 2005 were equipped with GTO technology based AC-AC traction convertors and these were having certain disadvantages like bulky size, excessive cooling, slower switching time etc. In-order to overcome these disadvantageous, new IGBT based AC-AC traction convertors were adopted in HHP locos	2005
2.	**Six-motor WDP4s (WDP4Bs):** For obtaining improved top notch tractive effort and closer dispersion of tractive effort at higher notches, WDP4 locos are being fitted with Six TM's.	2007
3.	**Twin cab WDP4s:** To overcome the visibility constrains being faced by Loco Pilots, twin cab version of WDP4B locos, was jointly developed by DLW and RDSO. This loco is designated as WDP-4D	2010
4.	**Hotel load WDP4s:** Use of smaller size of IGBT has paved way for incorporation of Hotel Load module in same dimensions of traction control converter for supply of electricity to coaches for lighting purposes from the locomotive itself. Three such locos have been built by DLW till date.	
5.	**Distributed Power System (DPS) For 4500 HP WDG4/WDP4s Locos:** In certain Ghat section, 5 WDG-4 locomotives are being utilized at the ends of the trains and operation is crew skill dependent, considered not to be a very safe mode of operation. A remote control system for Locos through wireless link is developed for controlling Locos placed in long haul trains from the leading Loco, this system is called "Distributed power control system". Distributed power control would permit better control and operation of locomotives.	
6.	**Twin cab WDG4s:** To overcome the visibility constrains being faced by Loco Pilots, twin cab version of WDG4 locos, was jointly developed by DLW and RDSO. This loco is designated as WDG-4D	2012
7.	**REMMLOT:** This system will enable the on line transfer of locomotive data like Locomotive health data, Fault Data with data packs, life time counters data, trip data counters and GPS Location information which will be very useful for sheds for failure analysis and preventive	

S N	Description	Use Since
	maintenance of the locomotive. The system will also have a Locomotive and Train management system, which will have LRMS communication module, database Management system, Web application Server, Application software etc. The same will enable to retrieve various reports like locomotive health status, fault records on a loco, list of Alert messages, GPS location of loco/ train etc	
8.	**Radial DBR:** Radial design DBR Hatch assembly has been used in WDG5 locomotive, which is compact and modular in design, requiring lesser space. The grid resistors are suitable for dissipating 3100 KW power during dynamic braking.	
9.	**AC cab:** Diesel locomotives are operating in extreme weather condition in Indian Railways which include extreme hot & humid conditions. These causes extremely uncomfortable situation for loco crew as there are no cooling arrangement provided on diesel electric locomotives. Hence, the air conditioning of driver's cab is being done	
10.	**Cab Heaters:** Diesel locomotives are operating in extreme weather condition in Indian Railways which include extreme cold conditions. These causes extremely uncomfortable situation for loco crew as there are no heating arrangement provided on diesel electric locomotives. There has been continuous demand from loco pilots for a very long time for cab heater in diesel electrics locomotive as in Electric locomotives. It can easily be retrofitted in existing locomotives in field. This would be very useful for retro fitment purpose.	

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13.1.2 Engine Development Directorate

1.2.1 1	**Introduction:** Engine Development Directorate was set up in RDSO in April 1987.The main objectives were- (i) Improvement in the rail diesel traction technology for- (a) Better fuel efficiency (b) Higher Reliability (c) Increased availability. (ii) Development of technology for increasing power output of existing diesel engines. (iii) To provide R&D backup to Railways and Production Units to maintain quality and facilitate indigenisation.
	Over the years the following objectives have also been additionally assigned: (i) Development of emission compliant engine technologies (ii) Development of green alternate fuels and appropriate /contemporary technologies for rail traction
	The Directorate has following major capabilities: (i) Engine Testing – 400 to 6000 kW (ii) Computerized engine test beds (iii) Mass emission measurement system (iv) Diesel engine improvements (v) Simulation of diesel engine processes (vi) Software for solid modelling and Finite Element Analysis of engine components
1.2.2	**Major achievements:** of the Directorate in the past have been – (i) Reduction in Specific fuel Consumption of ALCO 16-cylinder Engine from 166 to 152 gm/bhp-hr. At full load, 20% reduction in Lube Oil Consumption and reduction in Exhaust Gas Temperature by 100 ^{0}C. (ii) Reduction in Specific Fuel Consumption of ALCO 12-cylinder Engine from 168 to 155 gm/bhp-hr. At full load, 20% reduction in lube oil consumption and reduction in Exhaust Gas Temperature by 80 ^{0}C. (iii) Reduction in Specific Fuel Consumption of ALCO 6-cylinder Engine from 182 to 168 gm/bhp-hr. At full load, 20% reduction in Lube Oil Consumption and reduction in Exhaust Gas Temperature by 90 0C (iv) Power uprating of 16 Cyl. Engine Stage I - 2600 to 3100 hp Stage II - 3100 to 3300 hp Stage III - 3300 to 3600 hp (v) Power uprating of 12 cylinder engine from 1950 hp to 2300 hp (vi) Development of Swadeshi Steel Cap Pistons (vii) Indigenisation of Turbochargers (viii) Power uprating of 16-Cylinder GM-EMD G3B Diesel Engine from 4000 horsepower to 4500 horsepower (ix) Development of Emission Test car for measurement of emissions from IR Locos (x) Development of EFI system for ALCO 16-cylinder 3100 hp diesel electric loco
1.2.3	Details regarding some of the important projects on hand are as below-
a)	**Scaling up of Electronic Fuel Injection System:** EFI is an important technology which helps in reduction in fuel

	consumption. The first Diesel Loco equipped with "Electronic Fuel Injection (EFI)" was turned out at Diesel Loco Shed, Alambagh for operational service in September, 2011. This was the first ever retro fitment of Electronic Fuel Injection System on the ALCO loco in the world. It consists of an electronically controlled 16mm plunger diameter Fuel Injection Pump supplying fuel to the injector via a high-pressure pipe. Fuel injection is controlled by solenoid valve which is connected with Engine Control Unit (ECU). ECU is a microprocessor based control system which acquires data regarding the operating condition of the diesel engine and makes an intelligent assessment regarding the injection process. Tender specifications for bulk procurement through DMW, Patiala have been prepared for procurement action. Governor, OSTA and control rack are the major components that gets eliminated from a conventional pump line nozzle loco.
b)	**Reliability Engineering:** In today's scenario it is imperative to have scientific analysis of failures for facilitating decision making with respect life of components, vendor evaluation, design validation, etc, for reliability improvement. Reliability based engineering analysis takes time to build up but has immense potential for IR. For this purpose, a Centre for Reliability & Integrated Systems Engineering (C.RISE) has been set up in Motive Power Directorate of RDSO. Reliability Centre will lead to a paradigm shift in failure analysis of components and would help to base analysis on the established concepts of reliability engineering. A server has been located in the reliability center on which, a specialize software called "X Fracas" has been loaded. Shortly, Zonal Railways will be able to access this server to start updating failure data in an incidence form. Reliability center can be accessed through internet on the address "www.rdsoreliabilitycenter.org"
c)	**Design and Development of Common Rail Electronic Direct Injection Fuel System.(CReDI):** CReDI is second generation Electronic Fuel Injection System which leads to substantial reduction in specific fuel consumption and present levels of emissions. CReDI fuel system consists of a low pressure and high pressure fuel system. Salient feature of this system is that there are only two reciprocating 4 cylinder inline high pressure pumps which maintain a high fuel pressure for injection, approximately 1600 bar ,in the fuel common rail. The injectors are solenoid operated, controlled through an interfaced ECU with traction excitation control. Governor, OSTA, FIP and control rack are the major components that gets eliminated from a conventional pump line nozzle loco. RDSO is currently developing a CReDI system for fitment on ALCO and EMD 710 G3B diesel engines.
d)	**Design and development of Natural Gas based engine for Diesel Loco:** RDSO has taken a project for design and development of a Natural gas based diesel loco. Cost of natural gas per Mega joule of energy is approximately 50% of the cost of diesel. Thus, there is 50% reduction in the cost of diesel fuel. Also the emissions of smoke, particulate matter and NOx are reduced greatly. With diesel prices getting deregulated and abundance of world's reserves of natural gas this technology is worth pursuing. RDSO has proposed a high pressure direct injection of gas with micro pilot injection of diesel fuel for ignition as it is expected to give maximum displacement of diesel fuel during operations on energy basis. The loco will be built on a dual multi loco concept with a cryogenic LNG tank and conversion battery on the rear loco. The design is expected to give a lead of 1000 kms before refueling and can thus be used on closed circuit routes to start with, till the time technology gets matured and numbers of these locos increase over IR.
e)	**Design and development of a Miller Cycle Turbocharger:** Miller cycle technology works on the principle of using a higher boost to meet air requirements in combustion chamber in a smaller time window. This enables to eliminate the negative work being done by piston at present in the compression stroke. Further higher boost pressures achieve to provide a higher swirl and preparation of better homogenous air fuel mixture for combustion. Miller cycle TC is expected to give fuel saving benefits upto 2% along with NOx reduction. The solution will be retrofitable on existing locos. To suit the optimized design of Miller cycle TC suitable adaptation of design on camshaft shall also be done on the air and exhaust cam.
f)	**Design and Development of a Gas Turbine based 8.3 MW Loco:** It is planned to develop a high horsepower gas turbine based loco for heavy-haul and long haul goods train operations for shortly coming up dedicated freight corridors of Indian Railways. The need for development of high horse power gas turbine base loco is mainly due to availability of large reserves of Natural Gas (NG) in India (with new finding of source being reported regularly), which facilitate the easy availability and self dependency of combustible fuel. Additionally the current market price of NG is much lower than Diesel price presently in use for traction power to haul existing freight trains. This make it all the more important to go for development of a high horsepower loco running on alternate fuel .The additional benefit offered by gas turbine locos are more than 50% reduction in exhaust emissions as compared to present day diesel locos running in Indian railways. The operational and maintenance costs will be less due to less rotating parts. Gas turbine loco offer best power to weight ratio for a power generator i.e. it is possible to generate 12000 hp only with gas turbine technology
g)	**Development of Electronic Unit Injector System for EMD:** At par with Alco injection system, an Electronic Unit Injector system is being developed for the EMD 710 G3B engines with the following broad objectives: - • Reduced NO_x emissions • Reduced Black Smoke emissions • Reduced fuel consumption • Improvement in reliability of diesel engine by having restriction on the peak firing pressures. • On Board Diagnosis potential

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Chapter 14

Locomotive Data

14. LOCO DETAILS & DATA

14.1. WDM-1 CLASS, CO-CO, DIESEL ELECTRIC LOCO

During 1957-58, hundreds of mixed traffic locos were ordered on ALCO Products Inc., USA. The locos were built to the Berne Conference International loading gauge. The superstructure is constructed on conventional lines. The underframe comprises of two "I" sections inside longitudinal and two longitudinal side channels, strengthened with substantial cross members, and is of a fully welded construction

Two Pennsylvania type bogies of cast steel are provided. The superstructure weight is transmitted through a single centre pivot on to a cast steel double bolster attached with swing links to the bogie frame. Timken roller bearings are fitted on all the axles

The loco is powered by a single ALCO 12 cylinder, 4 stroke, turbocharged and intercooled diesel engine model 251 B, which develops 1977 hp at 1000 rpm under SAE standard climatic conditions

The diesel engine drives the main traction generator (General Electric's model GT-581) directly coupled to the crank shaft. This is a 10 pole shunt-wound machine with commutation poles, which has a single bearing and gear case at the outer end from which are driven the excitation generator, auxiliary generator and the blower for the leading bogie traction motors

Traction motors (General Electric Co.'s model GE-761) are axle hung and nose suspended. The motors are connected across the generator in two major connections; series - parallel and parallel. Each connection has shunted field steps. The transitions are made automatically according to the loco speed

The large vertical spindle cooling fan is driven from the engine through an electro-magnetic eddy-current clutch whose excitation is regulated by a water temperature thermostat. A throttle lever with eight motor notches and one idling notch regulates the engine speed. Compressed air brake for the loco and vacuum brake for the trains are provided.

14.2. WDM-2 CLASS, CO-CO, DIESEL ELECTRIC LOCO

Forty locos were built by M/s Alco Products, Inc., New York, to their model DL-560 C and put on line during 1962. Two hundred twelve (212) more locos were ordered on Alco during 1963-65, 12 out of them in knocked down condition to be assembled in Diesel Loco Works, Varanasi.

The loco is equipped with two 3-axle bogies of the Trimount type, fully equalized. In addition to the swivel bearing about which bogie swings, there are two pads, one on each side; the three thus form a 3-point support to carry the load on each bogie. The lateral spacing of pads affords stability on a curve and their frictional resistance prevents nosing at high speeds. The suspension is on four groups of springs, two outer and two inner helical coils each, the inner coils working in conjunction with friction snubbers. The axle boxes are of roller bearing type.

The loco is powered by one Alco / DLW make 251-B type, 16-cylinder turbo charged, 4 stroke, with open combustion chambers and solid fuel injection, diesel engine capable of developing 2636 HP under SAE standard climatic conditions. The engine is governed by an electro-hydraulic governor. (later on Woodward Governor also fitted)

The cooling equipment located at the long hood end of the loco incorporates an eddy current clutch drive for a vertical spindle roof-mounted fan. The eddy current clutch is driven by an extension of the engine crank shaft and has its speed thermostatically controlled.

The transmission is electric, consisting of one direct current main generator, shunt wound, 12-pole, GE Make, GT 586 model or HEIL make TG.5301 BX or TG 10931 AZ model and six axle hung nose – suspended, series wound traction motors, GE make 752 model or HEIL make 165 model one for each axle, geared for a maximum speed of 120 KMPH.

It is equipped with compressed air brakes on the loco and vacuum brakes for the train, the loco is also provided with the rheostatic dynamic brake equipment.

14.3. WDM-4 CLASS, CO-CO, DIESEL ELECTRIC LOCO

GENERAL MOTORS, USA built WDM-4 Locos (Makers' Model GT-16) were first put in service in 1962. These were built for mixed traffic service.

The loco is powered by a single 16 cylinder, Vee EMD make, 56703 type, turbocharged, 2-stroke diesel engine, capable of developing 2636 hp at 835 rpm under standard climatic conditions.

The transmission is electric and comprises of one direct current Traction Generator, model D-22 EMD, and six axle-hung, nose-suspended series wound EMD type D 47B traction motors, one for each axle, geared for a maximum speed of 120 kmph.

Transition control system enables the initial 2-series - 3 parallel combination to go through three stages of field-weakening before 6-parallel combination having full field and one weak-field stages being reached. This maintains constant KW output throughout the loco operating speed range within the voltage & current limitations of the Traction Generator & current limitations of traction motors.

The radiators are arranged in two vertical banks with three AC motor driven fans, roof-mounted between them. The temperature control is accomplished by use of a temperature regulated by-pass valve in the cooling water circuit

14.4. WDM-7 CLASS, CO-CO, DIESEL ELECTRIC LOCO

These locos were designed to replace the Steam Locos being phased out from B.G. branch line service.

The locos are powered by single 251 B type, 12 cylinder diesel engine developing 1977 hp at 1000 rpm under standard conditions (20°C - Sea level) and 1856 hp at site condition (55 °C, 600m).

Initially ten locos were equipped with electric transmission consisting of one direct current, shunt wound, separately excited self ventilated 10 poles main traction generator of BHEL make, type TG 10931 AZ and six axle hung, nose suspended, series wound force ventilated 4 pole traction motors of BHEL make, type 4501 AZ for a full power speed of 105 kmph operating with 17:94 gear ratio. These locos are not provided with dynamic brake.

The eleventh loco and onwards are provided with electric transmission consisting of one Alternate current, 3-phase, star connected, separately excited, self ventilated, 10 pole main traction Alternator of BHEL make, type TA 10105 AZ and six traction motors of same description as the first ten locos for a full power speed of 100 kmph operating with 17:94 gear ratio. The eleventh loco and onwards are provided with dynamic brake.

The underframe is of all welded construction comprising of two box section main beams with integral fuel tank at the centre, with suitable transverse bracings and stretchers at load points. The underframe is capable of withstanding buffing load of 400 t.

The loco is equipped with two 3-axle bogies of trimount type full equalized, fitted with individual traction motors on all axles. In addition to the swivel bearing on single piece cast steel bogie frame, about which the bogie rotates, there are two load bearing pads, one on each side of the cross member of the frame; the three thus form a 3-point support to carry the load on each bogie. The first carries 60% of the vertical load and also transmits and receives the traction and braking forces. The two bearers equally share the remaining 40% of the vertical load. The suspension is in four groups of springs, each group consisting of two outer and two inner coils. One inner coil in each group of springs works in conjunction with friction snubber.

14.5. WDM-3A CLASS, CO-CO, DIESEL ELECTRIC LOCO

The prototype WDM3A mixed service Loco was turned out from DLW on September 1994. Initially designated as WDM2C, it was re-designated as WDM3A vide Railway Boards letter No 2000/M(L)/466/44/8 (NC) dated 14.03.2002

These locos are more powerful versions of the WDM-2. Underframe of WDM3A loco is fabricated using rolled sections and plates with top plate for mounting major equipment. The frame section consists of a central box section as the main load-bearing member with side extensions at either end to the full width of the loco for carrying underframe equipment. The box section comprises of two-side longitudinal ISMB 400 I-beams with 14 mm top and bottom plates and a 22 mm plate between I-beam and the bottom plate.

Side extensions are provided by 5 mm plates bent in the form of an angle with 6 mm top chequered plate. The central box section of the frame, which carries main power equipment, is further strengthened by providing two additional central ISMB 350 beams over the requisite length. The bogie suspension of WDM3A is similar to that of WDM2.

The Bogie of the loco is similar to WDM2. Some of WDM3A locos are provided with high speed bogies. On high speed bogies conical rubber thrust pads are provided in the end axle boxes.

The loco is powered with DLW make 251B uprated fuel efficient 16 cylinder Diesel engine capable of producing 3100 HP at 1050 rpm under standard conditions with Napier NA 295 IR or ABB-VTC-304-VG15 model turbo supercharger and a large aftercooler for better after cooling of the engine inlet air commensurate with the increased air flow. Some of the WDM3A locos rebuilt at DLMW are provided with GE 7S 1716 turbo super charger

The loco is equipped with AC-DC transmission consisting of a directly coupled self ventilated BHEL make TA10102 CW model traction alternator with BHEL make panel mounted rectifier type ALR 5400A, driving 6 axle hung nose suspended BHEL TM4906AZ model traction motors geared for maximum speed of 120 km/h

The loco is equipped with IRAB-1 Brake system. Hand brake operated by a lever from driver's cab is provided for use on stabled loco and for holding a light loco on grade in emergency. The loco is suitable for multiple operation.

Other electrical and mechanical systems are similar to WDM2. Loco is provided with dynamic brake, rating and characteristic is similar to the one provided in WDM2 loco.

DLMW/PTA also started converting WDM2 locos into WDM3A during rebuilding from 2000 onwards. Existing cab and control stands on WDM2 are not disturbed. Alternator TA 10102CW and rectifier type ALR 5400A are provided in place of traction generator. TM 4907 type motors with roller type bearing are provided in place of TM4906. Also online centrifuge and pure air brake system is being provided.

14.6. WDP-1 CLASS, BO-BO, DIESEL ELECTRIC LOCO

The prototype WDP1 passenger Loco was turned out from DLW on 31-3-95.

Underframe of WDP1 loco is fabricated using rolled sections and plates with top plate for mounting major equipment. The frame section consists of a central box section as the main load bearing member with side extensions at the either end to the full width of the loco for carrying underframe equipment. The box section comprises of two side longitudinal ISMB 400 I-beams with 10 mm top and 12 mm bottom plates. The central box section of the frame which carries main power equipment is further strengthened by providing two additional central ISMB 350 beams over the requisite length. Suitable cross members have been provided to take bogie pivot, drawgear equipment etc. to give required rigidity to the frame.

The loco is equipped with two flexi-coil BO-BO bogies with nominal axle load of 20t. Since the loco has a bolster less bogie, weight of under frame is transferred to bogie frame through the secondary springs directly. The bogie frame is suspended on the primary springs. Tread Brake Units (TBUs) were provided instead of conventional brake cylinders.

The loco is powered with DLW make 251B uprated 12 Cylinder fuel efficient engine with Napier NA 295 A-520 or ABB-VTC304VG09 model turbo supercharger and a large after cooler for better cooling of the engine inlet air commensurate with the increased air flow. This engine develops 2300 HP at 1000 rpm under standard climatic condition

The loco is equipped with AC-DC transmission consisting of a directly coupled self ventilated BHEL make TA10106 AZ model traction alternator with BHEL make panel mounted rectifier type ALR 5400A, driving 4 axle hung nose suspended BHEL TM4906AZ model traction motors geared for maximum speed of 120 km/h

The loco is equipped with 28LAV-1 Brake system and panel mounted brakes applicable to dual air brake system. Hand brake operated by a lever from driver's cab is provided for use on stabled loco and for holding a light loco on grade in emergency

The loco is suitable for multiple operation. Other electrical and mechanical systems are similar to WDM2 loco except that dynamic braking has not been provided in WDP1 loco

14.7. WDG-3A CLASS, CO-CO, DIESEL ELECTRIC LOCO

The prototype WDM3A mixed service Loco was turned out from DLW on 17.07.95. Initially designated as WDG2, it was re-designated as WDG3A vide Railway Boards letter No 2000/M(L)/466/44/8 (NC) dated 14.03.2002

The box section comprises of two side longitudinal ISMB 400 I-beams with 16mm top and 25mm bottom plates. To give required rigidity to the frame, suitable cross members have been provided, where load from bogie pivot and draw gear equipment is transmitted. The length of underframe over buffer beam is 17.85 meters.

The loco is equipped with high adhesion CO-CO bogies with nominal axle load of 20.5t. This loco has two-stage suspension. Helical springs in the primary stage and rubber sandwich springs in the second stage have been provided. Vertical and lateral hydraulic dampers have been provided in the primary and secondary stages respectively. All traction motors are arranged unidirectional to increase adhesion.

Some of the locos are provided with TRSR - 50230/3800 HIRECT make self cooled rectifiers. Axle hung nose suspended BHEL 4906AZ model and 4906 BZ traction motors geared for maximum speed of 100 kmph are provided. Some locos have also been provided with BHEL 4907 model roller suspension bearing traction motors.

Other electrical and mechanical systems of the loco are similar to WDM3A. The loco is technically suitable for multiple operation

14.8. WDP-3A CLASS, CO-CO, DIESEL ELECTRIC LOCO

The first prototype WDP3A passenger Loco was turned out from DLW on 31.7.98. Initially designated as WDP2, it was re-designated as WDP3A vide Railway Boards letter No 2000/M(L)/466/44/8 (NC) dated 14.03.2002.

Underframe of WDP3A loco is fabricated using rolled steel sections and plates with top plate for mounting major equipment. The frame section consists of a central box section as the main load bearing member with side extensions at the either end to the full width of the loco for carrying underframe equipment. The box section comprises of two side longitudinal ISMB 400 I- beams with 14 mm top and 25 mm bottom plates. The central box section of the frame which carries main power equipment is further strengthened by providing two additional central ISMB 350 beams over the requisite length. Suitable cross members have been provided to take bogies pivot, draw gear equipment etc. to give required rigidity to the frame.

The loco is equipped with CO-CO two stage 3-axle flexicoil MK-V bogie. The bogie consists of two castings, bogie frame is one casting and the bolster is the other casting. The weight of the superstructure is transferred to centre pivot of bolster then through secondary spring it is transferred to bogie frame and from there to wheel-axle assembly. The bogie comprises of hydraulic dampers in the primary stage as well as in the secondary stage.

The loco is powered with DLW make 251B (uprated) 16 cylinder fuel efficient engine with Napier NA 295 IR model or ABB VTC 304-VG15 model turbo supercharger and a large aftercooler for better cooling of the engine inlet air commensurate with the increased air flow. The engine develops 3100 horse power at 1050 rpm under standard conditions.

The loco is equipped with AC-DC transmission consisting of a directly coupled self ventilated BHEL make TA10102 CW (model) traction alternator with BHEL make panel mounted rectifier type ALR 5400A, driving 6 axle hung nose suspended BHEL TM5002AZ model & CGL TM7362 model traction motors geared for maximum speed of 160 km/h.

Other electrical and mechanical systems are similar to WDM2 except that dynamic braking has not been provided in WDP3A loco.

The loco is equipped with IRAB-1 Brake system and panel mounted brakes. The hand brake operated by a lever from driver's cab is provided for use on stabled loco and for holding a light loco on grade in emergency. The loco is suitable for multiple operation.

14.9. WDM-3D CLASS, CO-CO, DIESEL ELECTRIC LOCO

WDM3D class mixed (freight& passenger) AC/DC diesel-electric loco which is microprocessor controlled, was introduced on the Indian railways in 2003. This loco is equipped with 16 cylinder up-rated engine capable of producing 3300hp under standard conditions and uses high adhesion bogies. This loco is a 19.5t axle load with 500mm shorter platform as compared to WDG3A. The starting tractive effort of the loco is 38.6t against 30.5t of WDM3A/ WDM3C.

The under-frame is a fabricated design using fabricated I –section & plates with top plates for mounting major equipments. The frame section consists of a central box section as the main load bearing member with side extensions at either end to tie full width of the loco for carrying under-frame equipment. The box section comprises of two side fabricated I -beam with 12mm top and 20mm bottom plates of specification IS:2062. Suitable cross members have been provided to take bogie pivot, draw gear equipments etc. to give required rigidity to the frame.

The loco is equipped with two high adhesion Co-Co bogies with two stage suspension and has nominal axle load of 19.5t. Helical springs in the primary stage and rubber sandwitch spring in the secondary stage have been provided. Vertical and lateral hydraulic dampers have been provided in the primary and secondary stages respectively. All traction motors are arranged unidirectional for increasing adhesion.

The loco is powered with 3300hp DLW make 251B (uprated) 16 cylinder fuel-efficient engine with ABB TPR-61 or GETS single discharge 7S-1716 or Turbomeca HS5800 NIGT model turbo-supercharger and a large after cooler for better cooling of the engine inlet air commensurate with the increased flow and better effectiveness.

The loco is equipped with AC/DC transmission consisting of a directly coupled self-ventilated BHEL make traction alternator model TA 10102 EV with alternator mounted rectifier of BHEL make type AR4500A driving 6 axle-hung nose suspended BHEL make TM5002B6Y model traction motors.

Other electrical and mechanical systems are similar to WDG3A loco. The loco is equipped with IRAB-1 panel mounted pure AIR brake system. Dynamic brake has also been provided. The loco has two table top driver's control desks with left hand drive. The loco is suitable for multiple operations up to a maximum of 3 locos.

14.10. WDG-4 CLASS, 3-PHASE, CO-CO, DIESEL ELECTRIC LOCO

21 locos (9 built and 12 knock down condition) of 4000hp GT46MAC 710 - GB fuel-efficient engine, were supplied by GM / USA in 2000 and were put on line. Thereafter, regular production of these locos started in DLW under TOT. Later on, in year 2010, production of 4500 HP locos was started.

The WDG4 loco is equipped with a turbocharged 16 cylinder 2-stroke 710 G3B diesel engine. This engine has high fuel efficiency and requires low maintenance. The fuel efficiency of this loco is around 11% better than the existing locos. This engine has many modern features like, laser hardened cylinder liners, unit fuel injectors which eliminate the problematic HP tube, Inconel valves, hydraulic valve adjuster, durable crankcase and piston structure. The diesel engine drives the main alternator.

The main alternator TA17 is a 3-phase, 10 pole, 90 slots machine equipped with two independent and interwoven sets of stator winding. The main alternator construction is such that it is basically two alternators in one - two sets of stator windings, permanently connected in series, work with a rotating field common to both the windings in order to provide higher alternator output voltage, which is a basic requirement of a low current high voltage alternator used on AC-AC locos. The main alternator converts the mechanical power of diesel engine into alternating current. The internal rectifier bank of the main alternator converts alternating current into direct current thereby providing a DC power output. The DC power output from the main alternator is called the DC link voltage and is applied to the traction inverters. DC link voltage varies with the throttle position from 600 V DC at Throttle - 1 to 2600 V DC at Throttle - 8. The inverter changes DC into variable AC power. The Loco is provided with self load feature, capable of testing full output of the engine

The Main Alternator Blower and Traction Motor Blower share a common housing mounted on the front side of the auxiliary generator. Although both the blowers are mounted on the auxiliary generator shaft an internal partition separates the two blower portions. Air is drawn from the central air compartment into the alternator blower close to the auxiliary generator and pass through a duct to the main alternator air box. Air from alternator blower first cools the main alternator rectifier banks then passes internally through the alternator and companion alternator to the engine room. This creates a slight positive pressure to keep the dirt from entering the engine room.

Companion alternator CA6B is a three phase AC steady state alternator of 250 kVA rating, which is physically connected but electrically independent of the main alternator. The companion alternator rotor field is excited directly by auxiliary supply of the loco (74+4 V DC). It receives the excitation current from the auxiliary alternator through a pair of slip rings which are located adjacent to the slip rings of the main alternator. The companion alternator develops power whenever the diesel engine is running. The output voltage is directly proportional to the speed of rotation but varies to some extent with change in alternator temperature and load. It is used for excitation of the main alternator as well as for supply to Inertial (dustbin) blower, TCC1 and TCC2 blower motor, TCC electronic blower, 55-220 V AC for radiator fans and various control circuits. An AC auxiliary alternator of 18 kW rating is used for meeting the auxiliary and control system load.

Outside air is cleaned by Inertial (dustbin) Blower, before it enters central air cabinet. In the Inertial Blower there are two inertial filter panels, one mounted on either side of the loco. Outside air is drawn rapidly through the tubes which contains specially designed vanes that induce a spinning motion to the contaminated incoming air. Dirt and dust particles, because they are heavier than air are thrown to the outer wall of the tube and carried to the bleed duct where it is removed by the scavenging action of the Inertial blower and expelled through the roof of the loco. The resulting clean air continues on through the smaller diameter portion of the tube where the air is again caused to swirl by internal vanes. The particles are carried to the bleed duct and the resulting clean air enters the central air compartment.

AC-AC transmission has the advantage of high adhesion and high tractive effort, maintenance free Siemens ITB - 2622 - 0TA02 3 - phase AC traction motors, high reliability and availability and higher energy efficiency. A specialty of this motor is that there is no separate stator frame resulting in reduction of weight. In braking mode, the three-phase motors act as generators and power is fed back to the DC link via the two inverters.

The Traction Motor Blower is mounted on the auxiliary generator, supplies air for traction motor cooling, generator pit aspirator operation, main electrical cabinet pressurisation and traction computer cooling. Air is drawn through a movable inlet guide vane through the blower, and delivered into a duct to the traction motors. A portion of this air is diverted through a set of filters for delivery to the computer module portion of traction inverter cabinets for module cooling. Another set of filters cleans the air used to pressurise the main electrical cabinet.

The loco has two inverters TCC1 and TCC2. The output converter, a pulse width modulated (PWM) inverter, is responsible for providing the variable frequency and the variable terminal voltage for the three-phase motor. The main alternator feeds electrical power to the DC link via two series connected diode rectifiers. Two identical PWM inverters TCC1 and TCC2 with GTO and their capacitors are connected electrically to the DC link via isolating switches. There is one traction inverter for each parallel set of three traction motors, which are responsible for supplying power to them. A protective circuit based on GTO is connected to the DC link to protect the inverters against any over-voltages. The TCC blower defuses heat produced by losses generated in TCC.

An electronic blower in each TCC cabinet driven by its own 3-phase AC motor draws the air from central air compartment in across the modules and expels it across the R2 snubber resistor. This air is used for cooling and pressurising in some parts of the inverter cabinet. This air keeps dirt from contaminating areas containing DC link capacitors, gate units and traction computers. The TCC blower motor is a dual speed 3-phase AC induction motor. It operates as a series-Y wound machine for lower speed (only low speed configuration is used on WDG4 locos). Power for the motors is taken from the companion alternator through the main contacts of TCC1SS and TCC2SS. EM2000 exercises control of the blower contactors at the request of the TCC via RS-485 serial link.

Radiator Cooling Fan Motors are of the inverted squirrel cage induction type and are integral part of the cooling fan assembly. Each cooling fan (total two per loco) is driven by a two-speed AC motor, which in turn is powered by the companion alternator. Cooling fans are powered through contactors, which are controlled by the EM2000 program. Each fan motor circuit consists of one slow-speed and two fast-speed contactors that are located in the AC cabinet.

The WDG4 loco is equipped with a microprocessor based computer control system. It provides fault detection of components and systems, it contains 'self tests' to aid in trouble shooting loco faults. It has basic features like, significant reduction in number of control modules, better fault detection of components, memory archive and data snap shot. The microprocessor EM2000 is the loco control computer. EM 2000 utilises "Flash PROM" memory. It is a 32 bit computer based on Motorola 68020 microprocessor running at 16 MHz with a math co-processor communication through RS-232 serial cable / port. EM 2000 controls the main loco functions based on inputs from two traction computers. This system is equipped with a diagnostic display system in the cab to provide an interface between the maintenance personnel and the computer. The computer is programmed to monitor and control loco traction power, record and indicate faults that have been incorporated into EM 2000 system. The Loco is provided with event recorder, which downloads various parameters for EM 2000 for later use

The loco is equipped with KNORR/NYAB make CCB(computer controlled braking) 1.5 system. This system is an electro-pneumatic microprocessor based system with 30A CDW type desktop controls. The overall purpose of using a computer (microprocessor) to control the air brake system is to eliminate as many of the electrical and mechanical devices as possible, thereby reducing periodic maintenance, simplifying trouble shooting, fault diagnostics etc. It allows greater reliability and flexibility for future system upgrade.

These locos are provided with a special feature called blended brake. The purpose of blended brake system is to maximize the use of dynamic braking. This is accomplished by causing dynamic braking to go its maximum value whenever blending is requested. Once the amount of asking brake effort is determined, the maximum amount of dynamic brake effort is determined from the flat top portion of dynamic brake curve. The amount of dynamic brake effort present at that time, then determines how much air brake cylinder pressure must be applied to complement the dynamic brake effort. This becomes the air brake cylinder reference value, which in turn, maintains the asking loco brake effort

Each unit of the Dynamic Brake Grid Blower Assembly consists of fan assembly powered by a 36 HP series wound DC motor. During dynamic braking, a portion of the current (rectified DC) from the traction motors is shunted around one of the resistor grids and used to power the grid blower motor. Air driven by the grid blower drives grid heat to atmosphere.

There are two SIBAS 16 traction control computers. Each computer is dedicated to one inverter. SIBAS 16 is a 16-bit computer based on an INTEL 8086 microprocessor running at 5.6 MHz. The TCC receives data via RS-485 serial link from the loco computer EM2000. The bi-directional bus carries data such as how much power for traction the TCC must develop as well as other information to control activation of devices like blowers and heaters. In addition to the RS-485 data, information constantly gets fed back into the TCC, to monitor various things such as status of relays and temperature of various components, voltages and currents. Based on this feedback data and information received via RS-485 serial link, the programs stored in the TCC work to drive the TCC as well as to protect it in the event of faulty operating conditions.

The WDG4 loco is equipped with a high adhesion HTSC (High Tensile Steel Cast) truck or bogie. The bogie assembly supports the weight of the loco and provides the means for transmission of power to the rails. The HTSC bogie is designed as a powered 'bolsterless unit'. Although the bogie or truck frame itself is rigid, the design allows the end axles to move or "yaw" within the frame. This movement will allow the wheels to position themselves tangent to the rails on curves for reduced wheel and rail wear. Axles 1 and 3 can move or kink a little bit to negotiate a curve from 0-8 degree deflection, increases the tractive effort and improves the rolling resistance. Traction loads are transmitted from the truck or bogie to the loco underframe through the carbody pivot pin assembly. Each bogie is equipped with three unidirectional AC traction motors for better adhesion characteristics. The motors are geared to the driving axles, which in turn apply rotational force to the rails through the wheels. The driving force is transmitted to the bogie through tractive rod attached to the journal-bearing adapter in the frame. From the truck / bogie frame the driving force is transmitted to the loco carbody through the carbody pivot pin.

Each loco is an independent power source. Several units may be combined for multiple operation to increase the load capacity.

The WDG4 loco has been designed on the 'platform' concept which means that the layout and the mounting of equipment is arranged in such a manner that retrofitment of equipment developed in future on existing locos as well as equipment changes/upgradation of the existing design of the loco can be implemented without any major change in the underframe, structure and even layout.

14.11. WDP-4 CLASS, 3 PHASE (A-A-1 1-A-A), DIESEL ELECTRIC LOCO

10 locos of 4000hp GT46PAC with 710 – G3B fuel-efficient engine, were supplied by GM / USA and were put on line in year 2001.

The design features of WDP4 is similar to that of WDG4 Locos. The only difference between WDP4 & WDG4 Locos is that the traction motor available in WDP4 Locos is Siemens ITB - 2622 - 0TB02 3 -phase AC traction motors.

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DIFFERENCES BETWEEN GT46 PAC (WDP4) & GT46 MAC (WDG4)

S.No	GT46 PAC / WDP4	GT46 MAC / WDG4
1.	Max. speed – 160 Km/h	Max. speed – 100 Km/h
2.	Axle load – 19.5 T	Axle load – 21T
3.	Max. Tractive effort – 27550 Kg.	Max. Tractive effort – 53000 Kg.
4.	A-A-I I-A-A Bogie	CO – CO Bogie
5.	Two traction motors in each bogie	Three traction motors in each bogie
6.	**Siemens traction motor ITB – 2622 - 0TB02** • Gear ratio : 17/77 • Max. power – 765 kW, • Max. speed – 3776 rpm	**Siemens traction motor ITB – 2622 - 0TA02** • Gear ratio : 17/90 • Max. power – 630 kW, • Max. speed – 3320 rpm
7.	**Traction Motor Blower** ➢ Air flow requirement – 1.2 m^3/s ➢ Cfm - 12450 ➢ Static pressure – 14.3 inch w.g. ➢ BHP – 65	**Traction Motor Blower** ➢ Air flow requirement – 1.0 m^3/s ➢ Cfm - 17550 ➢ Static pressure – 16.5 inch w.g. ➢ BHP – 125

14.12. WDP-4B CLASS, CO-CO, DIESEL ELECTRIC LOCO

First WDP-4B loco was manufactured by DLW in year 2007. Horse Power of WDP4 loco was increased to 4500 HP and number of traction motors increased to six (from four in WDP4) and this loco was designated as WDP-4B. All other design features of both the locos are identical. Fitment of Six TM's has improved top notch tractive effort and closer dispersion of tractive effort at higher notches

14.13. WDP-4D CLASS, CO-CO, DIESEL ELECTRIC LOCO

To overcome the visibility constrain being faced by Loco Pilots, twin cab version of WDP4B locos, was jointly developed by DLW and RDSO. This loco was designated as WDP-4D. First such loco was turned out from DLW in 2009.Provision of twin cab has sufficiently improved the visibility for crew and. With the use of fabricated bogie and optimized under frame, an axle load of 20.5 t has been maintained despite accommodating an additional cab at radiator end.

14.14. WDG-5 CLASS, CO-CO, DIESEL ELECTRIC LOCO

Indian Railways was actively looking for ways to enhance the horse power of its current fleet to meet the current demand for higher horse power locos to address the growing need for hauling heavier trains and higher throughput. With this intention, Indian Railways evaluated various options to enhance the horse power of EMD design locos. Indian Railways had entered into a TOT contract with M/s EMD/ USA in 1995, which included a transfer of technology for manufacture of WDG4 loco and also included a transfer of technology for EMD's 5000+hp 20 cylinder 710 series engine (loco application only). Since, present 16 cylinder engine was not capable of being upgraded beyond 4500hp, it was decided that the 20-710 engine would be ideal platform for enhancing the current power of the WDG4 to 5000+hp.

Hence, the 5500 HP design of EMD loco, called WDG5 was developed jointly by EMD and IR. It brings to IR advanced technologies such as Electronic Fuel Injection (For higher duel efficiency and emission control), Electrically Driven Auxiliaries (for higher reliability and energy efficiency) and user friendly driver console FIRE amongst other state of the art technologies. Both DLW and RDSO have been active partners in the design of this unique loco which provides enhanced 5500 HP within the constraints of axle load. The first WDG5 loco manufactured by DLW in year 2012.

The design of the WDG5 is a logical and technological extension of the knowhow originally procured by IR from EMD. It is also significant that the 5500 HP version of diesel loco as developed jointly by IR and EMD, is unique in the world where the standard configuration of power in modern freight loco is either 4000/4500 or 6000.

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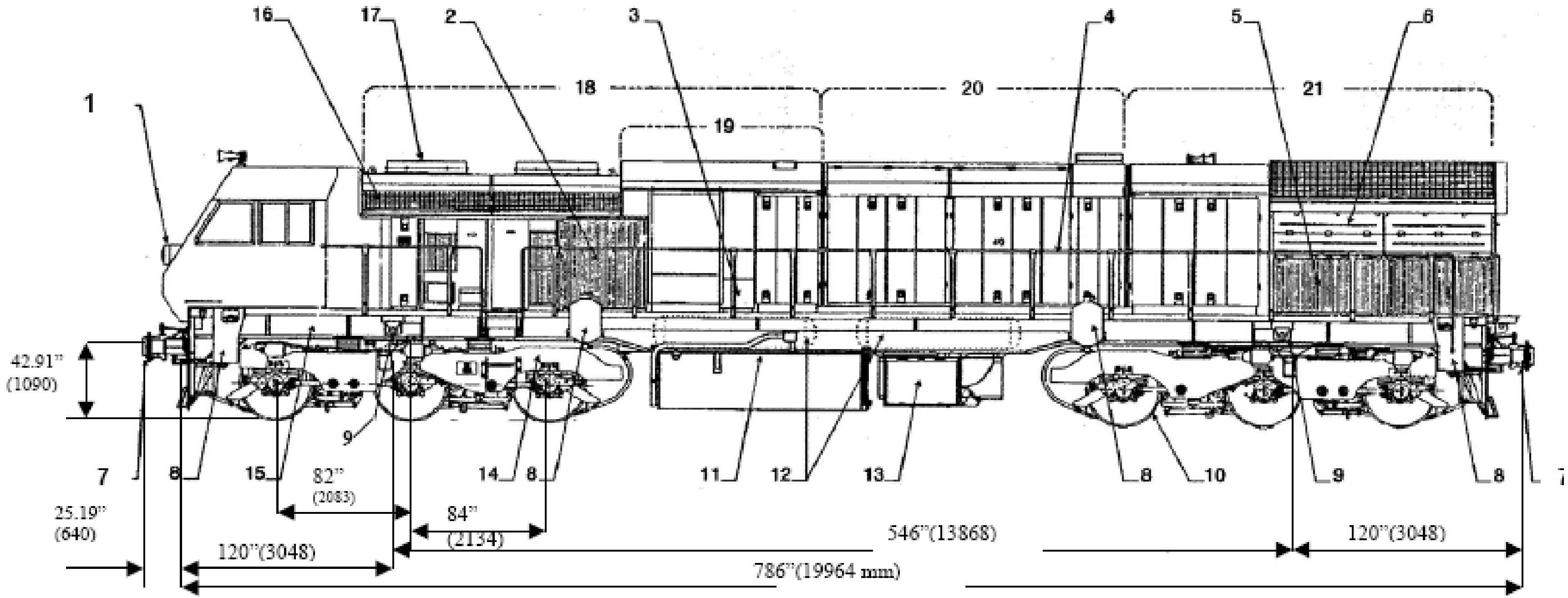
14.15. WDG-4D CLASS, CO-CO, DIESEL ELECTRIC LOCO

RDSO & DLW have jointly developed and manufactured in year 2013 a 4500 hp Freight Loco having twin cab so as to improve visibility for the crew.



1) Head Light
2) Inertial Filter Air Inlet
3) Starting Fuse and Battery Knife Switch
4) Handrails
5) Cooling System Air Inlet
6) Radiator and Fan Access
7) Coupler "E/F" Type
8) Sanding Box (8)
9) Jacking Pads (4)
10) Wheels (6)
11) Fuel Tank
12) Compressed Air System Main Reservoirs
13) Battery Box
14) Trucks (3 axles 2 motors HTSC type) Qty.2
15) Underframe
16) Dynamic Brake Grids
17) Dynamic Brake Fans (2)

CLASS	TYPE	GAUGE	SERVICE
WDP4	A-A-I	1676mm	PASSENGER

Equipment location
Figure – 1
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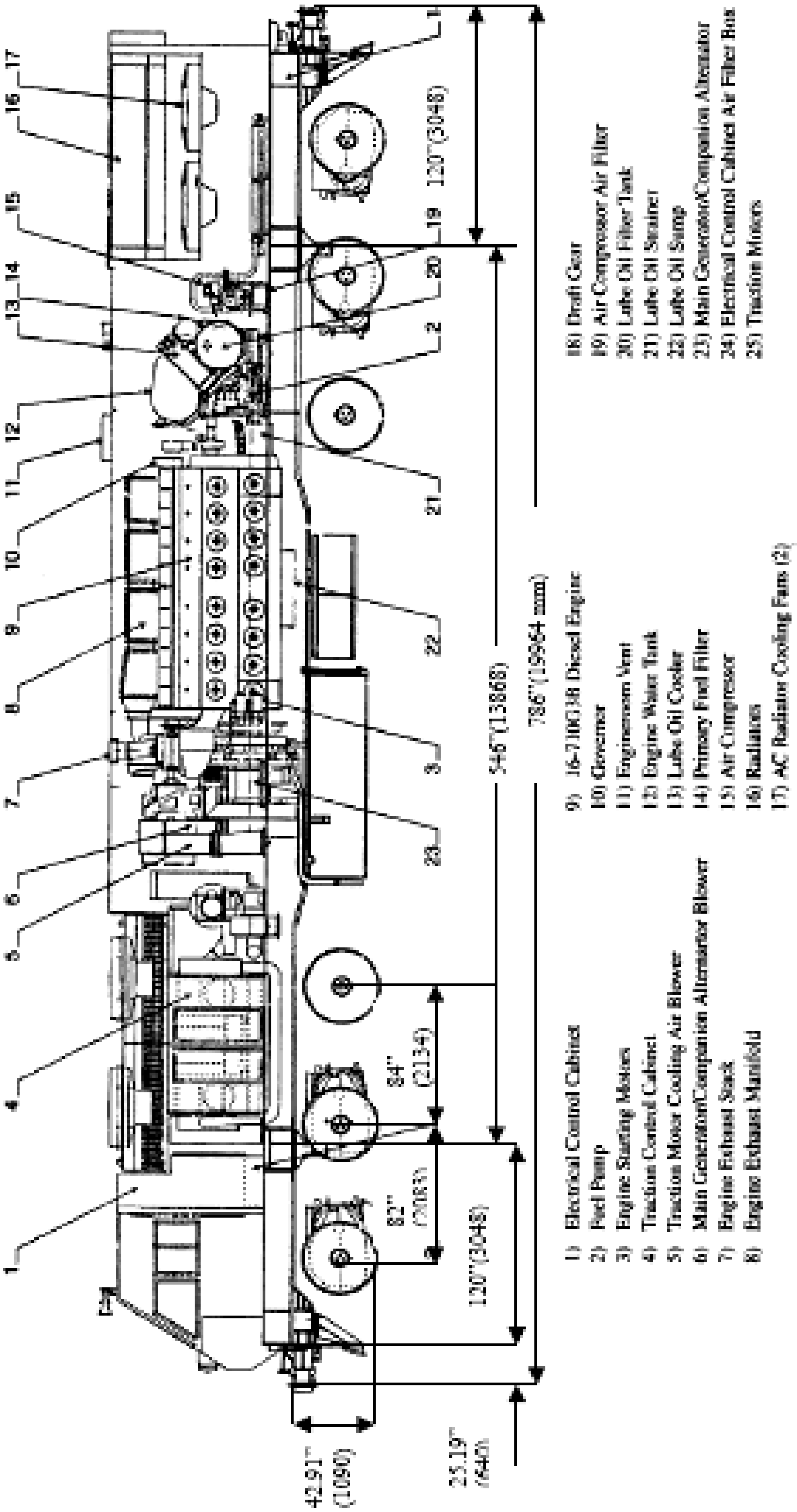
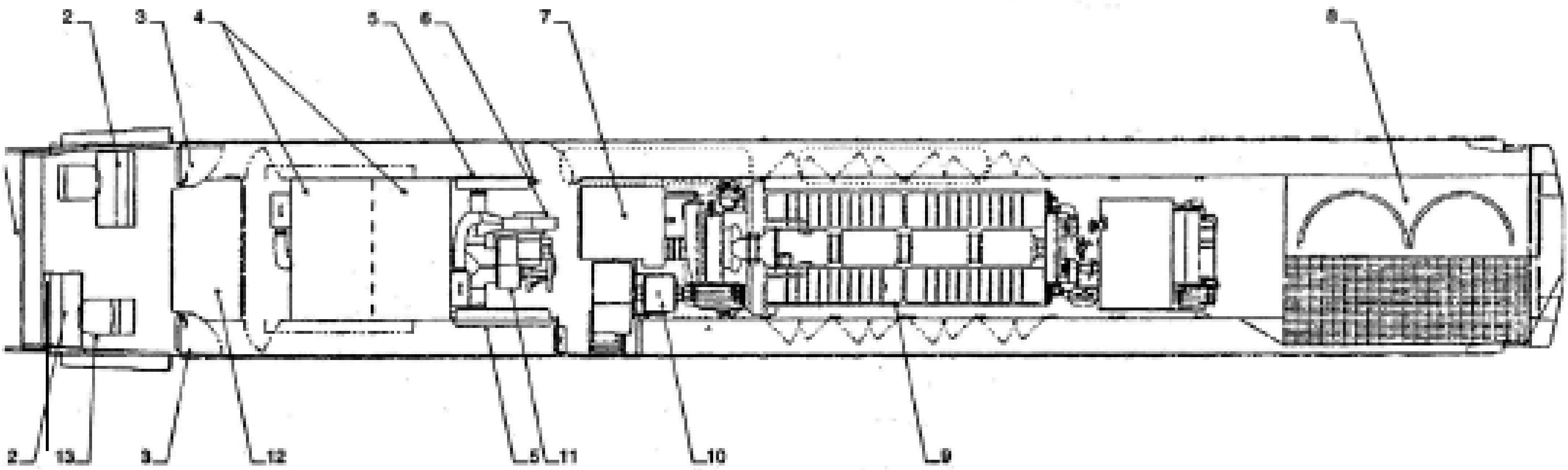


Equipment location

CLASS	TYPE	GAUGE	SERVICE
WDP4	A-A-I	1676mm	PASSENGER



1) Air Brake Rack
2) Engineers Control Console
3) Cab Door
4) Traction Control Cabinets
5) Inertial Air Filters
6) TCC Electronics Blower
7) Engine Air Filter
8) Radiators
9) Engine
10) AC Auxiliary Generator
11) Inertial Filter Dust Bin Blower and Motor
12) Electrical Control Cabinet
13) Cab Seat

CLASS	TYPE	GAUGE	SERVICE
WDP4	A-A-I	1676mm	PASSENGER

Equipment location

Annexure 14.1

DETAILS OF ELECTRICAL EQUIPEMENTS OF DIESEL ELECTRIC LOCOS

SN	TYPE OF LOCO	Description				
		Traction Generator / Alternator	**Traction Motor**	**Auxiliary Generator**	**Exciter**	**Batteries**
1	**WDM 2**	**Generator** GE/GT 586, max speed: 1000 rpm, Max Voltage: 780 V, Max current:5600 A, Weight: 5800 kg	GE/GE 752, 6 Nos, Cont. current: 975 A, Cont. Voltage: 288 V, one hour rating current 1000A, Max speed: 2445 rpm, Axle hung suspension, Weight: 3382 kg	GE/5GY 27, absorbed HP: 17 hp, rating: 12 KW. 75V @ 850/ 2400 rpm.	5GTA 6A1, HP absorbed: 12 hp, rating: 12 KVA, 200V, 2400 rpm, weight: 196 kg	Exide, Lead acid MGD-19, 64 Volts, 32 Cells, 450 AH (10 hr)
		BHEL/TG 5301BX, max speed: 1000 rpm, Max Voltage: 700±5 V, Max current:4520 A, Weight: 6075 kg BHEL/TG 10931AZ/M max speed: 1000 rpm, Max Voltage: 770±5 V, Max current: 4520 A,	BHEL TM 165/M BHEL TM 4906AZ 6 Nos, Cont. current: 980 A, Cont. Voltage: 285 V, one hour rating current 1050A, Max speed: 2275 rpm, Axle hung suspension, Weight: 3340 kg	BHEL/AG 51 absorbed HP: 17 hp, rating: 12 KW, 160A, 75V @ 850/ 2400 rpm Weight: 278 kg		
2	**WDM 3A (WDM2C)**	**Traction Alternator** BHEL TA 10102 CW max speed: 1050 rpm, Max Voltage: 1100 V, Max current:4400 A, Continuous rating- Low voltage: 3700A, 525 V, High voltage: 1760 A, 1100 V, Weight: 6400 kg	BHEL TM 4906AZ/ 4907 BZ 6 Nos, Cont. current: 1000 A, Cont. Voltage: 325 V, one hour rating current 1060A, Max speed: 2275 rpm, Axle hung suspension, Weight: 3690 kg	BHEL AG 3101AY/ AG 3101AY-1 absorbed HP: 17 hp, rating: 160A, 75V @ 950 rpm Weight: 435 kg	BHEL AG 3101AY absorbed HP: 30 hp, rating: 80V, 250 A @ 950 rpm Weight: 435 kg	Exide, Lead acid 4HMFG31KP, 32 cells, 64V, Capacity: 450AH (10 Hr)
				AG 2702AZ absorbed HP: 17 hp, rating: 160A, 75V @ 950 rpm Weight: 365 kg	AG 2702AZ absorbed HP: 30 hp, rating: 90V, 220 A @ 950 rpm Weight: 365 kg	
3	**WDM 3D**	**Traction Alternator.** BHEL TA 10102 EV, max speed: 1050 rpm, Max Voltage: 1100 V, Max current:4200 A, Continuous rating- Low voltage: 3600A, 585 V, High voltage: 1938 A, 1075 V, Weight: 6400 kg	BHEL TM 5002 BY/ CGL 7362A, 6 Nos, Cont. current: 925 A, Cont. Voltage: 380 V, one hour rating current 950A, Max speed: 2179 rpm, Axle hung suspension, Weight: 3250 kg	BHEL AG-3101AY-1, absorbed HP: 17 hp, rating: 75V, 160 A @ 950 rpm, weight: 435 kg	AG-3101AY-1/ AG 3101 AY, absorbed HP: 30 hp, rating: 80V, 250 A @ 950 rpm, weight: 435 kg	Exide, Lead acid 4HMFG 31KP 64 Volts, 32 Cells, 450 AH (10 Hr)
4	**WDG 3A (WDG2)**	**Traction Alternator** BHEL TA 10102CW, max speed: 1050 rpm, Max Voltage: 1100 V, Max current:4400 A, Continuous rating- Low voltage: 3700A, 525 V, High voltage: 1760 A, 1100 V, Weight: 6400 kg	BHEL TM 4906 AZ/ TM 4906 BZ & TM 4907 AZ/ 4907 BZ 6 Nos, Cont. current: 1000 A, Cont. Voltage: 325 V, one hour rating current 1060A, Max speed: 2275 rpm, Axle hung suspension, Weight: 3650 kg (TM 4906), 3750 kg (TM 4907)	BHEL AG 3101 AY/ AG 3101 AY-1 absorbed HP: 17 hp, rating: 75V, 160 A @ 950 rpm, weight: 435 kg	AG 3101 AY absorbed HP: 30 hp, rating: 80V, 250 A @ 950 rpm, weight: 435 kg	Exide, Lead acid 4HMFG 31KP, 32 cells, 64V, Capacity: 450AH (10 Hr)
			CGL TM 7362, 6 Nos, Cont. current: 900 A, Cont. Voltage: 363 V, one hour rating current 950A, Max speed: 2300 rpm, Axle hung suspension, Weight: 3250 kg	AG 2702 AZ, absorbed HP: 17 hp, rating: 75V, 160 A @ 950 rpm, weight: 365 kg	AG 2702 AZ, absorbed HP: 30 hp, rating: 90V, 220 A @ 950 rpm, weight: 365 kg	
5	**WDP 4**	**Traction Alternator** Weight (TA&CA): 8709 kg approx. GM TA -17, Max speed: 904 rpm, max. cont. voltage: 2600V DC, Max. cont. current: 1250A DC Companion Alt CA6B, Max. voltage: 230V AC, Frequency at 904 rpm: 120 Hz, Max power: 250 KVA	Siemens ITB-2622-0TB02, Cont. Voltage/ nominal rating: 2027V AC/ 638 kW, Max speed: 3776 rpm Axle hung suspension/tapered roller bearing, weight (with pinion, gear & gear case): 3016 kg	GM 5A-8147, HP absorbed: 18 kW, Rating: 74 V DC, 904 rpm	GM CA-6B, HP absorbed: 250 kVA, rating: 250 V AC, 904 rpm, weight: 647 kg	Make & type: Surrette, 16 CH-25 unitized 10 cells, Arrangement: 2 series connected, 5 cell NI-Cadmiun shaft-nife SRX1500P batteries, Voltage: 72.5 V DC, Capacity: 500 AH (8 hr)

SN	TYPE OF LOCO	Description				
		Traction Generator / Alternator	**Traction Motor**	**Auxiliary Generator**	**Exciter**	**Batteries**
6	**WDG 4**	**Traction Alternator** Weight (TA&CA): 8709 kg approx. GM TA -17, Max speed: 904 rpm, max. cont. voltage: 2600V DC, Max. cont. current: 1250A DC Companion Alt CA6B, Max. voltage: 230V AC, Frequency at 904 rpm: 120 Hz, Max power: 250 KVA **AC/DC - Alternator:** BHEL TA-10105 AZ, Max Volt: 750V, Max Current: 3600 A, Unit weight: 5675 kg	Siemens ITB-2622-0TA02, Cont. Voltage/ nominal rating: 2027V AC/ 500 kW, Max speed: 3220 rpm Axle hung suspension/tapered roller bearing, weight (with pinion, gear & gear case): 3016 kg	GM 5A-8147, HP absorbed: 18 kW, Rating: 74 V DC, 904 rpm **AC/DC**: BHEL AG 3101 AY. HP absorbed: 17, Rating: 75V, 160A, 18.75 KW, Weight: 278 kg	GM CA-6B, HP absorbed: 250 kVA, rating: 250 V AC, 904 rpm, weight: 647 kg	Make & type: Surrette, 16 CH-25 unitized 32 cells, Arrangement: 2 series connected, 16 cell lead acid batteries, Voltage: 64, Capacity: 500 AH (8 hr)
7	**WDG5**	GM TA -20 MBF, Max speed: 904 rpm, Nominal voltage: 2450V DC, Nominal current: 1575A DC Companion Alt CA9E,	A2921-6, Three phase AC	Auxiliary Power Converter (APC) Range: 44.4 VAC / 26.7 HZ @ 200 rpm (idle) : 200 VAC /120 HZ @ 904 RPM (full)	---	SAFT SRX1500P, Qty: 2 Nos/ loco, 5 cells/unit, Capacity: 155 AH, Ni-Cad

Annexure 14.2

DIESEL LOCOS ON INDIAN RAILWAY – ALCO LOCO PARAMETERS

SN	Description	WDM1	WDM4	WDM3	WDM7	WDP1	WDP3A
1.	**Name given**					Chetak	
2.	**Induction in IR**	1957	1962	1970	1987	1995	1998
3.	**Production continuing as on 31.03.2013**	No	No	No	No	No	No
4.	**Number of locos as on 31.03.2013**	0	0	0	14	62	40
5.	**Service**	Mixed	Mixed	Mixed	Mixed	Coaching	Coaching
6.	**Length in mm (over Buffers)**	18047	18540		16208	16092	19182
7.	**Width in mm**	2845	3088		2914	3016	3000
8.	**Height in mm**	3994	4087		4185	4162	4185
9.	**Top of U/Frame from R/L**	---	---			1690	1728
10.	**Buffer height from Rail (mm)**	1066	1066		1068/ 1090	1090	1090
11.	**Weight in working order (t)**	111.6	112.8		96.0	80.0	117
12.	**Adhesive wt. in working order (t)**	111.6	112.8		96.0	80.0	117.0
13.	**Axle Load in (t)**	18.6	18.8		16	20	19.5
14.	**Adhesion in %**	---	---		---	25	25
15.	**Wheel Dia. New / Cond. In mm**	1016	1092		1092	1092 1016	1092 1016
16.	**Type of bogie & Wheel arrgt.**	Single centre pivot on to a cast steel double bolster attached with swing links to the bogie frame.	H design bogie bolster supported by helical springs		Trimount CO-CO type, 2side bearers, 1centre pivot	Bolster less BO-Bo type, Flexi coil (side spring groups, centre pivot)	CO-CO type, flexi coil MK-V bogies, 1centre pivot, secondary springs
17.	**Suspension arrgt.**					2 stage, Primary & secondary springs with hyd.dampers in primary & secondary stage.	2 stage, Primary & secondary springs with vertical & lateral hydraulic dampers in primary & secondary stage.
18.	**Bogie Structure**	Cast steel				Fabricated	Cast steel
19.	**Weight transfer**				C.P 60% S.B 40%	Side spring group 100%	CP/side springs
20.	**Tractive effort in Kgs - Max.**	27900	28200		25920	20000	29250
21.	**Tractive effort in Kgs - Cont.**	19300	20600		DC/DC: 18900 AC/DC: 21500	16400	19950
22.	**Maximum Rated speed KMPH**	104	120		DC/DC: 105 AC/DC: 100	120	160
23.	**Min. continuous speed in KMPH**	19.0	24		DC/DC: 21.7 AC/DC: 18.1	29	32
24.	**Speed cleared by RDSO**					105/120	105/140
25.	**Fuel oil capacity in Liters, 1-No/Loco**	6060	5000		3200	3000	5000
26.	**Lube oil capacity in Liters**	756	830		756	760	1270
27.	**Cooling water capacity in Ltrs**					1210	1210

SN	Description	WDM1	WDM4	WDM3	WDM7	WDP1	WDP3A
28.	**Sand cap.(cu.m)/ No.of boxes**	0.40/4	0.34/ 8		0.4/4		
29.	**Rated HP of Eng**	Standard: 1977 hp. At site: 1856 hp	Standard: 2600 hp. At site: 2400 hp		UIC 1977 hp, At site: 1856 hp	UIC condition: 2300 hp, At site (47C-600m): 2231 hp	UIC condition: 3100 hp, At site (47C-600m): 3007 hp
30.	**HP available for traction**					2000	2750
31.	**Make, type of Engine, 1 per loco**	DLW 251B	GM 567D3		DLW- 251 B	DLW-251B (uprated)FE Weight (dry): 14982 kg	DLW-251B (uprated) FE, Weight (dry): 19026 kg
32.	**No. of Cylinders & arrangement**	12-45 deg V, 4 stroke	16-45 deg V, 2 stroke		12 – 45 deg V	12-45 deg.V 4 stroke	16-45 deg.V 4 stroke
33.	**Gear ratio**	94/17	61/16		94/17	18/65	22/61
34.	**Loco drive - left/right hand**					LH	LH
35.	**Dynamic brake facility**	Available	Available		Not Available	Not Available	Not Available

DIESEL LOCOS ON INDIAN RAILWAY - ALCO LOCO PARAMETERS

SN	Description	WDM2	WDM3A	WDG3A	WDM3D		WDM3F
1.	**Name given**		Gajraj	Shakthi	**With Equal beam**	**Without Equal**	**Without Equal**
2.	**Induction in I R**	1962	1994	1995	2003	2009	2009
3.	**Production continuing as on 31.03.2013**	No	Yes	Yes	No	Yes	No
4.	**Number of locos as on 31.03.2013**	642	1119	1133	350		4
5.	**Service**	Mixed	Mixed	Freight	Mixed	Mixed	Mixed
6.	**Length in mm (over Buffers)**	17120	17145	19132	18632	18632	19920
7.	**Width in mm**	3010	3010	3016	3090	3090	3084
8.	**Height in mm**	4185	4185	4162	4265	4265	4265
9.	**Top of U/Frame from R/L**	1600	1600	1654	1735	1735	-
10.	**Buffer height from Rail (mm)**	1090	1090	1090	1090	1090	1090
11.	**Weight in working order (t)**	112.8	112.8	123.0	117	118.2	120
12.	**Adhesive wt. in working order (t)**	112.8	112.8	123.0	117	---	---
13.	**Axle Load in (t)**	18.8	18.8	20.5	19.5	19.7	20
14.	**Adhesion in %**	27	27	33	33	33	---
15.	**Wheel Dia. New / Cond. In mm**	1092 1016	1092 1016	1097 1012/1008	1092 1016	1092 1016	1092 1016
16.	**Type of bogie & Wheel arrgt.**	Trimount CO-CO type, 2side bearers, 1centre pivot	Trimount CO-CO type, 2side bearers, 1centre pivot	Bolsterless high adhesion HAHS Co-Co type, 4 side load pads, 1cent pivot	Bolsterless high adhes HAHS Co-Co type, 4 side load pads, 1center pivot	Bolsterless high adhes HAHS Co-Co type, 4 side load pads, 1center pivot	Bolsterless high adhes HAHS Co-Co type, 4 side load pads, 1center pivot
17.	**Suspension arrgt.**	4 group of springs, 2 outer and 2 inner helical coils with friction snubbers and Equaliser beams (Long & Short)	4 group of springs, 2 outer and 2 inner helical coils with friction snubbers and Equaliser beams (Long & Short)	2 stage, Helical springs in primary & Rubber sandwitch springs in secondary, Equalizer & compensating beams with Vertical & Lateral hydraulic Dampers in Primary & Secondary stage.	2 stage, Helical springs in primary & Rubber sandwitch springs in secondary, Equalizer & compensating beams with Vertical & Lateral hydraulic Dampers in Primary & Secondary stage.	2 stage, Helical springs in primary & Rubber sandwitch springs in secondary with Vertical & Lateral hydraulic Dampers in Primary & Secondary stage.	2 stage, Helical springs in primary & Rubber sandwitch springs in secondary with Vertical & Lateral hydraulic Dampers in Primary & Secondary stage.
18.	**Bogie Structure**	Cast steel	Cast steel	Fabricated	Fabricated	Fabricated	Fabricated
19.	**Weight transfer**	C.P 60% S.B 40%	C.P 60% S.B 40%	Side load pads 100%	Side load pads 100%	Side load pads 100%	Side load pads 100%
20.	**Tractive effort in Kgs - Max.**	30450	30450	40600	38610	38610	38500
21.	**Tractive effort in Kgs - Cont.**	24600	28050	31920	25950	25950	
22.	**Maximum Rated speed KMPH**	120	120	100	120	120	120
23.	**Min. continues speed in KMPH**	18	22.8	20	26.1	26.1	
24.	**Speed cleared by RDSO**	105/120	105/120	105	105/120	105/120	80 (Prov)

SN	Description	WDM2	WDM3A	WDG3A	WDM3D		WDM3F
25.	**Fuel oil capacity in Liters, 1-No/Loco**	5000	5000	6000	5000	5000	5000
26.	**Lube oil capacity in Liters**	1070	1270	1270	1270	1270	1270
27.	**Cooling water capacity in Ltrs**	1210	1210	1210	1210	1210	1210
28.	**Sand cap.(cu.m)/ No.of boxes**	0.40/4	0.16m^3/4	0.16m^3/4	0.16m^3/4	0.16m^3/4	0.04m^3/8
29.	**Rated HP of Eng**	2600	UIC condition: 3100 hp, At site (47C-600m): 3007 hp	UIC condition: 3100 hp, At site (47C-600m): 3007 hp	UIC condition: 3300 hp, At site (47C-600m): 3152 hp	UIC condition: 3300 hp, At site (47C-600m): 3152 hp	3600 hp
30.	**HP available for traction**	2400	2750	2750	2950	2950	3300
31.	**Make, type of Engine, 1 per loco**	ALCO/DLW 251-B . Weight (dry): 14682 kg	DLW-251B (uprated) FE Weight (dry): 19026 kg	DLW-251B (uprated) FE Weight (dry): 19026 kg	DLW-251B (uprated)FE, Weight (dry): 19026 kg	DLW-251B (uprated)FE, Weight (dry): 19026 kg	DLW-251B (uprated)FE
32.	**No. of Cylinders & arrangement**	16-45 deg.V 4 stroke	16-45 deg.V 4 stroke	16-45 deg.V 4 stroke	16-45 deg.V 4 stroke	16-45 deg.V 4 stroke	16-45 deg.V 4 stroke
33.	**Gear ratio**	18/65	18/65	18/74	18/65	18/65	18/65
34.	**Loco drive - left/right hand**	RH	LH	LH	LH	LH	LH
35.	**Dynamic brake facility**	Available	Available	Available	Available	Available	Available

Annexure 14.3

DIESEL LOCOS ON INDIAN RAILWAY - HHP LOCOS PARAMETERS

SlNo	Description	WDG4	WDP4	WDG5
1	**Induction in I R**	2000-01	2001-02	2012-13
2	**Service**	Freight	Coaching	Freight
3	**Length in mm (over Buffers)**	21240	21240	22262
4	**Width in mm**	3070	3070	3250
5	**Height in mm**	4220	4220	4357
6	**Buffer height from Rail (mm)**	1090	1090	1090
7	**Weight in working order (t)**	126 t	117 t	134 t
8	**Adhesive wt. in working order (t)**	126	78	
9	**Axle Load in (t)**	21	19.5	22.3
10	**Adhesion in %**	42	42	
11	**Wheel Dia. New / Cond. In mm**	1092/1016	1092/ 1016	1092/1016
12	**Type of bogie & Wheel arrgt.**	Bolsterless high adhes HTSC CO-CO type, 4 side load pads, 1centre pivot	Bolsterless high adhes HTSC A-A-1, 1-A-A type, 4 side load pads, 1centre pivot	High Tensile Cast Fabricated (HTCF) bogie frame assemblies Co-Co
13	**Suspension arrgt.**	2 stage, Helical springs in primary & Rubber sandwich springs in secondary with Vertical & Lateral hydraulic Dampers in Primary & Secondary stage.	2 stage, Helical springs in primary & Rubber sandwich springs in secondary with Vertical & Lateral hydraulic Dampers in Primary & Secondary stage.	bolster-less secondary suspension system
14	**Bogie Structure**	Cast steel (HTSE)	Cast steel (HTSE)	High Strength Low Alloy steel
15	**Weight transfer**	Side load pads 100%	Side load pads 100%	Side load pads 100%
16	**Tractive effort in Kgs - Max.**	53000	27550	560 KN
17	**Tractive effort in Kgs -Cont.**	40774	20377	405 KN
18	**Maximum Rated speed KMPH**	100	160	105
19	**Min. continuous speed in KMPH**	20	22.5	30.6
20	**Speed cleared by RDSO**	105	105/160	105
21	**Fuel oil capacity in Liters, 1-No/Loco**	6000	6000	7500

SlNo	Description	WDG4	WDP4	WDG5
22	**Lube oil capacity in Liters**	950	1073, lube oil pan, bottom to top dipstick: 371	1596
23	**Cooling water capacity in Ltrs**	1045	1045	1235
24	**Sand cap.(cu.m)/ No.of boxes**	0.04/8	0.028/8	10 Cu ft/
25	**Rated HP of Eng**	AAR condition: 4132 CV, At site (47C-600m): 4012 CV	AAR condition: 4132 CV, At site (47C-600m): 4012 CV	5500 hp
26	**HP available for traction**	3726, Input to traction: 3780 CV	3726, Input to traction: 3780 CV	5332 Input to traction under site condition :
27	**Make, type of Engine, No per Loco**	GT 46 MAC 710 G3B, Weight (dry): 17963 kg	GT 46 MAC 710 G3B, Weight (dry): 17963 kg	710-G3B-ES
28	**No.of Cylinders & arrangement**	16-45 deg.V, 2 stroke	16-45 deg.V, 2 stroke	20- 45 Deg V, 2 stroke
29	**Bore and Stroke**	230.19 x 279.4	230.19 x 279.4	230.19 X 279.4
30	**Compression Ratio**	16:1	16:1	16:1
31	**Engine RPM idle**	269/200	269/200	200
32	**Engine RPM Max**	904	904	904
33	**Engine RPM during OSTA trapping**	990-1045	990-1045	---
34	**Firing Order**	1,8,9,16,3,6,11,14, 4,5,12,13,2,7,10,15	1,8,9,16,3,6,11,14, 4,5,12,13,2,7,10,15	1,19,8,11,5,18,7,15,2,17, 10,12,3,20,6,13,4,16,9,14
35	**Mean Piston speed M/sec**	8.38	8.38	---
36	**B.M.E.P (Kg/Sq.cm)**	11.23	11.23	---
37	**Type of Transmission (Electric)**	AC/DC	AC/DC	AC/DC
38	**Type of Turbo & make**	EMD Model G. Weight: 953 kg	EMD Model G	
39	**Type of Engine Governor**	WW	WW	
40	**Fuel injection system, Type of pump & Injector**	Direct Unit injection system, Displacement/ cyl: 11635 cm^2	Direct Unit injection system, Displacement/ cyl: 11635 cm^2	Electronic fuel injection with EMDEC, Displacement/ cyl: 11635 cm^2
41	**Cooling water system, pump type, & capacity**	Two water pumps, engine driven, Centrifugal, 3785 l/m @ 900 rpm	Two water pumps, engine driven, Centrifugal, 3785 l/m @ 900 rpm	
42	**Engine cooling**	Two radiator fans drive with AC motor of 113.4 hp	Two radiator fans drive with AC motor of 113.4 hp	One radiator fans drive with AC motor of 100 hp
43	**Lube oil system**	4 Lube oil pumps	4 Lube oil pumps	
44	**Engine air intake system**	Inertial with baggy type secondary filters (cyclonic)	Inertial with baggy type secondary filters (cyclonic)	
45	**Creation of Air and vacuum**	Compressor	Compressor	Compressor
46	**Cooling compressor/ Exhauster**	Water cooled KNORR (NYAB)	Water cooled KNORR (NYAB)	
47	**Traction motor isolation**	Full truck to be isolated in which defective motor is available	Full truck to be isolated in which defective motor is available	
48	**No. of transitions**	0	0	
49	**Traction motor arrangement**	LLL/RRR	LL/RR	
	No.of T.M's	6 (3 in parallel per bogie)	4 (2 in parallel per bogie)	
50	**Gear ratio**	17/90	17/77	90/21
51	**Engine cranking done by**	2 DC Starter motors	2 DC Starter motors	2 Air starting motors
52	**Master controller model**	Reversor handle,throttle handle,DB handle	Reversor handle,throttle handle,DB handle	
53	**Loco drive - left/right hand**	LH	LH	LH
54	**Min.radius of curvature in meters**	64.92	73.2	
55	**Brake system**	CCB (Electro pneumatic type), Air/Hand brake, Train: pure air brake	CCB (Electro pneumatic type) Air/Hand brake, Train: pure air brake	KNORR/NYAB-CCB1-IR, Microprocessor controlled air brake.
56	**Brake effort in tonnes**	27.534		
57	**Dynamic brake facility**	Available	Available	
58	**Dynamic brake working in case of traction motor isolation**	Effective for one truck	Effective for one truck	

SlNo	Description	WDG4	WDP4	WDG5
59	**Dynamic braking force**	26.25t	16.3t	
60	**Traction control computer**	SIBAS 16, Siemens.	SIBAS 16, Siemens.	
61	**Loco computer**	EM 2000	EM 2000	EM2000
62	**Traction inverters**	1GE 420 050 9010.00MB74, Voltage source inverter with gate turn-off thyristors, rating: 1430 KW, Qty: 2 (one per bogie)	1GE 420 050 9010.00MB74, Voltage source inverter with gate turn-off thyristors, rating: 1430 KW, Qty: 2 (one per bogie)	

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Annexure 14.4

PARTICULARS OF DIESEL LOCO WEIGHTS (in KGs)

SN	Description	WDM2	WDM3A	WDG3A	WDM3D	WDG4
1	Loco with Supplies	112795	112795	123600	123600	126010
2	Loco Light	105853	105853	114645	114645	
3	Diesel Engine (Dry)	19026	19026	19026	19370	17963
4	Engine Base	1816	1816	1816	1816	
5	Governor	59	59	39 - 64	39 - 64	
6	Crank Shaft and Extension Shaft Assembly	1725	1725	1725	1725	
7	Cylinder Block	5584	5584	5584	5584	
8	Cylinder Head Assembly	111.23	111.23	102	102	
9	Cylinder Liner	41	41	41	41	
10	Piston	-	-	23	23	
11	Piston and Connecting Rod Assembly	66	66	55	55	
12	Camshaft	243	243	243	545	
13	Camshaft Gear	70.4	70.4	73	73	
14	Turbo-Supercharger	545	545	613	613	953
15	Turbo-Supercharger Support	282	282	282	282	
16	Exhaust Manifold (Single Pipe)	227	227	148	148	-
17	Exhaust Manifold (4 Pipes)	795	795	-	-	
17	Turbo Air Aftercooler	136	136	136	136	
18	Water Pump	134	134	134	134	49
19	Lubricating Oil Pump	152	152	152	152	
20	Truck, Complete	23162	23162	25000	25000	21773
21	Truck without Motor	13015	13015	-	-	-
22	Truck Frame with BK. Rigging	-	-	5600	5600	-
22	Traction Generator	6075	-	-	-	-
22	Traction Alternator with accessories	-	6400	6400	-	8709
23	Traction Motor without Pinion	3382	-	-	-	-
24	Traction Motor with Pinion,Gear & gear case	-	3690	3650/3750	3680	3016
25	Traction Motor Pinion	22.7	22.7	22.7	24	
26	Wheel and Axle Assembly with Gear	1946	-	2150	2150	2631

SN	Description	WDM2	WDM3A	WDG3A	WDM3D	WDG4
27	Wheel, Motor Truck	483	-	-	-	
28	Equalizer	113.4	-	-	-	-
29	Traction Motor Blower, Front	81.6	80	80	-	-
30	Traction Motor Blower, Rear		105	105	-	-
31	Expresser (6CD4UC)	1089	-	-	-	-
32	Compressor	-	850	850	1089	1043
33	Hood over Engine	2019	2010	2019	2019	
34	Driver Cab Hood	-	-	-	-	-
35	Radiator Compartment Hood	-	-	-	-	-
36	Radiator(1)	788	788	788	788	1134
37	Radiator fan, Right angle Box & Eddy Current Clutch	360	360	360	360	-
38	Radiator fan,	53.5	53.5	53.5	53.5	408
39	Auxiliary Generator 5 GY 27	314	-	-	-	-
40	Auxiliary Generator AG 51	278	-	-	-	-
41	Exciter 5 GTA 6A1	196	-	-	-	-
42	Auxiliary generator GM, 5A – 814 & blower assly	-	-	-	-	647
43	Exciter, GM, CA - 6B	-	-	-	-	647
44	Auxiliary Generator & Exciter AG 3101AY	-	435	435	435	-
45	Auxiliary Generator & Exciter AG 2702 AZ	-	365	365	365	-
46	Cattle Guard (2 per Loco) wt. Each	300	300	300	300	
47	CBC (2 per Loco) wt. each	527	527	527	527	
48	Side Buffer (4 per Loco) wt. Each	166	166	166	166	
49	Cattle Guard Support (2 per Loco) wt. Each	350	350	350	350	

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