



भारत सरकार
GOVERNMENT OF INDIA

रेल मंत्रालय
MINISTRY OF RAILWAYS

(रेलवे बोर्ड)
(RAILWAY BOARD)

INDIAN RAILWAYS
MAINTENANCE MANUAL
FOR
DIESEL LOCOMOTIVES

1978

INDIAN RAILWAYS
MAINTENANCE MANUAL
FOR
DIESEL LOCOMOTIVES
1978

PREFACE

In pursuance of the recommendation No. 82(i) of the Railway Accident Inquiry Committee (1968), the Railway Board *vide* their letter No. 70/M(W)/7/16, dated 5th December, 1974, appointed a Committee consisting of the following officers for compiling a Maintenance and Operation Manual for Diesel Locomotives :

Shri H. P. Mital, Joint Director (Motive Power) R.D.S.O.

*Shri R. N. Ghosh Dastidar, Dy. CME (Diesel)/E. Rly.

Shri M. K. L. Narsimhaiah, Dy. CME (Diesel)/S. Rly.

Shri I. K. Gandhi, Dy. CME (Diesel)/N. Rly.

Note.—*Shri I. K. Gandhi was co-opted in place of Shri R. N. Ghosh Dastidar who proceeded on deputation to Ghana in May 1975.

2. This Manual contains goods practices and procedures obtaining on Indian Railways in respect of matters relating to the maintenance and operation of Diesel Locomotives. The rules and regulations contained therein shall generally apply in all cases, except where they are repugnant to any statutory obligations under the various acts of the Government of India.

3. Over a period of time, Railways have issued detailed maintenance instructions, based on experience gained in running of locomotives. These have been supplemented by instructions issued by RDSO from time to time. While the basic maintenance instructions are to be in accordance with those issued by RDSO, the details may vary from Railway to Railway. No attempt has been made to cover the entire range of individual working conditions which may exist on the various zonal Railways. The zonal Railways may, if considered necessary, supplement these instructions with subsidiary procedures for dealing with local peculiarities in working. Instructions contained in this manual should, therefore, be considered as a general guide for good maintenance.

4. This Manual has been prepared in loose leaf form to facilitate replacement of any superseded section by its revised version.

5. Suggestions from zonal Railways for additions/alterations to the contents of this Manual, with a view to make it more broad-based, comprehensive and useful are welcome. They shall, however, be addressed through proper channel to the Secretary (Traction), Railway Board.

V. P. SONI

NEW DELHI;
1978

*Director, Mechanical Engineering,
Railway Board*

CONTENTS

PARA		PAGES
Chapter 1—Organisation		
1.1	Traction Organisation of Mechanical Directorate in Ministry of Railways	1
1.2 } 1.3 } 1.4 }	Responsibility of and function of Chief Mechanical Engineer, coordination with C.O.P.S.	1
1.5	Inspection by CME and Addl. CME/Dy. CME (Diesel)	3
1.6 } 1.7 }	Responsibilities and function of Addl. CME (Diesel)/Dy. CME (Diesel)	3
1.8	Diesel Maintenance Organisation in CME's office	4
1.9	Maintenance Organisation in the field	7
Chapter 2—Operational Management		
2.1	Operational concept	10
2.2	Organisation at Railway Board's level	10
2.3	Daily outage	11
2.4	Ineffective position	11
2.5	Zonal Railways	11
2.6	Central Power Control Organisation	11
2.7	Facilities	12
2.8	Maintenance Schedules	12
2.9	Operation	12
2.10	Training of crews	12
2.11	Ten hour duty	13
2.12	Diesel operation organisation on the division	13
2.14	Driver Instructors	14
2.15	Diesel Locomotive Inspectors	14
2.16	Crew Booking	14
Chapter 3—Preventive Maintenance in sheds		
3.1	Object	15
3.2	Basis	15
3.3	Maintenance Schedules	15
3.4	Maintenance Methods	15
3.5	Unit Exchange	15
3.6	Sheds	15
3.7	Organising Preventive Maintenance	16
3.8	Record keeping : Data Analysis	18
Chapter 4—Maintenance shed layout and facilities		
4.1	Size and Location	27
4.2	Basic Features of shed Layout	27
4.3	Sequence of Repair operations	28
4.4	Servicing Facilities	28

	PAGES
PARA	
4.5 Shed Construction	28
4.6 Lifting and Material handling	32
4.7 Illumination	32
4.8 Shed building	32
4.9 Battery Charging	34
4.10 Shed Stores	34
4.11 Auxiliary Buildings	34
4.12 Compressed air	34
4.13 Repair Area	34
4.14 Fuel injection Room	35
4.15 Governor, Instruments and Brakevalve Repair Room	35
4.16 Laboratories	35
4.17 Filter Cleaning	35
4.18 Cleaning and washing	35
4.19 Shed offices	35
4.20 Plant and equipment	35
4.21 Fire fighting	35
4.22 Training School	36
4.23 Staff amenities	36
4.24 Terminal Maintenance shed	36
Chapter 5—Documents, Reports and Statements	
5.1 Daily position fleet	44
5.2 Daily Repair Summary	44
5.3 Repeated Booking Register	45
5.4 Lube oil consumption Register	46
5.5 Lube oil control	46
5.6 Wheel profile register	46
5.7 Loco scheduling register	46
5.8 Loco alterations	47
5.9 Water treatment record	47
5.10 Load test	48
5.11 Casualties	49
5.12 Locomotive records, schedules, components	50
5.13 Performance Boards	50
Chapter 6—Training	
6.2.1.1 Training of Officers	51
6.2.1.2 Orientation courses for Officers	51
6.2.2 Refresher course for Officers	51
6.2.3 Courses at System Training Schools	51
6.5 Equipment and Training Aids	52
Chapter 7—Stores	
7.1 Shed Store Organisation	62
7.2 Inventory Control	62
7.3 Procedure for procurement	63

PARA		PAGES
7.4	Procedure regarding approved suppliers	64
7.5	Procedure for inspection and acceptance	64
7.6	Trial Orders	64
7.7	Cash Imprest	64
7.8	Emergency purchase	64
7.10	Works Contracts	64

Chapter 8—Fuel

(A) Storage handling and Dispensing of diesel fuel oil

8.1	General	66
8.2	Fuel oil servicing facilities	66
8.3	Fuel oil unloading facilities	66
8.4	Fuel oil storage facilities	67
8.5	Fuel oil pumping facilities	68
8.6	Fuel oil distribution facilities	73
8.7	Fuel delivery to locomotives	74
8.8	Fire protection	74

(B) Procedure for Accountal of Diesel Fuel

8.10	Indenting	75
8.11	Loading Advice and Railway Receipt	75
8.12	Pocket card labels and Tie-on labels	75
8.13	Receipt and Accountal in Shed	76
8.14	Quality Control	76
8.15	Procedure in case of contaminated supplies	76
8.16	Temperature correction	77
8.17	Accuracy of measuring instruments	78
8.18	Tank wagon register	78
8.19	Missing Tank Wagons	78
8.20	Tank wagons diverted to other sheds	78
8.21	Periodical Return	78
8.22	Issue to locomotives of other Railways	78
8.23	Supply to Pumping station	79
8.24	Issue to other departments of Railways	79
8.25	Schedules of issues	79
8.26	Stock Registers	79
8.27	Stock Ledger	79
8.28	Monthly HSD oil account	79
8.29	Manning of fuelling installations	79

Chapter 9—Lubricants

9.1	Characteristics of Lubricants	89
9.2	Diesel engine lubricating oil additives	90
9.3	Transmission oils	92
9.4	Greases	93
9.5	Storage, Handling and dispensing of lubricants in sheds	94
9.6	Testing of used engine lube oils	96

PARA		PAGES
	Chapter 10—Safety	
10.1	Scope	99
10.4	Prevention of Fire	99
	Chapter 11—Miscellaneous	
11.1	Modifications	100
11.2	Trials	100
11.3	Pre-commissioning checks on new locomotives	101
11.4	Checks to be carried out on POH locomotives	101
	Chapter 12—Locomotive Data	
	Salient features of Standard locomotives—Haulage capability diagrams and charts	115-139



PREAMBLE

While the Indian Railways had earlier acquired a variety of small diesel locomotives, railcars, multiple units, large scale dieselisation started with the acquisition of one hundred 1950 hp diesel locomotives (WDM₁ type) from Alco in 1958-1959. These were followed by 2600 hp units (WDM₂ type) beginning 1962. This was rapidly followed up with setting up a manufacturing unit for production of diesel locomotives at Varanasi. The 1400 hp metre gauge diesel locomotive was added to the range. Chittaranjan Locomotive Works also commenced production of broad gauge shunting type and Narrow Gauge mixed traffic locomotives.

The changeover from Steam to Diesel Traction opened out a vast field of rapid, low cost transport with tremendous flexibility. It simultaneously necessitated development of workshops and maintenance depots, retraining of engineers and technicians, and re-orientation of the materials management organisation to deal with a new variety of spares. The Diesel Traction Manual has evolved from the experience gained by the Indian Railways in effecting this change and formalises a Code of Practice for the maintenance of Diesel Locomotives, Railcars and Multiple Units.

● ● ●

CHAPTER 1

BOARD, RAILWAYS — HEADQUARTERS, MAINTENANCE DEPOTS. MANAGEMENT AND EXECUTIVE CONTROL, MANAGEMENT INFORMATION SYSTEM, ORGANISATIONS AT HEADQUARTERS, ORGANISATIONS IN THE MAINTENANCE DEPOTS, BASIC SHED MANAGEMENT STRUCTURE

1. Organisation.

1.1 The *Traction Organisation* of the *Mechanical Directorate* in the *Railway Board*.

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 Defines maintenance objectives in consultation with RDSO, Manufacturers and Zonal Railways.

1.1.3 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, Manufacturers, RDSO and Import.

1.2 The *General Manager* of a zonal railway has the *Chief Mechanical Engineer* as the principal officer who is solely incharge and responsible for the maintenance of Diesel Electric/Hydraulic Locomotives, railcars and multiple units. C.M.E. liaisons with other Heads of Department for assistance in procurement of material, cost analysis, operation of locomotives, security etc. He has an organisation under him for suitably discharging the various functions related to the maintenance and operation of the diesel motive power units.

1.3 The principal *functions* of the C.M.E. in this regard are summarised 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 imported/centrally controlled items such as power packs etc.

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

1.3.2.1 C.O.S.—Availability of diesel spares at the maintenance points of the right quality and at the lowest possible cost inclusive of cost of service.

1.3.2.2. F.A. & C.A.O.—Continuous and current cost analysis for budgetary control.

1.3.2.3 C.S.O.—Provision and maintenance of suitable fire fighting facilities at the diesel maintenance depots, and diesel servicing installation stocking fuels and lubricants, and security of the above facilities.

1.3.2.4 C.O.P.S.—Planning of maintenance and servicing facilities to suit changes in traffic pattern and volume.

Effective utilisation of diesel locomotives with suitably planned deployment of locomotives in various traffic streams ensuring return of locomotives for attention to base depots in time while maximising services.

1.3.2.5 C.W.E.—Effective support from the workshops for POH of locomotives with requisite quality of outturn, supply of "repair and return" materials to the maintenance depots and supply of shop manufactured duplicates.

1.3.2.6 C.E./C.E.(Con)—Effectively progress construction of new facilities and maintenance of existing facilities.

1.3.3 The C.M.E. controls and effectively deploys the Headquarters organisation consisting of Addl. C.M.E./Dy. C.M.E.s in charge of Operations, Maintenance, Fuels & Lubricants.

1.3.3.2 The Field Executives at the base depots and servicing installations.

1.3.3.3 The Field Executives in the Operating division who are in-charge of the out-station servicing facilities, fuelling facilities, crews and utilisation of locomotives.

1.3.4 Liaison with production units for supply of motive power units, spare parts and specialised 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.

1.4 Modus Operandi.

While no one plan will fulfil the requirements of every railway but 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 COPS which should discuss—

1.4.1.1 Changes of locomotive ownership, type-wise & depotwise, 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 An evaluation of the progress in meeting such objectives over the past period.

1.4.2 The C.M.E. 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 programmes, refresher courses.

1.4.2.1.2 Availability of trained maintainers, recruitment and conversion programmes, 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 locomotive 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 equipment, transmissions, trucks, wheels, and

selected items such as intermediate casings, expressor cylinders, gas inlet casings, etc. Such lists will be drawn by the railway to meet their own special requirements.

1.4.3.3 Supply of selected shop manufactured duplicates, safety/vital items such as brake blocks etc.

1.4.3.4 Special repairs of locomotives such as repower packing, rewiring, rebuilding accident damaged units.

1.4.3.5 Overhaul of plant and machinery of maintenance depots which is required to be done by shops typically — lifting equipment, under-floor wheel lathes etc.

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 depots 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 depots and backshops 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 fuelling points in regard to cleanliness in dispensation of fuels and lubricants.

1.5 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. Similar inspections will be carried out by ACME/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-a-vis present, intermediate future, and long term requirements — progress of work.

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

1.5.3 Similar as above in regard to casualties.

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

✓ **1.5.5** Availability of unit exchange spares in good condition.

1.5.6 Lubricant conservation measures.

✓ **1.5.7** Inspection of shed premises to see if facilities, plant and equipment, trackage, inspection pits, lighting is maintained functional and clean.

✓ **1.5.8** Functioning of the staff grievance redressal system.

✓ **1.5.9** Random checks on vital items such as records of wheel profiles, testing of fire extinguishers etc.

✓ **1.5.10** Inspection of locomotives selected at random to monitor implementation of a particular casualty prevention measure, vital items such as speedometer, brakes etc. or lubricant conservation measures.

✓ **1.5.11** Records of load test of units so as to ensure that repairs have been satisfactory.

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

1.5.13 Review status of repair of major assemblies and equipment such as power packs, expressors, rotating electrical equipment, major auxiliaries, transmissions, gear boxes, trucks.

1.5.14 Availability of spares, storage conditions in stock rooms.

✓ **1.5.15** Selected shed statistics such as late starts, locos returning late for schedules, loco-wise defects register, lube oil change register, spectrograph reports etc.

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

1.6 The CME is aided by Addl. CME/Dy. CMEs in the following principal areas of maintenance and operation of diesel motive power. In their respective fields each Administrative Officer will be responsible for the effective discharge of the nominated functions and will report directly to the CME.

1.6.1 The Addl. CME/Dy. CME (Diesels) in charge of maintenance of units.

1.6.2 The Addl. CME/Dy. CME (Operations/Running) in charge of utilisation of diesel motive power units.

1.6.3 The Addl. CME/Dy. CME (Fuel) in charge of fuels & lubricants.

1.7 Functions of Addl. CME/Dy. CME(Diesels)

Intensive utilisation 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 the ACME/DCME(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 imported spares/bulk indent items and placement of demands by COS. As per present policy such requirements are bulked for ALCO designs of locomotives at DLW and MAK engined locomotives at CLW. Certain types of motive powers are processed by the railway directly such as General Motors etc. Follow up with COS the procurement and availability of spares in the maintenance depots.

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 SME(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 repair orders on trade of items which require specialised attention or are beyond the powers of the Division 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 and direct assistance to the maintenance depots 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 organisation on the Railways to provide the maintenance depots, backshops, COS with drawings, specifications, maintenance information.

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

1.7.16 Carry out periodic field inspections of the diesel maintenance depots so as to cover each major shed. (Guidance may be sought from para 1.5.1 through 1.5.16 — a set of selected topics being taken up in each visit).

1.7.17 Suitable liaison with backshops, production units and manufacturers on the basis of the feed back from the maintenance depots so as to

get a better end product and improved services. For this purpose, he will visit backshops. He will exercise technical control over Diesel Backshops.

1.8 The Diesel maintenance organisation in the CME's Office will basically consist of.

1.8.1 An *information acquisition group* normally under the ACME/ Dy. CME (Operations) who obtains the information from all over the system and furnishes a daily report to the CME, ACME/Dy. CME (Diesel), ACME/Dy. CME (Operations) listing the availability and performance of diesel units. Normally one inspector with necessary telephone, wireless, teleprinter/telex services is exclusively required for diesel services. Separate and reserved channels are necessary linking the major maintenance depots, backshops and important yards so that information can be obtained and decisions conveyed quickly. While needs vary a proforma furnished in Annexure which will prove useful for listing out the daily position.

1.8.2 A *Technical Services Group (Materials & Designs)* consisting of an experienced engineer in JA/SS, suitably assisted by a SS/JA engineers and a team of at least three inspectors assisted by a Drawings and Designs Offices. Depending on multiplicity of diesel units this nucleus group can be suitably expanded to meet diverse needs. This technical services group will cover.

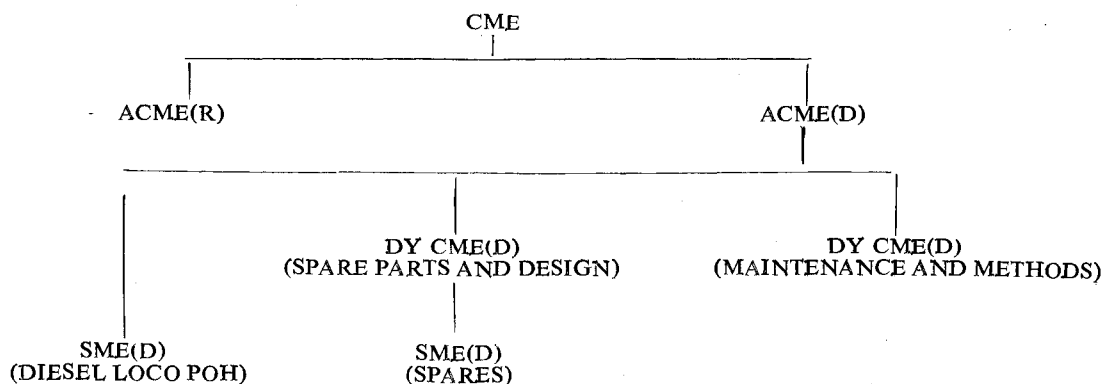
1.8.2.1 Procurement of spares — consisting of.

1.8.2.1.1 Scrutiny of all stock recoupment memos for diesel spares. Provision of drawings and specifications and vendor information to the Stores for aiding procurement.

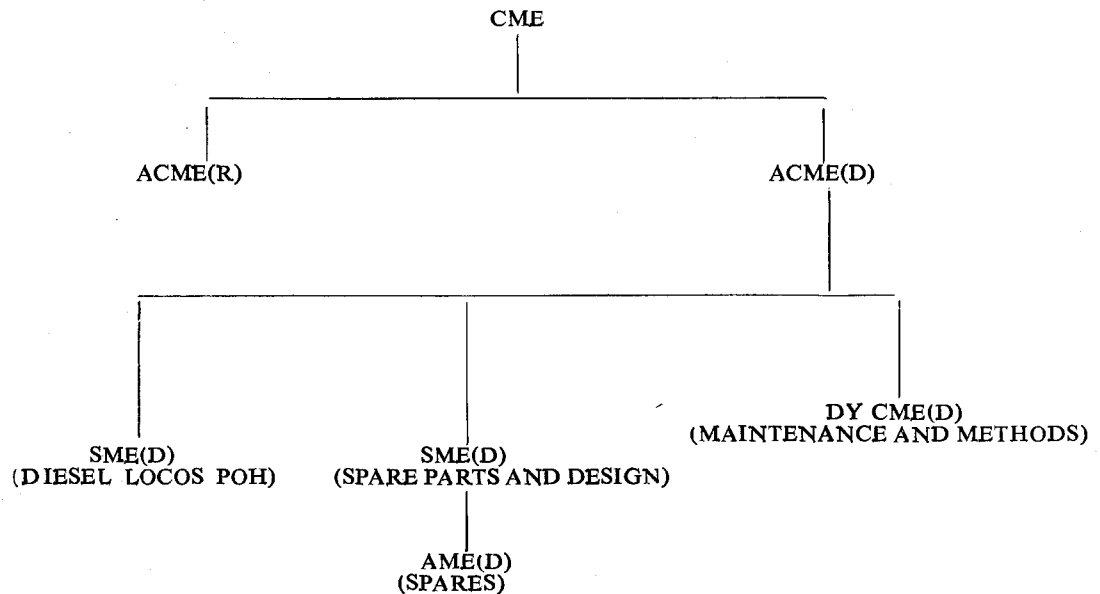
1.8.2.1.2 Scrutiny of all tender offers and furnishing a technical appreciation to the purchase office.

1.8.2.1.3 Liaison with maintenance depots, evaluation of feed back information on performance of designs and vendors.

HEADQUARTERS ORGANISATION FOR DIESEL (ELECTRIC/HYDRAULIC) LOCOMOTIVES, ZONAL RAILWAYS HOMING 200 LOCOS OR 3 AND MORE TYPE LOCOMOTIVES.



ZONAL RAILWAYS HOMING UPTO 199 AND NOT MORE THAN 2 TYPES OF LOCOMOTIVES.



1.8.2.1.4 Liaison with Production units, RDSO and manufacturers and railways updating for information on drawings, specifications and sources of supply.

1.8.2.1.5 Redesign components for better service at lower costs.

1.8.2.1.6 Indiginisation and development of designs to widen sources.

1.8.2.1.7 Liaison with depots to frame the bulk indents of the railways.

1.8.2.2 The typical functions of Drawing office is given in figure. The organisation will normally consist of units as described below. One or more such units covering 1.8.2.1 through 1.8.2.1.4 will be needed while secretarial and printing may be met from a common pool located in the Drawing/Design office.

1.8.2.2.1 Headed by a Chief Draughtsman/Chief Design Assistant.

1.8.2.2.2 Suitable complement of Head Draughtsman/Senior Design Assistants usually three to four are required.

1.8.2.2.3 Draughtsman/Design assistant — three for preparation of drawings.

1.8.2.2.4 Tracers — four required.

1.8.2.2.5 Secretarial assistances such as typist — one to two, record clerks — two.

1.8.2.2.6 Printing and book binding staff — ferro printers, machine operators, unskilled helpers.

1.8.2.2.7 The Drawing/Design office should be suitably equipped with ferro printing machines, duplicating machines, photocopying machine (Xerox), common measurement equipment such as micrometers, verniers, thread gauges, basic hand tools, filing cabinets and record keeping equipment, drawing storage equipment, draughting machines etc.

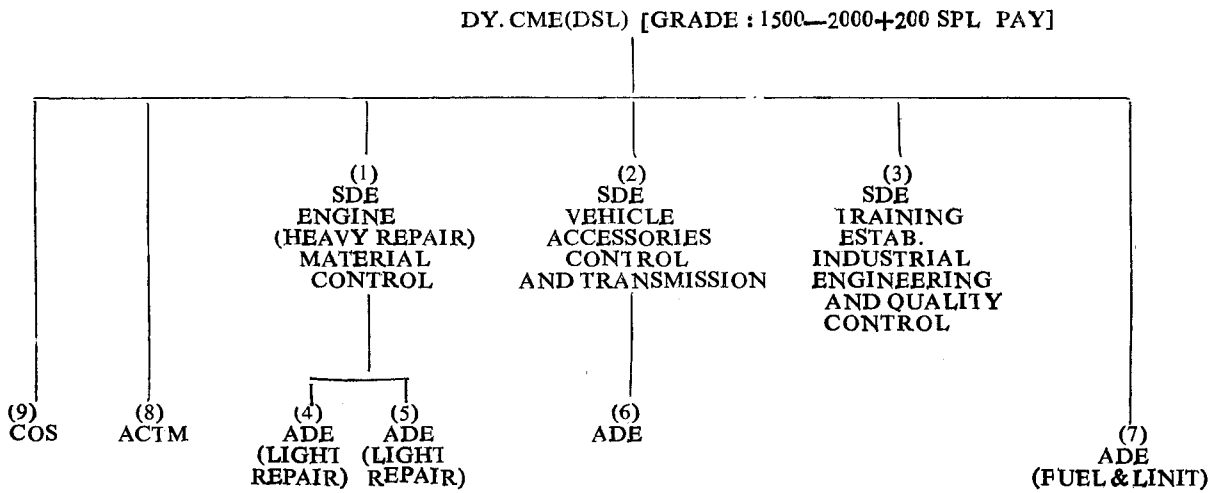
1.8.3 A Technical Services Group (Methods) consisting of an experienced engineer in JA/SS suitably assisted by experienced inspectors assists the Administrative officer to provide the backup support in the following fields.

1.8.3.1 Analysis of casualties, and follow up on casualty prevention procedures.

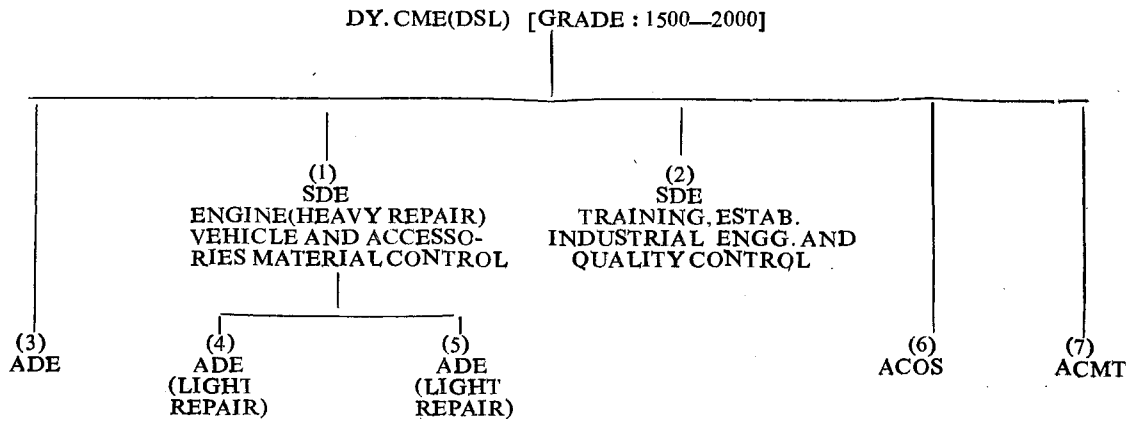
1.8.3.2 Follow up on modification advises.

MANAGERIAL ORGANISATION IN DIESEL DEPOTS.

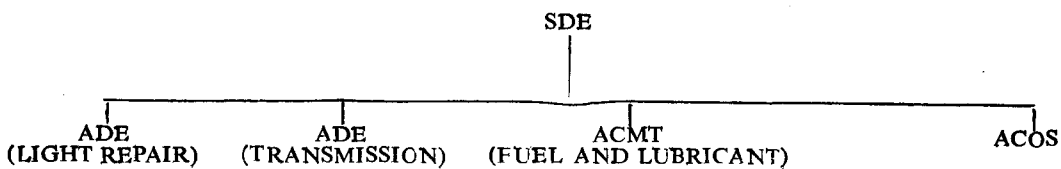
1. DEPOT HOLDING 80 TO 100 LOCO MOTIVES.



2. DEPOT HOLDING 51 TO 80 LOCOMOTIVES.



3. DEPOTS HOLDING 50 AND BELOW LOCOMOTIVES.



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

1.8.3.4 Staffing of maintenance depots — Planning & coordinating recruitment, training, refresher courses.

1.8.3.5 Dissemination of maintenance instructions, manuals etc. with the assistance of Drawing/Design office.

1.9 The field Organisation.

1.9.1 The Field Organisation on the railways consist of.

1.9.1.1 The Diesel motive power maintenance depots.

1.9.1.2 The outstation fuelling and servicing/trouble shooting points.

1.9.1.3 Backshops — not being covered in this manual at present.

1.9.2 A typical Diesel Motive power maintenance depot holding 40 locomotives usually maintains Rs. 18 crores worth of assets, spends annually a maintenance and lubricant budget of Rs. 1.5 crores, and is closely linked with an annual fuel budget of over Rs. 3.5 crores. Owing to the high level of investment and the high cost of out of service coupled with the complexity of the equipment maintenance activities are no longer simple servicing and break down repairs. The maintenance management organisation in the depot has to provide a comprehensive, well organised 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 availability of sophisticated cost and time saving diagnostic techniques is becoming a must. Managerial organisation Chart may be seen.

1.9.2.1 The Engineer-in-Charge of the Diesel Motive Power maintenance depot is in overall charge of all technical and administrative matters in the depot 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.

1.9.2.1.1 Plan preventive maintenance of the stock with judicious use of regular scheduled maintenance judiciously executed planned replacement, and as also breakdown maintenance —replace when defective in accordance with various guide lines of RDSO/manufacturers and the railways' experience.

1.9.2.1.2 Execute the above plan.

1.9.2.1.3 Design, operate and utilise a suitable management information systems (Guide lines are available in chapter on documentation).

1.9.2.1.4 Frame a budget and operate within it.

1.9.2.1.5 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 frequency of failures, Mean Time between failures (MTBF), data on rate of wear etc.

1.9.2.1.6 Oversees the planning and procurement of material, for which he will be assisted by a suitable stores organisation under the charge of an officer, the administrative control of the stores organisation will rest with the Engineer-in-Charge of the Shed.

1.9.2.2 While no single procedure of business can universally apply to all depots and types of motive power the following will serve as a useful guide line 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 "Documentation".

1.9.2.2.1 Short term.

1.9.2.2.1.1 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 locomotives from the various repair centres inclusive of average time taken. For planning the days work the Daily Position Sheet gives the disposition of locos at various repair centres. The early scrutiny of this position sheet permits early planning to get repairs off to a flying start.

1.9.2.2.1.2 A "Repair summary" of the locos that have come in the last 24 hrs. with remarks 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.

1.9.2.2.1.3 A "Repeated booking register" maintained locowise 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 improve and attention is shifted to another area.

1.9.2.2.1.4 A "Lube oil consumption" record is checked is over to locate locos requiring attention.

1.9.2.2.1.5 A "Lube oil control" record is checked over for spectrograph results, TBNE, Insolubles, fuel dilution etc. which gives a fair indication of engine conditions.

1.9.2.2.1.6 The "Loco scheduling" records provide information on planning of schedules, locating, overdues, and controlling maintenance attention so that optimisation is achieved. Typically an expressor overhaul/real change is synchronised with a yearly schedule.

1.9.2.2.1.7 The "Loco Alterations" records are scrutinised to monitor progress in effecting loco alterations directed from time to time.

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

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

1.9.2.2.1.10 Sample checks are done of the Low schedule forms to see test results.

1.9.2.2.1.11 Sample checks are done of the water treatment plants output.

1.9.2.2.1.12 Sample checks of fuel records.

1.9.2.2.1.13 Regular checks of plants and equipment out of commission of awaiting installation.

1.9.2.2.1.14 Sample checks of quality of work at various repair centres inclusive of night inspections.

1.9.2.2.1.15 Scrutiny of consumption of selected items — imported or high value — with a view towards devising ways and means of effecting reduction or replacement with more economical alternates.

1.9.2.2.1.16 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 on the sections concerned involved in failures.

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

1.9.2.4 Organisation of the maintenance Depots. Basically the organisation is functional. Arrangements vary to suit local conditions but they are grouped as under.

1.9.2.4.1 Annual and above schedules.

1.9.2.4.2 Semi annual schedules.

1.9.2.4.3 Monthly and quarterly schedules.

1.9.2.4.4 Trip and fortnightly schedules.

1.9.2.4.5 Non scheduled repairs.

1.9.2.4.6 Over hauling sections—divided into several subgroups covering controls, Airbrakes, fuel injection equipment, Switch gear, Governor, Auxiliary machines, Transmission, Traction Generator and Traction motors, Expressors, Tool room, Standards room for gauges, and their repairs inclusive of callibration of speedometers etc.

1.9.2.4.7 Trucks and chassis.

1.9.2.4.8 Millwright (inclusive of electrical equipment).

1.9.2.4.9 Statistics or Repair office organisation who does the scheduling and maintains the registers.

1.9.2.4.10 Machine shop.

1.9.2.4.11 Material Control.

1.9.2.4.12 Engine alterations.

1.9.2.4.13 House keeping services.

1.9.2.4.14 Drawing office—maintains drawings, updates maintenance instructions.

THE DRAWING OFFICE

FUNCTIONS	DRAUGHTSMAN				TRA- GER	ESTI- MA- TER	RE- COR- DS CLE- RK	TY- PI- ST	PRI- NT RO- OM	RE- MAR- KS
	CHI- EF	HE- AD	D/ MAN	ASST/ D/ M.						
OVERALL SUPERVISION	●									
DESIGN :										
ANALYSIS OF REQUIREMENTS & CALCULATION.	●	●								
LAY-OUTS & GENERAL ARRANGEMENTS.		●	●							
DETAILS AND COMPONENTS			●	●						
CHECKING :	●	●								
TRACING :					●					
TAKING OFF PRINTS :									●	
RECORDING, FILING, MAILING :							●			
REPAIRING :										
SPECIFICATION AND ENQUIRIES.		●	●							
ESTIMATES.						●			●	
CHECKING :	●									
TENDERS :										
CHECK AGAINST ENQUIRY & ESTIMATE.	●	●				●				
TECHNICAL AND FINANCIAL APPRAISAL.	●	●				●				
ORDERS AND CONTRACTS :										
PREPARATION FOR PURCHASING DEPT.		●							●	
PREPARATION FOR CENTRAL WORKSHOPS.			●						●	
CHECKING :	●									
RECORDS RELATING TO : DRAWINGS AND SKETCHES ORDERS & DELIVERY OF PLANT & EQUIPMENT. STANDARD CONDITIONS OF CONTRACT. INTERNAL STANDARDS/DIRECTIVES. BRITISH STANDARD SPECIFICATIONS. CATALOGUES & TECHNICAL LITERATURE. LIAISON WITH PLANT RECORDS & INVENTORY.							●			
TYPING. : CORRESPONDENCE AND FILING										
INTERNAL & EXTERNAL TECHNICAL LIAISON.	●							●		

●—COMMON DRAWING OFFICE FUNCTIONS.

CHAPTER 2

2.1 Operational Concept

2.1.1 Diesel locos are costly assets. Therefore, it calls for a different operational concept for their management to achieve effective utilisation and get the best results. Unlike steam locomotives, which require shed attention almost daily, the diesel locomotive lends itself to extensive operation for a week or 2600 Kms before requiring trip schedules. Therefore, whereas the steam locomotive homed in a shed on a division is mostly utilised on the parent division or upto the next major shed, the diesel loco could be used with advantage over long distance by only change of crew and refuelling. This feature cuts down detentions to through loads in major yards.

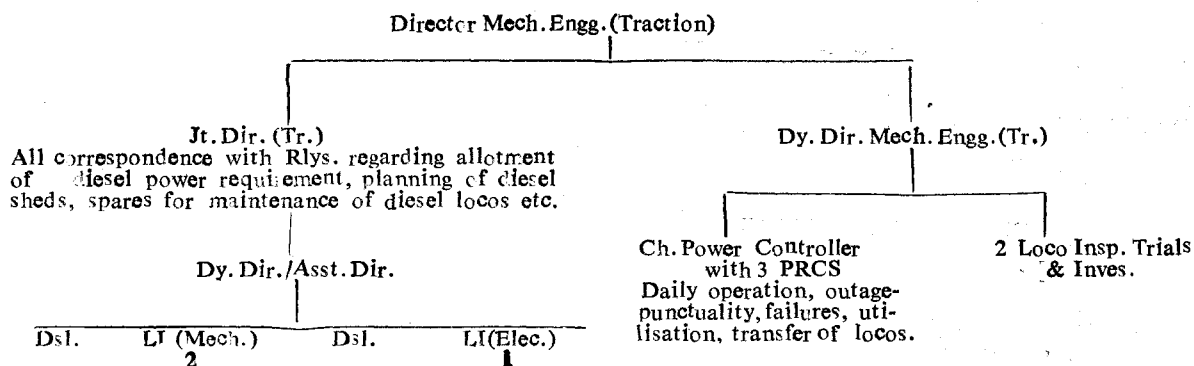
2.1.2 Thus in actual operation, a diesel locomotive would cater to the power requirement of several divisions and even on the adjoining railways. Therefore, an effective Central Power Control Organisation is required at the railway headquarter to monitor and direct the movement of diesel locomotive powers between different divisions in accordance with the requirement.

Similarly, at the Railway Board's level a daily and constant watch is required to be maintained for smooth co-ordination between the railways.

2.2 Organisation—Railway Board's level

2.2.1 The production of diesel locomotives, so far, being short of the demand placed by the Railways for replacement of over-aged steam locomotives and also to cater for the increase in traffic, the power requirements of 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 locomotives are put on the line, the workload of utilising these costly assets for the optimum return and coordination of diesel operation between different railways would increase. In view of the above, these functions can best be looked after by a separate Director Mechanical Engineering, Incharge of Traction. He should be assisted by a Joint Director (Traction) and a Dy. Director (Traction) as per organisation chart given below:



This organisation will be responsible for the following:

2.2.3.1 Allotment and distribution: The requirement of diesel locomotives 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 locomotives from one zone to another for making necessary adjustments. Development of the diesel maintenance facilities to meet the operational demand is also required to be planned to keep pace with dieselisation.

2.2.3.2 Daily outage: Exercise watch over performance of different zonal railways with regard to daily availability of locomotives 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 trains.

2.2.3.4 Analysing failure of diesel locomotives on line with regard to reliability of their performance.

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

2.2.3.6 Utilisation of locos i.e., engine kms/day/ engine 'In use' and 'On Line'.

2.3 Daily Outage :

The outage of diesel locomotives for goods traffic would be fixed on the following basis :

2.3.1 Total locos on line	=N
2.3.2 Ineffective percentage	= .125N
2.3.3 Locomotives in use	= .875N
2.3.4 Spare for running maintenance	= 10% of .875N = .088N
2.3.5 Outage	= .787
Working balance from the above—	
2.3.6 Outage	=X
2.3.7 Total No. of locomotives in use	= 1.1X
	.125
2.3.8 Repair allowance	= $\frac{.125}{.875}$ of 1.1X = .157X

2.4 Ineffective Position :

2.4.1 Ineffective position of diesel locomotives on each railway would also be watched daily to maintain the maximum outage of diesel locomotives. If any locomotives 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 in engine allotment towards maintenance is 12.5% of the total locomotive holdings (consisting approx. of 6% for heavy schedules, 2½% for POH and 4% for corrective maintenance, waiting on material etc.)

2.5 Zonal Railways :

Addl. CME(R) will be responsible for the following aspects of diesel operation :

2.5.1 Planning and utilisation of diesel powers by supplementing with steam traction to meet with the requirements of passenger, goods and other services on the Railway.

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

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

2.5.4 Co-ordinate with other railways for diesel operation.

2.5.5 Watch daily utilisation of diesel locomotives on each division and other railways.

2.5.6 Reduce detentions to diesel locomotives on line.

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

2.5.8 Ensure reliability of diesel locomotive in operation. Keep a check on daily position of diesel locomotive failures and its repercussions on punctuality to Mail/Express trains and goods operation. Analyse cases of engine failures and take remedial measures.

2.5.9 Movement of disabled engines.

2.5.10 Conversion and Refresher Training of running staff for diesel operation.

2.5.11 Keep a check of drivers' links for passenger services and 10 hour duty working for goods services.

2.5.12 Provision of HSD installation for fueling of diesel locomotives.

2.5.13 Fuel Economy.

2.6 Central Power Control Organisation :

A Central Power Control Organisation 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 one Power Controller in each shift to function round the clock. A clerk shall also be provided in each shift as a General Assistant to the shift duty Power Controller for maintaining the various records. The Central Power Control will be responsible for —

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

2.6.2 Availability of diesel power from each shed for traffic on 4-hourly basis.

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

2.6.4 Ineffective locos in sheds.

2.6.5 Watching position of engines for schedules attention.

2.6.6 Forecast of diesel locomotives to be turned out from shed.

2.6.7 Keeping a watch on the movement of disabled engines.

2.6.8 Daily utilisation of diesel locomotives on each division.

2.7 Facilities :

The Central Power Control Organisation 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 centralised power control organisation is prompt and efficient communication facilities. Central Power Control Organisation should be able to contact all diesel sheds, Divisional Control Organisation and all the major yards directly, and if possible, simultaneously so that instructions to all concerned can be conveyed without delay. In addition to the P&T Line, Micro Wave Communication facilities should also be available to enable Central Power Control to get in touch with Central Control on other Railways and also their diesel sheds. Separate and reserved channels are necessary linking the major sheds, back shops and major yards on teleprinter/telex services.

2.8 Maintenance Schedules :

2.8.1 Strict enforcement of maintenance schedule is one of the important items of responsibility for the Central Power Control Organisation. If the locomotives are not attended for schedule maintenance in time, it would not only affect its reliability but would also have serious set back to the maintenance as well as availability of diesel locomotives. The uneven flow of locomotives will result in shed capacity going under-utilised during lean periods and engine waiting for repairs when there is bunching of locomotives.

2.8.2 Since all the schedules are on a time basis, the date for weekly, fortnightly and monthly schedules should also be prominently stencilled on the locomotives. As a rule, the locomotive 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 locomotives which are due schedule attention three days in advance and relay these numbers to the divisions on which the engines are working on that day so that they could be booked on goods trains working towards the homing shed.

2.9 Operation :

2.9.1 Passenger services :

2.9.1.1 Allotment of diesel locomotives for passenger services is made on the basis of engine links. Only those services should be considered for diesel operation where the combination of load and the speed are beyond the capacity of

a WP locomotive. Engine links for working passenger services should be framed to get the maximum advantage of extended runs by providing fuelling facilities and change of crews en route.

2.9.1.2 In some cases it is possible that there is no suitable passenger service for the return link and the engine has to lie-over for a long period for the return link. In such cases, advantage could be taken for using locomotive for working short distance goods trains on fixed path provided by doing so the locomotives do not burst their stipulated trip kilometrage for trip schedule attention. The main difficulty in linking goods services with passenger links is generally the different standards of punctuality and reliability. The success, therefore, of any such mixed linking of the locomotives will depend on rigid and strict compliance of time-based running of the link goods trains.

2.9.2 Goods operation :

2.9.2.1 The allotment of diesel power for each division is worked on the basis of number of through goods to be run daily on different sections. The number of diesel locomotives required for working the planned number of trains is arrived at on the basis of targets of engine kms. per day per engine in use. Normally, utilisation of 500 km. on B.G. double-line and 400 km on B.G. single-line and 300 km. on M.G. per day per engine should be adopted. The actual targets should be fixed by each railway taking into consideration the operating conditions obtaining on that railway.

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

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

2.10 Training of Crews :

2.10.1 Conversion training of steam crews for diesel operation and conducting refresher courses for the running staff should be organised by the Headquarters Office at the various diesel sheds located on that Railway. A driver would be required to pass the conversion course for each type of diesel locomotive. A certificate must be issued to the driver after he has been trained and qualified for operating each type of diesel

locomotive. The staff should be given a familiarisation course if there is a gap of more than six months after his training and actual utilisation.

2.10.2 In addition, special courses for diesel operation shall also be organised for the Driver Instructors and Loco Inspector — Duration of training courses should be as follows :

- | | |
|---|-------------|
| 2.10.2.1 Conversion training for steam drivers | — 13 weeks. |
| 2.10.2.2 Conversion training for 1st F/Man | — 11 weeks. |
| 2.10.2.3 Refresher course for diesel drivers | — 3 weeks. |
| 2.10.2.4 Refresher course for diesel asstt; | — 3 weeks. |
| 2.10.2.5 Diesel Instructor & Loco Inspector | — 14 weeks. |

2.11 Ten-Hour Duty :

Implementation of 10 hour duty of running staff is one of the important function of Central Control Organisation. A special duty Inspector for the Central Organisation 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 analysed and suitable remedial measures taken.

2.12 Diesel Operation Organisation on the Division :

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 locomotives working under its control. On the division the diesel operation is at present looked after by the Sr. DME/DME who is also responsible for the management of steam sheds, maintenance of steam locomotives as well as their operation. The diesel operation, therefore, does not receive the undivided attention which is deserved. Fuelling Installations provided on the divisions for fuelling of locomotives are also under the charge of Sr. DME but locally they are supervised at a very low level of Fuel Issuer. Considering the cost of fuel stocks and fuel issues being made by each fuelling point, the fuel installations shall be under the charge of Fuel Inspector or Installation Foreman.

2.12.2 There should, therefore, be a separate DME for each division responsible for the diesel operation on the division, in addition. The Power Control Organisation on the division shall have a separate Cell for diesel operation which should be adequately staffed depending

upon the workload. 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 powers available in time according to the outage quota and the forecast of goods trains. The daily outage would be worked by taking the average of the number of locomotives available on 4 hourly basis.

2.12.2.2 Utilisation :

To achieve the optimum utilisation, every diesel locomotive 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 analysed daily to work out the :

- (a) Section-wise powers on line. (*)
- (b) Kms. per day per engine 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 number of engine hours of all locos, including idle hours by 24.

viz. Total kms. earned by all locos of one class : Total No. of locos in use.

2.12.2.3 Engine failure :

There are two categories of engine failure :

- (a) Category I Statistical failure.
- (b) Category II Non-statistical failure.

(1) Statistical failure :

A loco is considered to have failed when it is unable to work its booked train within prescribed load from start i.e. after coming on the shed bar line on the outgoing trip to destination i.e. to the first shed or point wherein engine is booked to cut off or to work another train as per link diagram or cause a delay in arrival at destination of 30 mts. or more in case of diesel and electric locomotives due to causes mentioned below :

- (a) Defective design.
- (b) Defective material.
- (c) Bad workmanship in shops.
- (d) Bad workmanship in shed.
- (e) Mismanagement by engine or loco crew.
- (f) Bad fuel.
- (g) Bad water.

(2) Non-statistical failure :

- (a) Locomotive undergoing repairs at the end of its trip at station/terminal yard/shed and not being available for the return trip.

- (b) Failure of locomotive booked on trial after heavy schedules or change of major components like armature, turbo generator etc.
- (c) Failures of locos which are overdue by more than 24 hours.
- (d) Cases of heavy time lossess (more than 30 mts) on the run as a result of inclement weather like dust storms, heavy rains etc. when visibility of signals is affected or slipping of wheels takes place and cannot be attributed to faulty operation of running staff.
- (e) Cases of heavy time losses (more than 30 mts. due to overload load being more than specified).

NOTE : (i) Loco failures of all trains, assisting and light engines but not those of departmental, regular shunting and siding engines, are to be included. Failure of foreign railway locos are to be excluded but relayed separately to the owning railway.

(ii) The time made up by a locomotive must be deducted from the time lost when calculating the aggregate detention.

If the failed diesel loco cannot be attended for repairs by the staff at outstation or at the outstation servicing points, it should be promptly worked back to the home shed light or otherwise attached with a goods train or light engine for necessary investigation and repairs.

2.12.2.4 Crews :

Each division shall have sufficient number of crews trained in diesel operation, posted at stations of crew changing. Crews 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.

2.13 The Divisional Power Control Organisation should also be well equipped and provided with suitable accommodation to ensure undisturbed working. There should be effective communication facilities with each station of the division and other Divisional and Central Power Control offices.

2.14 It is necessary to provide adequate strength of Drivers' Instructors 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 yardstick of one Driver Instructor for every 25 crews should be observed so that he can —

2.14.1 Monitor performance of the crews.

2.14.2 Investigate avoidable diesel loco failures due to mismanagement of crews.

2.14.3 Educate diesel crews in trouble shooting and fuel economy.

2.15. Similarly, the strength of Diesel Loco Inspectors on the divisions need to be increased to monitor the performance of locomotives for defects as well as improve their utilisation. At least one Diesel Loco Inspector should be available on each Division.

2.16 Crew Booking :

Foreman (running) working under DME (Diesel) in operating division will look after operational aspect of diesel locos in shed. The Foreman (Running) will be responsible for the following :

2.16.1 Maintain close liaison with the Central and Divisional Power Control Organisations.

2.16.2 Maintain 4-hourly position of diesel outage.

2.16.3 Maintain minor schedule forecast register trip, fortnightly and monthly schedules.

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

2.16.5 Maintain Appendix 'A' & 'B' showing particulars of engine No. home shed, Driver's name etc.

2.16.6 Maintain signal visibility register.

2.16.7 Check speedometer records.

2.16.8 Drivers's shed notice book.

2.16.9 Drivers' Duty taking over Register.

2.16.10 Trial Engine Register.

2.16.11 ME-62 Records regarding the drivers' in possession of spectacles etc.

2.16.12 Engine set-out Register.

2.16.13 All reports of failures or repercussions of engine set-outs etc.

2.16.14 Lube oil consumption register, date-wise and loco-wise.

2.16.15 Shedman's Diary.

2.16.16 FOR's Relief Diary containing important instructions to be followed by the ALFs in shift duties.

CHAPTER 3

PREVENTIVE MAINTENANCE IN DIESEL SHEDS

3.1 Object : Railways follow the system of Preventive maintenance for the Rolling Stock. The object is to secure the best possible availability and maximum reliability in service. The system of preventive maintenance envisages a schedule for maintenance attention at regular specified intervals and replacement of components. It aims to replace the components before they actually fail in service due to ageing, wear and tear, whilst also endeavouring to obtain maximum life possible for the components. The system also aims at synchronisation of attention to all related components so that the man power and engine-days lost on account of the examination is kept to the minimum.

3.2 Basis : The system of preventive maintenance is evolved normally on any of the following basis :

- (i) Time basis ;
- (ii) KM basis ;
- (iii) Engine hour basis.

Time basis shall be employed for the preventive maintenance of diesel locos on account of its simplicity, time involved between schedules being adjusted according to the utilisation of the locomotives.

3.2.1—Frequency of Maintenance Schedule : The locomotives shall be stopped for preventive maintenance attention as follows :

Nature of schedule attention.

1. Trip/Schedule or weekly
2. Fortnightly
3. Monthly
4. Quarterly
5. Half-Yearly
6. Yearly
7. 2 Yearly
8. 3-Yearly.

3.3 Maintenance Schedule : The schedule of attention to various items in the loco and the frequency of attention shall be as indicated in the tentative maintenance schedule issued by R.D.S.O. vide tentative schedule of standard examinations of WDM2 locos during September 1967 and July 68 for YDM4 locos.

Any changes warranted for the above shall be authorised only by the CME and such changes discussed in the ensuing DMG meeting for final adoption as considered necessary.

3.4 Maintenance Methods : The maintenance methods followed shall be in Conformity with the DMI(S) issued from RDSO. The number of copies of DMI(S) distributed to each Depot shall be adequate to cater for all the Officers and senior supervisors of the Depot.

After attending to the Schedule, the same shall be certified in the relevant cards/registers maintained for the purpose.

3.4.1 Any major out of course repairs to locos as a result of accident or otherwise, or any major modifications requiring large inputs, should be preferably carried out by sanction of a separate estimates, in back shops or maintenance Depots, to avoid any repercussion on normal maintenance.

3.5 Unit Exchange : The unit exchange method of repairs shall be followed in the Diesel Sheds.

Explanation of the Process :

The defective unit/assembly/sub-assembly is withdrawn from the loco and replaced by a Unit/Assembly/Sub assembly in good order, kept stored ready for use in a pool. The defective unit is then repaired, overhauled tested and kept stored in the pool.

The same procedure will be used for Assembly/Sub-assembly needing overhaul during schedules.

List of items to be kept as unit exchange spares is shown at Annexure I.

3.6 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 decentralised to a certain extent to suit the requirements of operation in each area.

The decentralisation shall be on the following lines :

3.6.1 Trouble shooting/outstation points : These may be located at selected marshalling Yard/Fuelling or crew changing point. 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 a home shed for attention.

3.6.2 Staff provided at such trouble shooting points shall comprise of a Junior Maintenance Inspector alongwith Highly Skilled Fitter Mechanical & Electrical in each shift. Strength of Staff may, however, be increased, if local conditions so warrant.

3.6.3 The composition of tools and equipment to be provided and nature of work that may be undertaken at these points is indicated in Annexure II.

3.6.4 Home Sheds : All repair work and schedule maintenance attention will be undertaken at home sheds, barring P.O.H.

The facility, staff and organisation required shall be as indicated at 7.2, 7.2.2 and 7.2.3.

3.7 Organised Preventive Maintenance :

3.7.1 Comprises of :

Provision of requisite maintenance facilities.

Provision of requisite spares, oils and lubrication, other miscellaneous items.

Provision of requisite staff and organisation.

3.7.2 Comprises of providing a shed with proper layout the various general purposes and special tools, plant and machinery.

3.7.2.1 Shed lay-out is dealt with separately in Chapter IV.

3.7.2.2 Special tools—Special tools as listed at in Annexure III shall essentially be provided in all Diesel Sheds. The list indicates the minimum required to be provided.

General purpose tools : Adequate number of single-ended, double-ended ring and box spanners of sizes, pliers, wrenches, Allen Keys, Nylon hammers, Micro-meter and other precision measuring instruments etc. shall be provided in each shed.

Caution : No chisel or steel hammer shall be provided.

Plant & Machinery : The minimum amount of Plant and machinery to be provided in each Diesel Shed is listed at Appendix 4.3 in Chapter IV.

3.7.3 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 overstocking of items.

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

- (a) For imported items and items of long lead : 18/24 months stock to be maintained with recoupment done every year.

- (b) For indigenously available items : 12/12 with recoupment balance returns done every year.

- (c) Items such as Filters, Gaskets, Carbon Brushes, Brake-blocks and hardware should be procured on 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) Lubrication and hardware items: As at (c) above.

3.7.4 Staff :

3.7.4.1 Yardstick. Staff shall be normally provided in the Diesel Sheds as per the yard stick given below :

Diesel maintenance staff :

- (a) **Artisan :** At the rate of ~~3.5~~^{3.4} per loco.

The distribution shall be : 20% in H. S. Gr. I.
25% in H.S. Gr. II.
55% in Grade III.

- (b) **Supervisor :** At the rate of ~~0.8~~^{0.7} per loco.

The distribution shall be : Sr. Foreman 7-1/2 %
Jr. Foreman 12-1/2 %
Sr. Chargeman 25 %
Jr. Chargeman 55 %

- (c) **Ancillary skilled Staff :** Shall be provided at 22% of Artisan staff with the same distribution as under (a).

- (d) **Un-Skilled Staff :** According to the requirements at each shed which is likely to vary according to local conditions. Diesel Sheds shall, however work to a target of 2.75 Un-skilled staff per loco. In addition un-skilled staff for ancillary categories shall be provided according to local conditions.

- (e) Distribution of staff between Mechanical and Electrical grades shall be made according to local conditions.

- (f) **Laboratory Staff :** Every diesel shed shall have a full fledged laboratory attached to it headed by a Asstt. Chemist & Metallurgist who will be assisted by a Laboratory Supdt. and staff of C&MA's cadre. Diesel Shed homing upto 40 locomotives shall have 4 C&MA's and 4 Lab. helpers for each shift working and LR/RG. One C&MA with one Lab. helper shall be provided additionally for every 10 locos increase or part thereof. Sheds having Spectrographic or undertaking oil refining etc., shall be provided with such additional staff of Lab. Cadre as may be required.

(g) *Operating Staff*: Staff of the operating cadre such as Asstt. Foreman, Shedman, Power Recorder/Telephone Attendant, Diesel Shunter, Pointsmen, Callmen, Box Porters shall be provided for round the clock work with adequate provision for RG/LR.

(h) *Inspectorial Staff*: Diesel sheds homing upto 50 locomotives shall have one SLI (DSL) and one JFI(DSL). Additional LI(Diesel) and SFI(Diesel) shall be provided when the loco holding is above 51.

(i) *Engineering staff*: Adequate staff under the charge of one IOW shall be provided by the Engineering Deptt. exclusively for maintenance of shed structures, Building and all others installation inside the shed premises. Such staff shall be under the administrative control of the Engineer-in-Charge of the shed.

(j) *Millwright and Electric Power Supply maintenance staff*: Diesel sheds shall have their own organisation for maintenance of machinery & plant and electric power supply arrangement (excluding the feeding substations) inside the diesel shed. Such staff shall be placed under one Sr. Charge-man for their respective work.

(k) *Staff for Handling Fuel, Lubricants, Stores Tools etc.*: Fuel Issuer, Stores Issuers, Tool Checkers shall be provided for handling fuel oil, lubricants, stores and tools round the clock, with adequate provision for LR/RG.

(l) *Ministerial Staff*: Adequate Ministerial staff be provided in the offices of Engineering-in-Charge, General Foreman, Fuel and Store for execution of various function of the respective offices.

(i) Office of the Engineer-in-Charge shall have an office Incharge with adequate staff for Budget, Establishment, D&AR, Machinery & Plant Programme, Works Programmes, Technical correspondence, Staff grievances and welfare, Receipt and Despatch, Store work, Stationary, Typing etc.

(ii) Office of General Foreman shall have staff to look after Establishment, Pass/PTO, Time Keeping & salary Bill preparation, D&AR, Typing.

(iii) Fuel & statistics office shall have staff for Fuel accountal, Fuel & operating statistics, Fuel Economy etc.

3.7.4.2. Duties & Responsibilities: The duties and responsibilities of the Senior Supervisors of the Diesel Sheds are indicated at Annexure IV.

3.7.4.3 Recruitment, Training and Promotion: With a view to ensure the requisite standards for staff for satisfactory maintenance of the sophisticated and complex equipment in a Diesel loco,

as also to provide for a fair chance of promotion for existing staff, the following procedure for recruitment shall be adopted:

(a) *Un-skilled*: Unskilled Staff shall be recruited preferably with technical back ground such as trained in ITI etc.

(b) *Supervisor*: Direct recruitment of Diploma holders in Mechanical/Electrical Engineering shall be done generally in the lowest supervisory category up to 50% of the total vacancies shall be filled from amongst the qualified Intermediate Apprentices and balance 25% vacancies shall be filled by promotions of Artisans on the basis of selection. Shortfalls if any, shall be made good by direct recruitment. Engineering graduates shall be recruited to appropriate Supervisory Category.

3.7.4.4 Training:

(a) *Unskilled Staff*: At each Diesel Shed, there shall be Basic Training school. to provide for training to unskilled staff to qualify themselves to the skilled grade.

The duration of training provided will be about six months for staff with ITI, back-ground and 12 months to those who do not have any technical background.

(b) *Skilled and Supervisory*: There shall be a centralised training school on each Railway for the training of skilled staff and supervisors.

(i) The duration of training for directly recruited skilled staff shall be 6 months.

(ii) The duration of training for the directly recruited Chageman 'B' shall be 2 years and AFO(AEF) one year.

(iii) The duration of training for the Artisan staff to qualify themselves for promotion to Chageman will be 6 months.

3.7.4.5 Promotion:

(a) For promotion from unskilled to skilled grade:

Eligibility: Minimum 3½ years service in unskilled in the Diesel Shed and successful completion of the training course indicated under 7.2.2.3.2(a).

Trade Test: The promotion will be based on Trade test. The syllabus to be adopted is at Annexure V.

(b) From skilled Gr. III to H. S. Gr. I & H. S. Gr. II.

Eligibility: Minimum 2 years service in each grade. Successful completion of the training course indicated in 7.2.2.3(b) for directly recruited staff.

Trade Test: Promotion will be based on a written test as per syllabus indicated at Annexure VI.

Chargeman 'B' Promotion will be based on a written test as per syllabus indicated in Annexure VII.

Eligibility : A minimum of 8 years service in skilled grade(s).

Senior Chargemen : Promotion will be based on written test as per syllabus indicated in Annexure VIII.

Eligibility : Minimum 3 years in Chargeman 'B' grade.

Foreman Gr. Rs. 700-900 : Promotion will be based on written test as per syllabus indicated in Annexure IX.

Eligibility : Minimum 5 years as Senior Charge-man.

3.8 Record Keeping : Data Analysis :

3.8.1 For evolving an efficient system of maintenance a comprehensive "Record Keeping" is essential so that failures could be analysed 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 that basis. Trends of consumption of spares/lubricants could be watched and expenditure controlled.

3.8.1.1 The following cards shall be maintained :

- (a) Loco Master Defect Card.

- (b) Component Defect Card.

- (c) Analysis Defect Card.

These Cards and Sheets are self-explanatory and all aim at the above mentioned objective.

3.8.2 Other Shed Records to be maintained

The General Foremen/Shed Superintendent shall maintain the following registers in the shed :

- (a) Schedule Forecast Register as per specimen at Annexure X.
- (b) Engine Repair Book as per specimen at Annexure XI. This book shall always go with the loco and is meant for the drivers to book such repairs as they consider necessary.
- (c) Repeated Booking Register.—As per Annexure XII.
- (d) O. K. Register.—As per Annexure XIII.

Specimen forms of the above registers are shown from Annexure X to XIII.

3.8.3 Certification of Locos :

The locos must be certified before being turned out for traffic that 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 I

REQUIREMENT OF UNIT EXCHANGE SPARES

S. No.	Description of the items	Requirements of			S. No.	Description of the items	Requirements of		
		50 Locos	100 Locos	More than 100 Locos			50 Locos	100 Locos	More than 100 Locos
1	Diesel engine power pack complete with generator and turbo supercharger.	..	1	1	21	Traction Motors (apart from those with the trucks).	18	36	42
2	Truck assy. complete with wheels, bearing springs, traction motors etc.	2	4	5	22	Aux. generator of HEIL make (suitable to be used as exciter of HEIL as well as aux. generator of GE).	1	2	2
3	Turbo supercharger .	2	4	5	23	Excitor alternator GE .	1	2	2
4	Expressor . . .	2	3	4	24	Dynamic braking blower motor	1	2	2
5	Radiator set . .	1	2	3	25	Fuel pump motor .	3	6	8
6	Lube oil cooler . .	2	3	4	26	Crank case exhaustor motors.	3	6	8
7	Radiator fan drive with eddy current clutch with complete gearbox.	1	2	3	27	BKTs 1 & 2 . . .	1	2	2
8	Engine crankshaft .	1	2	3	28	Reversor 1 & 2 . .	1	2	2
9	Fuel injection pumps .	1	2	3	29	Power contactors .	1	2	3
10	Fuel injector nozzle with holder complete.	2	4	5	30	FS contactors . .	1	2	3
11	Fuel pump supports .	1	2	3	31	Excitor panel . .	1	2	3
12	Cylinder heads . .	1	2	3	32	Voltage regulator .	2	4	5
13	After cooler. . .	2	3	4	33	FS resistance . .	1	2	3
14	Water pump . . .	1	2	3	34	Dynamic brake grid resistance.	1	2	3
15	Lube oil pump . . .	1	2	3	35	Governor GE/Woodward.	1	2	3
16	RTIM blower . . .	1	2	2	36	Techo Generator .	2	4	5
17	Air maze oil bath filters	1	1	2	37	Axle alternators .	2	5	6
18	Pistons with conn. rods and caps	1	2	3	38	All safety relays . .	1	2	3
19	Traction Generator (apart from those with the power pack)	1	2	3	39	Batteries . . .	2	4	6
20	Air brake valves . .	1	2	3	40	Fuel oil pump . .	3	6	8
					41	Governor oil pump .	3	6	8

ANNEXURE II

1. Tools and Equipments

Two boxes containing standard tools such as double end spanner, bi-hexagonal ring spanner, reversible ratchet, pipe wrenches, nylon hammer, universal joint and extension handle, different sizes of boxsockets and socket spanners, special tools for dismantling expressor valves and ring, cranking bar, feeler gauge, tyre condemning gauge etc. will be made available.

The following electrical tools are also required :—

- (1) Simpson Multi Meter.
- (2) Meggar.
- (3) Volt Meter 0-3-0.
- (4) Hydrometer for checking specific gravity.
- (5) Spare cable loads for battery charging.
- (6) One Elec. Lamp with 50' lead wire.

ANNEXURE III

SPECIAL TOOLS

Sl. No.	Description	Alco Cat. No.	Sl. No.	Description	Alco Cat. No.
1	Kiene Diesel Engine Pressure Indicator.	2478003	17	Voltmeter 1000 Volts	8DPLVY 69
2	Grinder, Valve seat basic set	2470225	18	Portable tachometer frequency indicator (for engine speeds, speed relay calibration).	8943485 G2
3	Power wrench set (torque Multiplier set) 7:1	2470195 head 2470198 251 in line 2470197 251 V	19	Electric hand tachometer with adaptors and carrying case.	8943485 G2
4	Power wrench set		20	Meggar hand operated 0 to 2000 megachim 1000 volts with 12 foot leads (James D. Biddle Co. 7680 Testing resistance of insulation).	101×910
5	Gauge Elongation Con : rod	2470043	21	Portable Test set, 2EVA, 2000 to 110 volts.	79×815
6	Grinder, ridge removal		22	Hand pyrometer with rigid extension and Prong extension arm and carrying case.	582×70
7	Gauge elongation main Drg.	247004	23	Pinion puller with adaptors	108×87
8	Wrench	2471101 Inter main Brg. Bolts.	24	Commutator grinder with adaptor and stones.	
9	Wrench LH main Drg. Belt	2471103	25	Micrometers inside and outside of various sizes.	
10	Wrench RH	2471104	26	Dial calipers, vernier to read to 0.0001".	
11	Volt meter 100 MV, 100 division for Gen. field current.	86×997	27	Depth gauge	
12	Ammeter 0—1 Amp. Exciter field current.	86×524	28	Torque wrenches	
13	Ammeter 0—15 Amperes	86×529	29	Crimping tools	
14	Test Kit for setting speed relays checking speed meter, sequence of relay and tractor operation.	17 MM 14 B1			
15	Voltmeter 0 to 150 volts, 400 cycles.	8 A S 5 VAA 6 H4			
16	Voltmeter 0.15/1.5/15/150 volts for Gen. Voltage.	8DP9VY299			

ANNEXURE IV

Loco Foreman (Diesel)

1. General Supervision over maintenance, train operation, power and crew arrangements.
2. General establishments and administrative matters.
3. Supervision over receipt, issue and account of fuel oil.
4. Investigation of failures and defects and submission of reports, co-ordinating with Electrical Foreman wherever necessary.
5. Shed developments and improvements and cleanliness shed premises and power units.
6. Attending operating meetings, seminars and conducting supervisors meeting.

Maintenance Inspector I

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.
5. Responsible for the outturn by the ancillary staff assisted by chargemen.
6. Responsible for the maintenance of machinery and plant and tools (Special and General), condemnation and recoupment of tools.
7. Supervision over the light schedules section and bench repair section and assisting the Loco Foreman in the turnout.
8. Surprise inspection and sample checks on locomotives during night and day.

Maintenance Inspector II

1. Independent inspection of locomotives on quality of schedules and load box tests of heavy schedules locomotives.
2. Drawing up of maintenance schedules (Programming & Planning).
3. Wheel change programme.
4. Maintenance of records and statistics, assisted by chargeman.

5. Inspection of accident locos and submission of special report and evolution 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, and demonstrated to the staff, and ensuring that these instructions are followed.
8. Supervision over the heavy schedules and assisting the Loco Foreman in the outturn.

Responsibilities

I. Electrical Foreman (General) incharge

He is overall in-charge of the following :—

1. General administration with regard to staff: correspondence with Hd. Qrs. 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. Finalisation of failure reports.
6. Responsible for turnout of locos.

II. Maintenance Inspector

1. Responsible for the maintenance schedules with regard to revision of schedules and maintenance practice as necessary for the electrical equipment of the diesel locomotives.
2. Follow up modifications and trials including trials of indigenous components on the electrical side and submission of reports thereon (assisted by ELC).
3. Responsible for turnout of heavy schedule locomotives assisted by AMF.
4. Planning of material requirements, preparation of stocking application and follow up action thereon (assisted by ELC).
5. Scrutiny of drawings, specifications etc. (assisted by ELC).
6. Inspection of samples and supplies (assisted by ELC).
7. Load Box testing.
8. All maintenance statistics (assisted by ELC).
9. To look after the current duties of EF/DSL whenever he is away from headquarters.

ANNEXURE V

SYLLABUS FOR TRADE TEST FOR THE POST OF SKILLED FROM UNSKILLED

1. Knowledge of diesel engines and its working components—Principles and their function.
 2. Ability to handle various precision tools such as micrometer, Vernier caliper, dial gauge Torque Wrenches.
 3. Knowledge of overhauling diesel components such as Turbo, Fuel injection pump, waterpump, lub oil pump, Traction Motor Blower, cylinder head, expressor 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.
 7. Knowledge of various brands of lubricants used in diesel locos.
 8. Knowledge of various systems such as lubricating oil, fuel oil, coolant water and Air brake system.
-

ANNEXURE VI

SYLLABUS FOR THE POST OF H. S. GRADE I & GRADE II

1. Knowledge in different types of diesel locos that are in use and their principles and functions.
 2. Knowledge of various major preventive maintenance schedules and the correct repair method instructions of dis-assembly overhaul and assembly of major diesel components.
 3. Ability to handle precision instruments, various special tools and equipments that are used in maintenance of diesel locos.
 4. Knowledge of various systems of diesel locos such as lubricating oil, fuel oil, coolant water and Air Brake.
 5. Trouble shooting and remedial action to be taken.
 6. Ability to read simple drawings and inspect the components and record the sizes of various components.
 7. The importance of various tests conducted in the laboratory for lub oil, fuel oil and water.
 8. Knowledge of spring gear, and under truck assembly of diesel loco.
 9. Load testing and observation to be made during testing.
-

ANNEXURE VII

CHARGE MAN : B

1. Knowledge in basic principles and working of diesel engines and electric and hydraulic transmission.
2. Knowledge of functioning, maintenance and test of the following engine power pack assemblies, turbo supercharger, auxiliaries lub oil pump, water pump, air cooler, link oil cooler, blowers, radiator and radiator fan.
3. Knowledge of fuel system, lub oil system, cooling water system, air brake system, troubles and maintenance.
4. Knowledge of functioning and maintenance of air and brake system including vigilance control device.
5. Knowledge of functioning and maintenance of Expressors.
6. Knowledge of inspection and attention to under truck and loco chassis.
7. Knowledge of working and attention to woodwards Governors.
8. Knowledge of periodical tests carried out in the Diesel laboratory on lube oil, fuel oil, cooling water and control over their quality.
9. Knowledge of overhauling and testing fuel in section equipment.
10. Knowledge of load testing remedial measures to be taken based on observations.

SYLLABUS FOR CHARGE MAN (TRANSMISSION)—'B'

1. Types of Diesel locos in use and their general working principles.
2. Principles of different excitation systems and principles of governing power pack assembly.
3. Knowledge of G. E. Electro-hydraulic governor and its function.
4. Sound knowledge of safety devices and their function.
5. Trouble shooting—ability to locate defects and rectify.
6. Dynamic braking working principles—calibration and re-calibration of circuits.
7. Load testing and object of load testing.
8. Knowledge of Indian Electrical Act and rules.
9. Maintenance of switch gear relays.
10. Knowledge of warning systems.

ANNEXURE VIII

SYLLABUS FOR THE POST OF AEF/DIESEL

1. Different types of diesel locos manufacture, comparative merits and demerits of different systems of transmission adopted for diesel locos with regard to transmission efficiency and suitability for adoption to different services.
2. Comparison of diesel locos with straight elec ; locos, use of monomotor bogies and suspended motors—comparison.
3. AC & DC generation of diesel electric locos and factors influencing them.
4. Continuous rating and sustained tractive effort—Dynamic braking effect of diesel electric locos—their significance and evaluation of load haulage ability and controlling ability of diesel locos.
5. Knowledge of different systems of excitation provided on diesel locos—Principle of governing power pack systems. Type of Governors employed on diesel locos—hydraulic governor and its function.
6. Storage Batteries : Principles, requirement of traction batteries, acceptance test, commissioning of new batteries and capacity test—Maintenance procedure for batteries.
7. Load testing of locos—Object of conduction load test, significance of the different readings and adjustments to be made. Horse power limit and current limit and current limit test efficiency calculation.
8. Application of semi-conductors to Diesel Electrical Locomotives Comparative advantages—Principles of working transistor circuits.
9. Knowledge of Indian Electricity Act and Rules.

ANNEXURE IX

SYLLABUS FOR THE WRITTEN TEST TO BE HELD AS PART OF SELECTION FOR THE POST OF FOREMAN/A.S.S./T.A.

1. Must be conversant with broad principles of working high speed internal combustion engines and transmission systems.
2. Must have detailed knowledge of BG & MG diesel locomotives working of Indian Railways.
3. Must have detailed knowledge of BG & MG Rail Car working on Indian Railways.
4. Must be conversant with all technical information in regard to maintenance of diesel locomotives and diesel rail cars and submission of warranty claims.
5. Must be conversant with Payment of Wagons Act, Hours of Employment Regulations and Workmen's Compensation Act.
6. Must be conversant with hours of employment regulations pertaining to duties of running staff particularly in regard to hours of work, payment of various allowances, rest rules, etc.
7. Must have ability to read and write English besides knowledge of one or more regional languages.
8. Must have a flair for labour control and management of establishment with 500 to 1000 men.
9. Must be conversant with maintenance of roller bearing.
10. Must be conversant with different properties of lubricants and Petroleum products.
11. Must have knowledge in ultrasonic testing of axles and journals of diesel locomotives.

ANNEXURE X
SCHEDULE FORECAST REGISTER

Sl. No.	Loco No.	Date put on line	Date of POH	Last yearly Schedule		Orly. Sch.	Half Yrly Sch.	Orly. Sch.	Yearly Schedule		Orly. Sch.	Half Yrly. Sch.	Qty. Sch.	Yearly Sch.	Re- marks
				Date	Type				Date	Type				Date	Type

ANNEXURE XI
RAILWAY

Driver's Name	T. NO.	Train NO.	Loco NO.	Items to be handed over and taken over by drivers.	
Asst. Drivers Name	T. NO.	From Load as per journal	To Guard's	1. M. U. Jumper cable.	
Driver's home shed				2. V.R.R. Spare fuse.	
Type of Schedule attended at home shed/Satellite and date		Actual Dep. time	Dt.	3. Ground relay cut-out switch seal.	
Type of Schedule, due and date		Actual Arr. Time	Dt.	4. Indication lamps and caps.	
KMs earned during the trip		Fuel Consumption	Litres.	5. Fire extinguisher.	
				6. 28VS COC open sealed or closed.	
				7. Vigilance control COC.	
				8. RTTM blower bolts.	
				9. Mechanical Speedometer.	
				10. Fuel fillings caps.	
				11. Windshield wipers.	
				12. Emergency telephone key and seal	
				13. One spare transition screw coupling.	
Drivers bookings	Shift Charge man's/outstation/Mechanics remarks.	Signature of Driver handing over		Signature of Driver taken over	
		Name		Name	
		Designation		Designation	
		Home Shed		Name Shed	
		Date		Date	
Signature of Driver	Signature of Shift Charge man/outstation Mechanic.				

Levels

- | | |
|--|---|
| 1. Lub. oil sump level———added———litres. | 4. Governor all level———added———litres. |
| 2. Express or sump level———added———litres. | 5. Expansion tank water oil———added———litres. |
| 3. Generator gear case level———added———litres. | 6. Air maze oil bath filter level———added———litres. |

READING:— To be recorded every half-an hour.

- | | |
|--|---|
| 1. Time | 7. Water temperature. |
| 2. Boostler pressure. | 8. Expressor oil pressure. |
| 3. Fuel oil pressure. | 9. Speed. |
| 4. Lub. Oil pressure. | 10. Gradient. |
| 5. Load ammeter readings. | 11. Notch. |
| 6. Battery charging armature. reading. | 12. Position of Dyn. brake selector handle. |

Motoring(M) or Dyn. braking (B)

- | | |
|---|-----------------------------|
| 1. Time | 7. Water temperature. |
| 2. Boostler pressure. | 8. Expressor oil pressure. |
| 3. Fuel oil pressure. | 9. Speed. |
| 4. Lub. Oil pressure. | 10. Gradient. |
| 5. Load ammeter readings. | 11. Notch. |
| 6. Battery charging armature. readings. | 12. Position of Dyn. hands. |

Motoring (M).

ANNEXURE XII

.....RAILWAY

DIESEL SHED.....	LOCOMOTIVE TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	Re- marks

1. Throttle not responding.

2. Loadmeter not responding.

3. Engine hunting

4. Low booster pressure

5. Expressor throwing oil

6. Power ground

7. Loco brakes not releasing.

8. Power contractor flut-
tering during transition

9. Low lube oil pressure

10. Fuel pressure dropping on higher notches

11. Vent pipe leaking or cracking

12. Battery charging rate on high side beyond 20 amps.

13. Wheel slip indication

14. F.P. circuit braker tripping.

15. Experiencing jaks while handling

16. Transition not picking up properly.

Make out a black dot in a circle.

ANNEXURE XIII

.....RAILWAY

O.K. REGISTER

Date	Loco No.	Train No.	Shed Dep.	Vigilance condition	Vigilance COC	HB-5 COC	H-5 COC	Brake Cyl-COC	28VB COC	Vac. on 5/16" leak plate SH	Vac. on dummy	Vac. on 5/16" leak plate BH
1	2	3	4	5	6	7	8	9	10	11	12	13

Fire Ex		MRQA Pr		Sender		Senders	Wind Wipers	Speedometer		Checksealing of Gear No.		Drivers Name	Signature
ER	Cab.	Cut In	Cut In	A	9 3 A			Recorder	Indicator & Clock	case bolt & SUSPENSION ON BEARING			
										Cap. Bolts			
14	15	16	17	18	19	20	21	22	23	24	25	26	

CHAPTER 4

MAINTENANCE SHEDS—LAYOUTS AND FACILITIES

4.1 Size and Location of a Maintenance Shed :

4.1.1 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 locomotives, it is not very essential to have sheds at points coinciding with large traffic yards. It would suffice if a shed is located at a train examination or crew changing point.

4.1.2 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, changeover 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.

4.1.3 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 personalised attention is a pre-requisite. In the homing shed, full history of each locomotive should be readily available so that locomotives needing more attention can be selectively nursed even during minor repair schedules. Personalised attention is feasible when the number of locomotives in a shed is limited to a maximum of between 80 and 100. When the number increases beyond 100, attention gets diffused and when it exceeds 120, personalised attention fails.

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

4.1.5 The maintenance shed should be preferably located at or near an industrially developed town. The sophisticated assemblies used in a diesel locomotive sometimes require facilities of a kind which may not be readily available in the shed or which it 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.

4.1.6 The maintenance shed has to be provided with good communications facilities for effective maintenance. Good P&T communications link

with large industrial centres help in arranging materials and components at short notice in case of emergencies.

4.1.7 In case general requirements necessitate a large holding in one shed, merits and demerits of large concentration of work force from the point of view of good management must be given due consideration.

4.1.8 The shed should be located away from a steam locomotive shed to avoid the nuisance of smoke, ash and cinder etc.

4.1.9 From the point of view of efficient maintenance, all repair schedules including the trip schedule should preferably be carried out in the homing shed. Only under very exceptional conditions should recourse be taken to outstation or satellite sheds. Even in such cases, monthly maintenance schedules and above must be invariably be carried out in the homing shed.

4.2 Basic Features of Shed Layout :

4.2.1 A uni-directional movement of locomotives in the shed is preferable.

4.2.2 Separate entrance and exit points should be provided to avoid bottlenecks.

4.2.3 The layout should permit a locomotive to skip stage of servicing without hampering the flow of other locomotives.

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

4.2.5 Each line in the covered repair area of the shed should be able to hold 3 locomotives. The layout should provide for possibility of expansion widthwise i.e. by providing more lines side by side. Expansion along the length of the running lines should not be adopted.

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

4.3 Sequence of Repair Operations :

4.3.1 The recommended sequence of operations for servicing is—

- Cleaning and washing of under-gearing and body.
- Sanding.
- Fuelling.
- Inspection and topping of tube oil and cooling water.
- Repairs.
- Departure.

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

4.4 Servicing Facilities :

4.4.1 Washing and Cleaning :

- (1) 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 undergearing and body of the locomotives.
- (2) Manual washing with brushes (fitted with long handles) is recommended for small sheds. Automatic washers with mechanised sprays, brushes etc. can be justified only for very big running sheds sealing with a large number of locomotives.
- (3) 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.
- (4) Fig. 4.1 shows schematically a washing installation.

4.4.2 Sanding:

- (1) Sand should be stored under cover to keep it dry. Sand drying arrangements may be necessary in areas having heavy rainfall.
- (2) Sand should be properly sieved before being filed to prevent the sanding apparatus on the locomotives getting choked.
- (3) For small sheds, manual filling of sand boxes is adequate. Mechanised sanding facilities are recommended for large running sheds.
- (4) The sanding point should be at an adequate distance away from the fuelling installation and the running shed building.

- (5) The sand should generally conform to Indian Railways Standard Specification No. Z9-66.

4.4.3 Fuel supply installation :

This has been dealt with in Chapter 8.

4.4.4 Lubricating oil storage and dispensing :

This has been dealt with in Chapter 9.

4.4.5 Cooling water treatment and dispensing :

Diesel engine water should be treated in accordance with maintenance instructions laid down for different classes of locomotives. The most widely used treatment is that with chromate. The method of chromate water treatment is given at Appendix 4.1 to this Chapter.

4.5 Shed Construction :

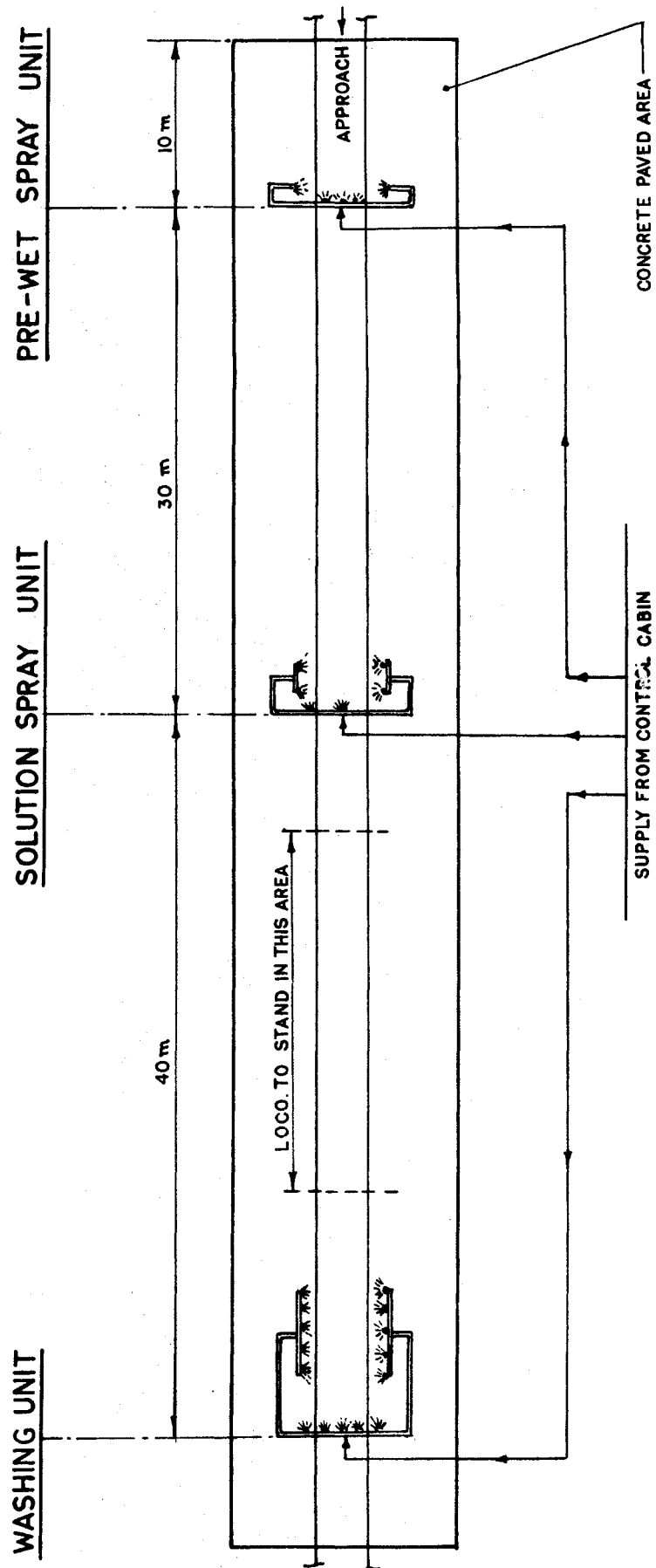
4.5.1 A 3-level working floor arrangement should be provided. The rail level in the repair area is the same as the general shed floor level. The depressed floor area outside the rails is kept lower than the shed floor level so as to be able to attend effectively to the bogies and under-gear. The pit level between the rails is kept still lower to enable proper examination of under-gearing. Above the depressed floor level, a platform level is provided, which is at the same height as the locomotive floor, to attend to all components of the locomotive above the underframe. 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 arrangement is shown in Appendix 4.6.

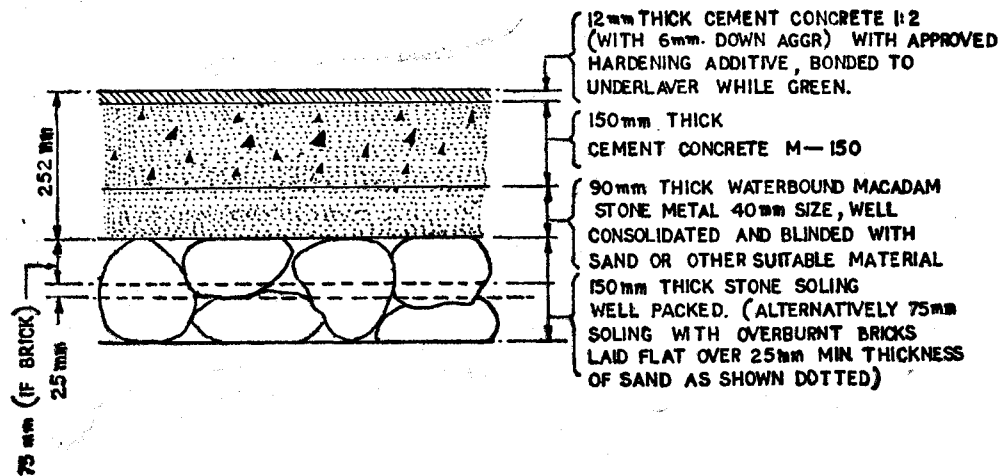
4.5.2 Flooring should be easily washable so that split oil can be effectively removed. All flooring should be finished with a hard top to withstand abrasion resulting from handling of heavy parts and movement of material trollies etc. Wooden flooring is not recommended. Concrete flooring is acceptable. Figure 4.2 shows a typical flooring suitable for average type of soil.

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

4.5.4 To minimise cracking and to facilitate repairs flooring should be divided into rectangular panels, with sides not exceeding 2 metres, using dividing strips.

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





TYPICAL DETAIL OF FLOORING

FIG. 4.2

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

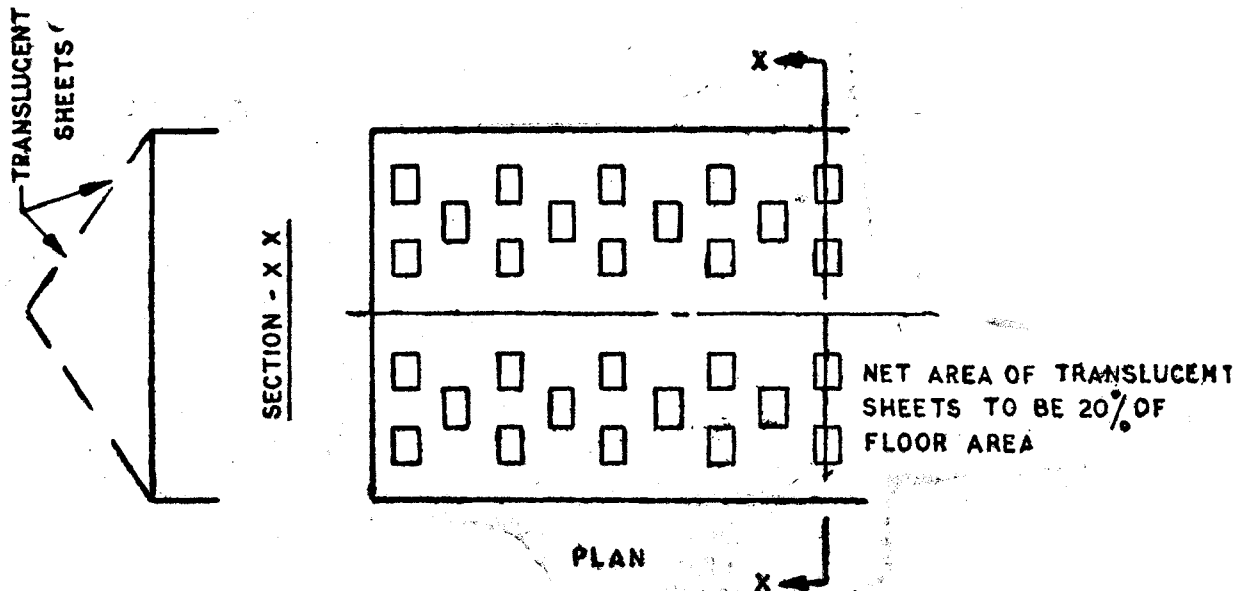
4.5.7 The edge of the elevated platform should be suitably raised to provide a rim to prevent tools and materials from rolling off. This also reduces the possibility of men slipping at the edge.

4.5.8 To minimise the dust nuisance in working areas, a length of approximately 30 metres beyond the cover area should be paved.

4.5.9 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.

4.5.10 The roof should be of a construction that caters for maximum natural light in working area. Translucent corrugated sheets suitably arranged in "pepper-pot" form (Fig. 4.3) is recommended in preference to north-light glazing.

4.5.11 A typical north-light roof of saw-tooth type is shown in Fig. 4.4. Fig. 4.5 shows a fink roof truss with ordinary monitor and Fig. 4.6



"PEPPER POT" ARRANGMENT OF TRANSLUCENT SHEET ON ROOF

FIG. 4.3

shows a fink roof truss with north-light monitor. Except when the bays run north to south, the double sloped fink type truss with ordinary or north-light monitor should be adopted in preference to the saw-tooth type truss.

4.5.12 Roof extractors and exhaust fans should be provided at suitable locations to remove smoke and fumes.

4.5.13 Fabrication of roof structure by welding is preferable in order to conserve steel.

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

4.5.15 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.

4.5.16 To protect personnel working on the elevated platform from falling down when the line is not occupied by a locomotive, 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 locomotive is placed alongside. Provision of sockets in the platform floor in which steel pipes can be inserted is a convenient method of doing so.

4.6 Lifting and Material Handling Facilities :

4.6.1 Overhead cranes of suitable capacity should be provided to serve heavy repairs area, free floor space, a part of the machine shop and stores. Crane capacity should be sufficient to lift the heaviest single repairable component or assembly. Overhead crane is not intended to lift complete locomotive singly; however, it should be capable of lifting a complete locomotive from one end so as to enable a bogie to be run out from under it.

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

4.6.3 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.

4.6.4 Hand carts and trolleys should be used for movement of components. Fork lift trucks should also be provided in large maintenance sheds.

4.7 Illumination :

4.7.1 Good illumination is necessary for efficient repair work. In the repair area fluorescent light or mercury vapour lamps giving an even illumination of atleast 200 lux at platform and floor levels should be provided.

4.7.2 Pits should be provided with bulk head fittings for direct lighting of the under-gear of the locomotive. Here also minimum illumination level of 200 lux is necessary.

4.7.3 At fuelling, sanding and washing points and turn tables etc. illumination level of 100 lux is sufficient.

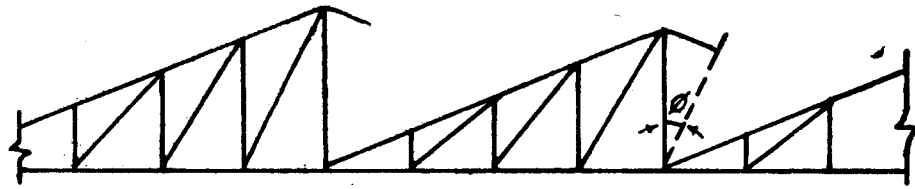
4.7.4 At the area where relief train is stabled, an illumination level of approximately 60 lux should be available. The general level of illumination in the yard in the maintenance shed should also be of the same order.

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

4.8 Shed Building :

The shed building, besides providing for the repair area, machine shop etc., should accommodate the following :

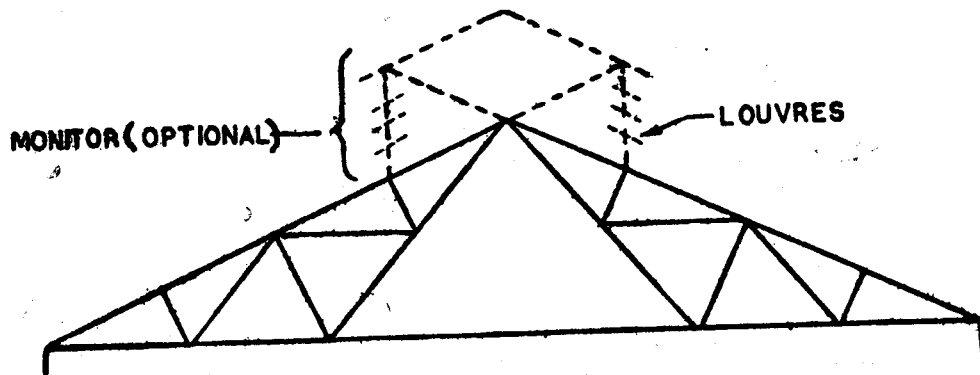
- (1) Battery charging and storage room.
- (2) Instrument repair and testing room.
- (3) Fuel injection repair and testing room.
- (4) Engine governor repair and testing room.
- (5) Brake testing room.
- (6) Flaw detector room (magnetic and zygló etc.)
- (7) Filter storage.
- (8) Tool room.
- (9) Lockers and washing room.
- (10) Laboratory.
- (11) Driver's lobby and lockers.
- (12) Booking office.
- (13) Supervisors' office rooms.
- (14) Shed Officers' rooms.
- (15) Office room and record room.
- (16) Library.
- (17) Lecture or Meeting room.



$$\phi = 23\frac{1}{2}^\circ - \theta \text{ (WHERE } \theta = \text{LATITUDE)}$$

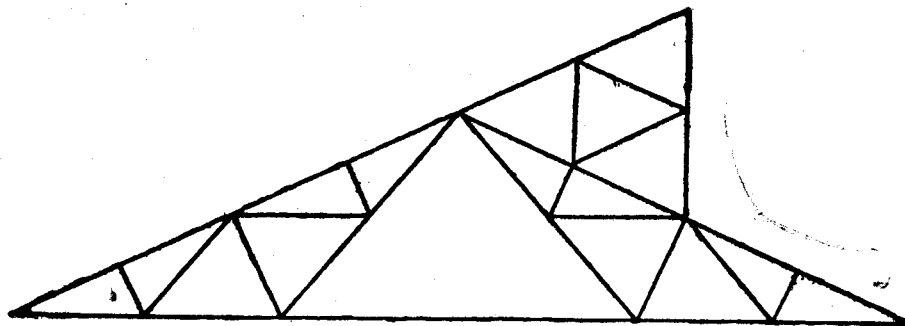
(a) NORTHLIGHT ROOF FOR PLACES WITH LAT: LESS THAN $23\frac{1}{2}$

FIG. 4.4



FINK ROOF TRUSS WITH ORDINARY MONITOR

FIG. 4.5



FINK ROOF TRUSS WITH NORTH LIGHT MONITOR

FIG. 4.6

4.9 Battery Charging :

4.9.1 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.

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

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

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

4.10 Shed Stores :

4.10.1 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.

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

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

4.10.4 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 effect of temperature.

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

4.10.6 To reduce material handling to a minimum and same 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.

4.11 Auxiliary Buildings :

4.11.1 A small shed should be provided in the vicinity of the main shed building for stabilising spare wheels and bogies. A 3-tonne gantry should serve the stabling line and the line next to it for proper loading and unloading of the wheels.

4.11.2 Under-floor type of wheel lathe should be provided in a large maintenance shed for in-situ reprofiling of worn locomotive wheels. A separate shed for the underfloor wheel lathe is preferable.

4.11.3 A load-box for testing a locomotive under power should be provided in every home shed. This applies to sheds handling only diesel-electric locomotives.

4.12 Compressed Air :

4.12.1 Air compressor should be installed in 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.

4.12.2 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 near locations such as machine shop, fitter repair benches, blacksmith shop etc. compressed air is also required for blowing out dirt, to operate hand tools etc.

4.12.3 Air receivers should be provided in the compressed air line at suitable locations to minimise pressure drop.

4.12.4 For small sheds to house upto 10 locos, a 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.

4.13 Repair Area :

4.13.1 In the general repair area, separate areas should be demarcated for specialised repair groups such as—

- Diesel engines.
- Electric rotating machines.
- Hydraulic transmission.
- Cooling equipment and radiators.
- Brake equipment and valves.
- Final drives, gears cardan shafts.
- Under-gearing components.

4.13.2 Fitter's benches should be suitably provided in each of the demarcated areas.

4.13.3 For ease of handling during repairs, suitable hoists and chain pulley blocks etc. should be provided.

4.13.4 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. Special holding trays etc. should similarly be provided for bearing shells, fuel injection nozzles etc.

4.14 Fuel Injection Room :

4.14.1 As indicated in para 4.8, 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.

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

4.14.3 Non-skid oil proof flooring should be provided in the fuel injection room.

4.14.4 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 :

- Test stands for checking nozzle spray and pressure.
- Fuel pump calibration stand.
- Nozzle valve lapping tools and machine.

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

4.15 Governor, Instruments and Brake Valve Repair Rooms :

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

4.15.2 All these rooms should be made dust free. Air-conditioning is not necessary but arrangements for supply of filtered air are required.

4.16 Laboratories :

4.16.1 In every diesel locomotives 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 carrying out metallurgical and chemical inspection parts and supplies received in the shed.

4.16.2 Appendix 4.2 gives the general equipment that should be available in the shed laboratory.

4.16.3 The essential tests required to be carried out on fuel oil and lubricating oil are described in chapters 8 and 9 respectively. Some of these tests as also tests on cooling water are required to be carried out during every trip schedule. For such tests, the laboratory should function round the clock.

4.17 Filter Cleaning :

4.17.1 All diesel locomotives are fitted with air-filters. Most locomotives have the first stage air filter in the form of impingement type filters

and the second stage as oil bath type filters. Whatever be the type of filters, their periodical cleaning is absolutely necessary. Choked filters lead to high thermal loading, low engine power and high specific fuel consumption.

4.17.2 In every large shed, mechanised filter cleaning equipment should be provided to the extent possible. Where the workload does not justify mechanisation, a separate area for manual cleaning of filters should be provided.

4.18 Cleaning and Washing :

4.18.1 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.

4.18.2 Cleaning of 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. Wherever justified, mechanised cleaning equipment should be provided.

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

4.19 Shed Offices :

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

4.19.2 The driver's booking office and lobby should be located near the point where the locomotives are inspected and prepared for despatch.

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

4.20 Plant and Equipment :

4.20.1 A list of machinery and plant required in maintenance sheds of different sizes is given at Appendix 4.3 to this Chapter. This list is generally applicable to sheds homing WDM2 type of locomotives. Suitable adjustments can be made for locomotives of other types. This list does not include ordinary tools such as spanners, chisels, files, hammers etc.

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

4.21 Fire Fighting :

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

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

4.21.3 The above arrangements shall be planned and provided by Security Department.

4.22 Training School :

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

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

4.22.3 The training school should be provided with a library with sufficient books and technical literature and audio visual aid for training.

4.22.4 Model room in the training school should display cut-way models and working models of as many components as possible.

4.23 Staff Amenities :

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

4.23.2 Adequate precautions are necessary against dermatitis amongst workers handling fuel oil, lubricants, chromates 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.

4.23.3 Staff lockers rooms, cycle and scooter stand, canteen and other essential amenities should be provided in the shed.

4.24 Terminal Maintenance Shed :

4.24.1 From operating considerations it becomes necessary sometimes to provide terminal running sheds. Whereas the homing sheds are provided for all facilities described above, in the terminal shed only the minimum facilities enough to ensure satisfactory completion of the return trip to the homing shed are necessary. Facilities should also provide for minor repair work.

4.24.2 The basic facilities required in a terminal shed are sanding, fuelling, inspection pit, 3 level working platform, topping of lubricating oil and treated water, checking and charging of batteries.

4.24.3 Following minimum accommodation should be provided in the terminal shed.

- Stores room.
- Foreman and Supervisors room.
- Repair benches.
- Sand House
- Fuel installation.
- Mobile lubricating oil dispensing arrangement.
- Driver's lobby.

4.24.4 Enough covered area should be provided for berthing of locomotives undergoing inspection and repairs.

● ● ●

APPENDIX 4.1

TREATMENT OF DIESEL ENGINE COOLING WATER WITH CHROMATE TYPE OF CORROSION INHIBITOR

1. Composition of the Chromate Compound Corrosion Inhibitor :

Sodium Chromate	60%
Sodium Carbonate	30%
Potassium Dichromate	5%
Calgon (Sodium Hexameta phosphate)	5%

Chemicals of the highest purity should be used as far as possible.

2. Cooling water requirements :

The water should be free from visible impurities like suspended matter, silica and organic growth like fungus and moss suspension and should be soft. Use of distilled/de-mineralised water or steam condensate is recommended.

3. Qualities of treated water :

3.1 Chromate concentration

The treated water should contain a minimum of 2500 ppm of chromate compound expressed in terms of *Potassium dichromate* at the time the locomotive leaves the shed. The concentration should not be allowed to fall below 2000 ppm at any stage. This should be particularly watched in *outstation sheds* having trip inspection facilities only.

3.2 pH Value :

The treated water should have a pH value between 8.5 and 9.5. In case the pH value obtained is higher for a concentration of 2500 ppm, the proportion of sodium carbonate in the mixture may be reduced suitably.

4. Addition of the Chromate Compound :

4.1 It is not desirable to add the mixture directly to the expansion tank.

4.2 The mixture should first be dissolved in a few litres of the cooling water and this concentrated solution should then be charged into the engine cooling system.

5. Testing of coolant water :

5.1 The coolant water should be tested in the laboratory during each trip inspection.

5.2 The method for determining the chromate content, chlorides, hardness and pH value are given at para 10.

6. Limits for the change of treated water :

6.1 The coolant water should be changed when the sample drawn from the loco is contaminated with lube oil, fuel oil or suspended matter etc.

6.2 The coolant water should also be changed when the total hardness and the total chloride content exceeds the following limits :

Total hardness	200 ppm as Ca Co
Chlorides	50 ppm as Na Cl.

7. Cleaning of the coolant system :

The coolant water should be cleaned and flushed at least once in a year and whenever oil contamination is detected. After cleaning the system with clean water, 4.5 kg. of Trisodium phosphate dissolved in clean water should be charged into the system. The engine should be operated with this solution for one day. The system should then be drained, flushed with water and then filled with coolant water treated with chromate compound.

8. Topping up cooling water :

Only distilled/demineralised water should be used for topping up. Over flowing of the system and topping with raw water at outstation should be avoided.

9. Drawing out sample for testing :

The sample of cooling water should be drawn from the cooling water circuit immediately after stopping the engine. The sample should be drawn from a point where there is a regular flow of water. At least 2 to 3 litres of the coolant should be allowed to drain off before collecting the sample.

10. Estimation of Chromate, Chloride, pH value and Total Hardness :

10.1 Estimation of Chromate :

- (1) Pipette out 25.0 cc of the coolant water collected from the loco into a 100 cc conical flask.
- (2) Add 10 cc of 25% Hydrochloric acid (or) 25% Sulphuric acid.
- (3) Shake well and add 15.0 cc of 1.5% Potassium Iodide solution.
- (4) Shake well and titrate slowly against N/10 Sodium Thiosulphate solution till a straw yellow colour is obtained.
- (5) Now add 1.0 cc of freshly prepared 0.25% (W/V) Starch solution.
- (6) Add N/10 Sodium Thiosulphate solution from the burette drop-wise till the blue colour suddenly disappears.
- (7) If V is the volume in c.c. of N/10 Sodium Thiosulphate solution consumed, then the concentration of Chromate as Potassium Dichromate is $200 \frac{V}{V}$ ppm.

10.2 Estimation of chloride :

- (1) Pipette out 50.0 cc of the coolant water collected from the loco into a 3" diameter china dish.
- (2) Titrate slowly against N/58.5 Silver Nitrate solution till a permanent brick red colour is obtained.
- (3) If V is the volume in c.c. of standard Silver Nitrate solution consumed, then the concentration of Chloride as Sodium Chloride is $20 \frac{V}{V}$ ppm.

10.3 Estimation of pH value :

- (1) pH value of the coolant solution is estimated with a pH meter using coloured and glass electrodes.
- (2) In case pH meter is not available/out of order BDH-Narrow Range pH Indicator Paper (pH 8.5 to 10) manufactured by BDH (India) Pvt. Ltd., Laboratory Chemical Divisions, 19, Witter Road, Bombay-1 may be used.

10.4 Estimation of Total Hardness (EDTA method):**10.4.3 Calculation :**

- (1) *Indicator Solution* : Dissolve 0.5 gm of Erichrome black T in 100 ml of Triethonclamine.
- (2) *Buffer Solution* :
 - (a) Dissolve 40 gms of Borax in approximately 8000 or distilled water.
 - (b) Dissolve 10 gms of Sodium Hydroxide, 10 gms of Sodium Potassium Tartarate and 5 gms of Sodium Sulphide in 100 ml of distilled water.
 - (c) When cool, mix the two solutions (a & b) and dilute to 1000 ml of distilled water.

Note : The buffer reagent should not be used for more than one month after preparation.

- (3) *Standard EDTA Solution* (0.02 N) :

Dissolve 3.72 gms of Disodium Ethylene-diamine Tetra-acetate Dihydrate in one litre of distilled water.

10.4.2 Procedure :

- (1) Pipette out 50 ml of the coolant water sample into a 250 ml conical flask.
- (2) Add 2 to 3 drops of indicator solution and mix well.
- (3) Add 0.5 ml of buffer solution and mix.
- (4) Titrate immediately with EDTA solution with continuous shaking of the flask until the colour changes from red to blue.

Note : As the end point is approached the solution shows some blue colouration but a definite reddish tinge is observed and discharged at the end point. For coloured solution like Chromate water the end point i.e., change in colour, is to be carefully observed.

10.4.3 Calculation :

$$\left. \begin{array}{l} \text{Total hardness} \\ \text{as CaCO}_3 \text{ in ppm} \end{array} \right\} = 1000 \times \frac{V_1}{V_2}$$

Where V_1 = volume in ml of std. EDTA solution consumed.

V_2 = volume in ml of the sample taken for test.

Note : The above method is equally applicable to raw-water analysis and coolant water treated with Sodium Nitrite and Sodium Benzoate as given in Part-III.

APPENDIX 4.2

LABORATORY EQUIPMENT FOR TESTING WATER, FUEL OIL, LUBE OIL AND RUBBER

S. No.	Description	Loco Shed upto 50 locos	Loco shed 50 to 100 locos	Loco shed above 100 locos	S. No.	Description	Loco Shed upto 50 locos	Lcco Shed 50 to 100 locos	Loco Shed above 100 locos
1	2	3	4	5	1	2	3	4	5
I. Equipment for testing lubricating oils :					2	Silica or porcelain crucibles.	12	12	12
(A) For 'viscosity' determination.					3	Desiccator	1	1	1
1	Constant temperature water bath for kinematic viscosity as per IS-1448 Part I P25-1960.	1	1	1	4	Balance Analytical (preferably Chainmetic).	1	1	1
2	Cannon-Fe ske Viscometer tubes calibrated No. 350.	12	12	12	5	Balance Physical capable of reading upto 10 mg	1	1	1
(B) For fuel dilution determination.					(E) For Sediment Content test.				
3	Thermometer ASTM 28 F and 46 F.	2	2	2	1	Variable speed centrifuge (as per ASTM D-893).	1	1	1
4	Stop watches .	6	6	6	2	Centrifuge tubes cone shaped (as per ASTM D-893).	12	12	12
5	Rubber su tion bulbs .	6	10	12	(F) For Neutralisation value test.				
(C) For water contamination test.					1	Apparatus for Neutralisation value determination by potentiometer titration—as per ASTM D-664.	1	1	1
1	Pensky-Martens open Flash Tester with thermometers I.P. 15F and I.P. 16F.	1 set	1 set	1 set	2	Alkali resistant conical flasks capacity 250 cc.	12	12	12
2	Cleveland Open Cup. ASTM-D.92.	1 unit	1 unit	1 unit	3	Microburette	2	2	2
3	A small petrol gas generator.	1	1	1	(G) Blotter test.				
(D) For ash content test.					1	Whatman No.1 or any good quality analytical filter paper to be used.	Consumable items as per requirements.		
1	Hot plate with variable temperature control 2000 watts.	1	1	1	(H) Miscellaneous Equipments.				
2	Porcelain crucibles about 40 mm dia.	12	12	12	1	Air oven Range upto 150 °C.	1	1	1
3	Pair of tongs (indifferent sizes).	4	4	4	2	Lubricating oil sampling gun.	2	2	2
4	Dean and stark water determination apparatus with ground glass joints, 500 cc, flask 2 cc receiver and a suitable electric heater.	1 set	1 set	1 set	3	A dark field microscope for determining qualitatively the condition of additives in lubricating oil.	1	1	1
(D) For ash content test.					4	Chemicals and reagents for qualitative analysis of metals and quantitative analysis of water.	1 unit	1 unit	1 unit
1	Muffle furnace with calibrated pyrometer-max. temperature range upto 1000 °C.	1	1	1					

APPENDIX 4.2—Contd.

1	2	3	4	5	1	2	3	4	5
5	Miscellaneous glass apparatus like test tubes, breakers, flasks etc.	As per requirements.			Thermometer ASTM 8F	2Nos.	2 Nos.	2 Nos.	
II. Equipment for Testing Greases					7 Apparatus for determination of Existent Gum content in fuels as per ASTM D-381.	1 unit	1 unit	1 unit	
1	Penetrometer-with accessories including 'grease worker' as per I.P. 50/48 or ASTM D-217.	1 unit	1 unit	1 unit	IV. Equipment for Engine Cooling water Test :				
2	Drop point apparatus as per ASTM D-566.	1 unit	1 unit	1 unit	1 Chloride test :				
III. Equipment for Testing Diesel fuels :					(i) Porcelain (China) dish 80 mm dia.	2 Nos.	2 Nos.	2 Nos.	
1	Density/Specific gravity test.				(ii) Burettes 50 ml capacity graduated.	2 Nos.	2 Nos.	2 Nos.	
(i)	Graduated hydrometer of floating type—Range 0.500 to 1.000.	1	1	1	(iii) Wooden or cast iron burette stand with 2 clamps.	2 Nos.	2 Nos.	2 Nos.	
(ii)	Thermometer—Range 0 to 110 °C.	1	1	1	2 Pocket Refractometer—to determine the oil content in the emulsion.	1	1	1	
2	Viscosity — Cannon-Fenske Viscometer tubes No. 100.	6	6	6	V. Equipment for Testing Metallic Wear :				
3	Flash point—Pensky-Martens and closed flash point apparatus with suitable thermometer—IS-1448 Pt. I.P. 21-1960.	1 unit	1 unit	1 unit	1 Spectrograph—one for each Rly.				
4	Total sulphur-Bomb calorimeter with accessories.	1 unit	1 unit	1 unit	VI. Rubber Testing :				
5	Carbon residue—				1 Durometer—"Shore-A" Hardness Tester.	1 No.	1 No.	1 No.	
(i)	Remsbottom carbon residue apparatus including calibrated pyrometer.	1 unit	1 unit	1 unit	(Supplier)—Indian Engineering Co. Worli Naka Bombay.				
(ii)	Coking bulbs—Pyrex type (for the replenished as per use).				2 Electric Oven—for ageing characteristics, temperature range upto 250 °C.	1 No.	1 No.	1 No.	
6	Distillation apparatus as per ASTM D-158 with 6 Nos. of distillation flasks.	1 unit	1 unit	1 unit	3 Swelling Test apparatus. Pyrex Beakers—4, Branded mineral oils of known characteristics.	1 unit	1 unit	1 unit	
					4 Soxhlet Apparatus—for extraction.	2 units	2 units	2 units	
					5 Rubber Tensile Testing Machine with Dumbbells cutters to prepare test specimens. Capacity 250 to 500 kg. max.	1 No.	1 No.	2 No.	
					Supplier : Kamal Metal Industries, Arun Park Shahipura, Ahmedabad-8 (Gujarat).				

APPENDIX 4.3

MAIN ITEMS OF MACHINERY & PLANT REQUIRED IN DIESEL SHEDS

S. No.	Description of Machinery/Plant	Loco shed upto 50 locos	Loco shed 50 to 100 locos	Loco shed above 100 locos	S. No.	Description of Machinery/Plant	Loco shed upto 50 locos	Loco shed 50 to 100 locos	Loco shed above 100 locos
1	2	3	4	5	1	2	3	4	5
Handling Equipment :					23 Valve refacing machines :				
1	E.O.T. cranes 40 tons .	1	1	2	(i) For valve (ii) High pressure fuel line. }		1	2	2
2	E.O.T. cranes 10 tons .	1	2	2	24	Lap Master 60" .	1	1	1
3	Whitingjacks .	1 set (set of 5 jacks)	2 sets (set of 5 jacks)	2 sets (set of 5 jacks)	24A	Lap Master 24" .	1	1	1
4	Tram beam (3 t) cranes .	3	4	6	25	Cylindrical Grinder .	1	1	1
5	Pillar cranes with 1.5/1 ton hoists.	8	16	16	26	Lapping machine injector nozzle seats.	1	2	2
6	Fork lift truck (2t) .	1	2	2	Testing, Calibrating and other Equipment :				
7	Platform truck (2t) .	2	4	5	27	Fuel pump calibrating stand (including kit master calibrating).	1	2	2
8	Pick up van .	1	2	2	28	Governor test stand .	1	1	1
9	Truck 3 tons .	1	1	1	29	Cylinder head test stand	1	1	1
10	Monorail with hoists for :				30	Load box .	1	2	2
	(i) Battery room .	3	3	3	31	Inj. nozzle valve grinder	1	2	2
	(ii) Cylinder head .				32	High potential test set .	1	1	1
	(iii) Piston assembly .				33	Nozzle test stand .	1	2	3
11	Hoists (100 kg)				34	Dye penetration testing equipment.	1	1	1
	(i) Governor .	3	5	7	35	Carbody filter plant .	1	1	1
	(ii) Heavy switch gear. }				36	Elec. baking oven for gen. & motors (2×2× 1.5 m) and (1×1×0.5 m).	2	2	2
	(iii) Arm section .				37	Welding plant A.C. .	2	3	4
Machines					37A	Welding plant D.C. .	—	1	2
12	Underfloor wheel lathe .	1	1	1	38	Sand drier and filling equipment.	1	1	1
13	Lathes (of sizes including tool room).	2	4	5	39	Lube oil dispensing system.	1	1	1
14	Shaping machine (24") .	1	1	2	40	Chromate water drainage and conservation system.	1	1	1
15	Drilling machine (Radial)	1	2	2	41	Pre. lub. pumping system "	1	1	1
16	Valve seat grinder .	1	2	2	42	Ultrasonic cleaning bath ' for strainer and bearing.	1	1	1
17	Hand screw press .	1	1	1					
18	Hand tube bending .	1	1	1					
19	Hack Saw .	1	1	1					
20	Double ended 'grinder (Floor).	1	2	2					
21	Buffing machine (contact tips Elec.Sw. gear).	1	1	1					
22	Tool grinder .	1	1	1					

1	2	3	4	5	1	2	3
43	Chrome-plating equipment.	—	1	1	62	Cylinder liner ridge remover and honing equipment.	1 1 1
44	Dynamic balancing machine.	one for each	Railway.		63	Engine compression testing equipment.	2 4 4
45	Industrial vacuum cleaner	1	2	2	64	Engine blow-by testing equipment.	1 2 2
46	Spray painting equipment	1 set	1 set	1 set	65	Laboratory equipment for testing water, fuel oil, lube oil and rubber.	As per list attached.
47	Engraving machine	1	1	1 ^t	66	Gas welding set	1 2 2
48	Hydraulic jacks (portable).	4	4	4	67	Eutalcoy Kit for reclamation of components.	1 2 2
49	Crimping machine with die set.	1	1	1	68	Gasket die punching press	1 1 1
50	Coil winding machine	1	1	1	69	Electrical control equipment test stands.	1 set 1 set 1 set
51	Oscilloscope	1	1	1	70	Test rig for vacuum pressure and temperature gauges.	1 set 1 set 1 set
52	Piston cleaning equipment.	1	1	1	71	Hydraulic press for bushings.	1 1 1
53	Battery charging unit	1	2	2	72	Lub. oil cooler cleaning equipment.	1 1 1
54	Loco washing and cleaning equipment.	1	1	1	73	Radiator cleaning equipment.	1 1 1
55	Diesel engine part cleaning plant.	1	1	1	74	Deep freeze for shrinking in valve seat inserts, storage of chemicals etc.	1 1 1
56	Demineralite plant & dispensing system.	1 (6000 litres)	1 (12000 litres)	1 (36000 litres)	75	Speedometer test rig.	1 1 1
57	Air compressor & pipe lines.	2 (210 cfm)	3 (500 cfm)	3 (500 cfm)	76	Fuel/Lub. oil systems valves test rig.	1 1 1
58	Smithy equipment including blower.	1 set	1 set	1 set	77	Hydraulic pump for pressure testing of air vessels.	1 1 1
59	Marking table 2 ¹ / ₂ m x 1.5 m.	1	1	1	78	Fuel booster pump and motor test rig.	1 1 1
60	Air brake test stand	1	1	1			
61	Cyl. head cleaning equipment.	1	1	1			

CHAPTER 5

OBJECTIVES OF DOCUMENTATION AND RECORDS SERVICES, ORGANISATION, TYPICAL FORMATS FOR VARIOUS RECORDS

5. Documentation and Records

5.1 Purpose

The documentation and record keeping services are designed to provide comprehensive, well organised records which should suitably.

5.1.1. Provide the basic data for directing maintenance for minimising breakdowns, optimising costs.

5.1.2. Compliance with internal directives, schedule requirements, statutory and mandatory regulations.

5.1.3. Assess performance.

5.2. Organisation

5.2.1. The usual Loco Repair and Documentation Services are brought together under a Records or statistics group. This group is headed by a senior supervisor of proven ability and wide

experience. This is vital as this unit is the eyes and ears of the maintenance effort. Meticulous and effective record keeping and "separating the grain from the chaff" requires or high order of knowledge and competence. The statistics in charge is assisted with a small organisation consisting usually of a supervisor, four mechanics record clerks and a typist who log, abstract and record the maintenance/operations data. They post and update all the maintenance charts and boards maintained in the Foremen's rooms so that units are correctly spotted and planned for repairs.

5.2.2. The statistics unit requires adequate well lit room area suitably equipped with card units, lockers — one for each locos records & located preferably on the rooms adjoining maintenance plat-forms so that records are immediately accessible to the maintainer.

5.3. Typical records are illustrated in Annexures.

• • •

ANNEXURE 5.1

DAILY POSITION SHEET

Frequency —daily, Distribution —Shed Officers, Foremen by 06.00 hrs at residences Office copy Kept for 3 months.

Format

Depot											Date
Loco holdings typewise											
Actual out	0	4	8	12	16	20	Average	0	4	Punctuality..	
Ready locos									Target out..		
POH	Loco/No/Date stopped,					Loco No/Date stopped ...					
Annual & above	Loco No/Date stopped/PDC,					Loco		No/Date		Stopped/PDC	
Semi annual	Loco No/Date stopped/PDC,					Loco		No/Date		Stopped/PDC.	
Quarterly	Loco No/Date stopped/PDC ...										
Monthly	Loco No/Date stopped/PDC ...										
Fortnightly	Loco No/ , Loco No....										
Trip.	Loco No/ Loco No....										
Non schedule Repairs(Light) Loco No/PDC/Nature of repairs (Expected out same day)											
Heavy Repair Loco No/Date stopped/PDC/Nature of repairs Waiting Material Loco No/Date stopped/Hems required.											
Average time under repairs (i.e. total time out of traffic) of locos out in the last 24 hours.											
Schedule	No.of Locos					Time in hours					
Trip	X X X					X X					
Fortnightly	X X X					X X					
Monthly	X X X					X X					
Quarterly.	X X X					X X					
Stock of HSD oil in litres ... T wagon in Tf.yd ...Decant...Awlg...											
Stock of Lube oil in litres.... Round turn of T.Wagons.... Casualties...											

ANNEXURE 5.2

DAILY REPAIR SUMMARY

(Frequency — daily — To be ready in loose leaf sheets on a clipboard in the shed control centre (ALF's office) by 08.30 hrs. for perusal by shed officers, Foremen and shift-in-charges. After scrutiny, these are filed monthwise in a binder, subsequently bound into six monthly books for record. To be kept for 3 years. At 10.00 hours the book is withdrawn and the statistics-in-charge abstracts and communicates instructions recorded therein.

Format

Loco No.	Date	Schedule	Important repairs booked & Action taken

ANNEXURE 5.3

REPEATED BOOKING REGISTER

Frequency — daily. To be made available in the shed control centre (ALF's Office) at 8.30 hrs. for scrutiny by shed officers and Foreman. A sample page is illustrated. Usually these are bound books — each book covering approximately 3 to 6 months depending on frequency of bookings. At 10.00 hours the book is withdrawn and the statistics-in-charge abstracts and communicates instructions recorded therein.

A typical list of items against which booking dates are recorded is given below. The list is illustrative and may be tailored to suit local requirements.

Description of item	Abbreviated thus
Fuel oil pressure	FOP
Lube oil pressure	LOP
Booster Air Pressure	BAP
Oil throw from chimney	Oilthrow engine
Vacuum brakes	Vacuum
Air brakes	Air brakes

Description of items	Abbreviated thus
Oil throw from Expressor	Oil throw exp.
Engine overspeeding	Overspeeding
Engine hunting	Hunting
Speedometer/speed recorder	Speedometer
Rough riding of locomotive	Riding
Shutting down-other than over-speed.	Shut down
Weak battery	Weak Batt.
Traction Generator	T. Gen.
Traction motor	T. Motor
Wheel slip	Wheel slip
No power	No power
Water pump leaking	Water pump

Sample page of Repeated Booking Register

FOP	LOP	BAP	Oilthrow	Vac. brake	Air brake	Oil throw Exp.	etc.....	Instruction
10-2-75		10-2-75						
11-2-75		11-2-75			12-2-75			
13-2-75		13-2-75						

Note after each set of entries of a particular spell of duties is completed—next set of entries should be on fresh line.

LOCOMOTIVE NO. 18040

Date:—

Loco No.:—

COMPRESSION & FIRING PRESSURES Lbs/Sq.in.						CYL. HEAD TEMPERATURES			
Location	Comp.	Firing	Location	Comp.	Firing	Location	Oc	Locaiton	OC
1R			1L			1R		1L	
2R			2L			2R		2L	
3R			3L			3R		3L	
4R			4L			4R		4L	
5R			5L			5R		5L	
6R			6L			6R		6L	
7R			7L			7R		7L	
8R			8L			8R		8L	

Special observations and Remarks :

DF

EF(D)

ELC

FIC

ANNEXURE 5.4

LUBE OIL CONSUMPTION REGISTER

Usually this is maintained in cards, Loco wise, in Kardex cabinets in the Records/statistics office. A

typical card reads as follows:—

Date	Lube oil topped (Litres)	HSD Oil consumed (Litres)	Km. earned	Lube oil Lit/1000 E Km.	Lube to fuel Ratio	Remarks
------	--------------------------	---------------------------	------------	-------------------------	--------------------	---------

Every month the lube oil topped is totalled and the locomotives divided into ABC categories with respect to lube oil consumption and taken up for maintenance attention.

These records are to be maintained from POH to POH.

ANNEXURE 5.5

LUBE OIL CONTROL

These are usually maintained in the form of cards and filed in Kardex Cabinets with the Lube Oil consumption data. These contain qualitative data on

the analysis of lube oil as derived from the routine checks inclusive of the spectrograph data. Records are maintained from POH to POH.

ANNEXURE 5.6

WHEEL PROFILE REGISTER

Usually entered in cards maintained loco wise in Kardex cabinets records of wheel diameter, root wear, flange wear km earned from last reprofiling etc. are recorded for each quarterly schedule and above and as also when reprofiled. The remarks column gives the reasons for reprofiling. The re-

ords are maintained in antinuous time requirence so that progressive wear can be easily spotted. Any change in the reprofiling period necessitate a scrutiny of correct functioning of reprofiling machine, truck conditions etc.

Date	Schedule	Km.	Wear Data						Remarks
			Wheel No.1	Wheel No.2	Wheel No.3	Wheel No.4	Wheel No.5	Wheel No.6	
			L. R.	L. R.	L. R.	L. R.			

ANNEXURE 5.7

LOCO SCHEDULING REGISTER

Usually maintained in Cards, loco or unitwise, in Kardex cabinets. Provides information on date schedules done, down time for such schedule, km

earned from last POH or commissioning. Suitable flags spot out overdues. This record is basically used for planning repairs.

ANNEXURE 5.8

LOCO ALTERATIONS

Usually maintained in registers through cards are preferred. Those records are better maintained both locowise and alteration wise. In the locowise cards the information is recorded thus:—

Alteration No. 1 2 3 4 5

Date done

In the Alterations records a card reads as follows:

Alteration No.

Reference of procedure/Authority

Description

When it is to be done

Locomotives for unit No. completed/date.

ANNEXURE 5.9

WATER TREATMENT

Usually maintained in cards — locowise — from POH to POH. Drop in concentration is used to spot locos with water leaks which are being topped on road

by drivers. These are advised to maintainers for corrective action.

Date	Schedule	Concentration ppm		Remarks
		Incoming	Outgoing	

In addition to the above cards a board is kept at the Dimineralising plant which can hold data for 10

days. After the board is full the oldest date is wiped out and fresh date/data chalked in thus

Date	Raw water			Dimineralised water			Remarks
	Hardness ppm.	Ph	Total dissolved solids in ppm.	Hardness ppm	Ph	Total dissolved solids in ppm.	

The data in raw water is recorded every week on a fixed day. The data on dimineralised water is record-

ed daily except for TDS which is recorded every week on the same day as the raw water is checked.

ANNEXURE 5.10

LOAD TEST

Load tests forms vary in accordance with the type of unit and facilities available in the maintenance depot. The format adopted by the manufacturer forms

a useful starting point. A typical adoption for a Diesel Electric Locomotive is illustrated here:

LOAD BOX RESULTS

Date _____ Loco No _____ Schedule _____

NOTCH POSITION	R.P. M.	Volts	Amps	Reference voltage				Exciter volts AC/DC	LCR	Rack mm	F.O.P. Kg/Cm2	B.P. Kg/Cm2	L.O.P. Kg/Cm2	Water Temp. Oc
				31E 31T (S)	29A 4(E)	22F 4(E)	31E 31F (E)							
1														
2														
3														
4														
5														
6														
7														
8														

NO LOAD VOLTS : Idle—8th Notch.

GOV. DRY RUN mm

REFERENCE VOLTS

EXCITER VOLTS

RPM Idle/8th Notch.

BATTERY VOLTS/Av. Sp. GR.

OVERSPEED TRIP SETTING(r.p.m.)

Axu, Gen. Volts.

H.P.- =

ANNEXURE 5.11

CASUALTIES

The Casualty Register is maintained as a continuous register commencing every year. Within the register, every month starts with a fresh page. Entries normally cover two pages with the register opened out to provide adequate space.

Following data is entered in columns. The cases are discussed on a fixed day of the week with officers, senior supervisors and section in charges that have featured for corrective action.

Date

Loco/Unit No.

Train No.

Load

Driver

Location

Division

Last schedule date

Initial Report

Actual defect found and repairs done

Instruction

Codification

Final action

The Casualty Register provides the basic data for a monthly analysis which is maintained in accordance

with the Boards manual of "Codification of Defects".

ANNEXURE 5.12

PERFORMANCE BOARDS

The Motive power depot must have a large board suitably displayed bringing out the following daily features. This board should be posted before the commencement of the morning general shift.

Date

Average loco out in the last 24 hours

Average out last 10 day period

Target out

Punctuality on loco account

Casualties in the last 24 hours

Casualties in the last 10 day period

In addition various foreman have their planning boards posted daily. Information is typically presented as follows :

Schedules due	. . . Loco Nos. are posted below, monthly, quarterly, half-yearly, Yearly and above, POH. Scored out when done.
---------------	---

Express or crankcase vacuum	Loco Nos. are posted below predetermined horits scored out when attended,
-----------------------------	---

Expressor Lube oil pressure	. . . Ditto.
-----------------------------	--------------

Booster Air Pressure	. . . Ditto.
----------------------	--------------

Lube oil consumption	. . . Ditto.
----------------------	--------------

Engine Lube oil pressure	. . . Ditto.
--------------------------	--------------

Water leak	. . . Ditto.
------------	--------------

Wheel slip and high millirott drop across WSR.	Loco Nos. are posted and scored out when done.
--	--

T. Gen. flashover	. . . Ditto.
-------------------	--------------

Control Grounds	. . . Ditto.
-----------------	--------------

Low HT Insulation	. . . Ditto.
-------------------	--------------

Water pump leak	. . . Ditto.
-----------------	--------------

CHAPTER 6

6. Training

6.1 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 have brought out repeatedly the necessity of training maintainers at all levels, initially, followed by refresher courses as well as familiarisation courses to cater for changes of design and equipment. The training organisation plays a vital role in making this type of motive power viable and permits the railways to achieve smooth and economical transition from the older forms of traction such as steam to the modern economical though sophisticated diesel.

6.2 Scope

6.2.1 The Central Training Establishments such the IRIM&EE.

6.2.1.1 The Foundation course for new Engineer/Officer—The course is suitably supplemented with training at manufacturers works, backshops, motive power maintenance depots and RDSO. This course shall be of 6 months duration and prepare the trainee for executive responsibilities in backshops and maintenance depots. All new Engineer/Officers of the IRSME cadre will complete this course during their probation period. In addition Selected Working Engineer/Officers of the Railways shall also undergo training for 8 weeks duration so that each Railway has within the system a suitably trained cadre. Syllabus may be seen at Annexure 6.1.

6.2.1.2 An orientation course for Administrative grade engineer/officer at the IRIM&EE designed to familiarise him with planning, operation and maintenance of diesel units. The course shall be of 6 weeks duration. All Administrative grade officers of the IRSME cadre will be covered. Syllabus may be seen at Annexure 6.2.

6.2.2 Refresher courses/seminars on subjects of topical interest at IRIM&EE, RDSO, Railway Staff College, Manufacturers Works for Engineers/Officer engaged in design/manufacture/maintenance of diesel units. Duration one to two weeks.

6.2.3 Various courses at the System Training Schools of the Railways as listed below. These training establishments should be at close proximity

to Diesel backshops or maintenance depots. This is *vital* for the training to be meaningful.

6.2.3.1 Conversion/Foundation course for steam supervisors of sheds shops as well as new trainee supervisors for handling maintenance and overhaul of Diesel Hydraulic (WDS4) units. Duration 30 weeks. Syllabus at Annexure 6.3.

6.2.3.2 Similar courses for Diesel Electric units. Duration 30 weeks. Syllabus at Annexure 6.4.

6.2.3.3 Foundation course for trainee supervisor for handling electric transmissions and controls. Duration 30 weeks. Syllabus at Annexure 6.5.

6.2.3.4 Conversion/Foundation course for Operating Supervisors. Duration 14 weeks. Syllabus at Annexure 6.11.

6.2.3.5 Conversion/Foundation course for artisans — Artisans for diesel hydraulic (WDS4 units). Duration 30 weeks. Syllabus at Annexure 6.6.

6.2.3.6 Similar as above for artisans for diesel electric units. Duration 30 weeks. Syllabus at Annexure 6.7.

6.2.3.7 Foundation course for artisans for dealing with electric transmission and control — Duration 30 weeks. Syllabus at Annexure 6.8.

6.2.3.8 Promotional courses for unskilled to Diesel Mechanics. Duration 30 weeks.

6.2.3.9 Foundation/conversion course for steam drivers to diesel. The above course will also apply for steam shunters/diesel shunters moving upto diesel drivers when supplemented separately with the common course dealing with safety, general and subsidiary rules etc. Duration 13 weeks.

6.2.3.10 Foundation/conversion course for steam shunters to diesel shunters. This will also apply for diesel assistants as well as leading fireman when taken in conjunction with necessary courses on safety, general and subsidiary rules etc. Duration 13 weeks.

6.2.3.11 Foundation/conversion course for steam firemen to diesel Assistant. Duration 11 weeks.

6.3 It should be noted that the courses for running staff train the operators for a particular type of unit which should be endorsed in their certificates. After a driver/shunter/diesel assistant has done the basic course of a diesel electric unit, he can be retrained for diesel hydraulic unit with a short 8 week familiarisation course and vice versa. Such courses should include 2 weeks of road operation as a trainee.

6.4 In the event of a driver/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 or 3 shifts as a trainee. In the event of the period exceeding 18 months the 8 week familiarisation course of 6.3 has to be repeated.

6.5 Equipment and Training Aids.

6.5.1 Large class rooms with adequate space for models, cut away sections, wired panels, control stands, brake systems, are required. 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 these.

6.5.2 Each class room should be fully equipped and self contained to teach a major aspect of the system. For example, one class room may be developed for power pack, another for transmission, a third for controls, a fourth for brakes equipment etc. One centralised model room has not been found very effective due to interference between several groups.

6.5.3 The class rooms should preferably have "white boards", writing being with coloured chalk. This permits diagrams to be projected and one can also write down important data

or illustrate connections directly on the projected drawing on the whiteboard.

6.5.4 Class rooms should have slide projector, epidiascope, overhead projector. Adequate numbers of cassette tape recorders are extremely useful for delivering a standard lecture while the instructor suitably supplements it with explanations and illustrations.

6.5.5 The training establishment should have a well equipped library.

6.5.6 The training establishments should be *liberally* provided with ferro printing duplicating, and Exerox copying equipment so that training instructions, diagrams etc. can be given the trainees freely.

6.6. Training establishments dealing with supervisors/artisans should be headed by an experienced officer of senior scale rank.

6.7 The number of trainees in the class room should be limited to a maximum of 15 per instructor to permit proper individual attention being given.

6.8 In the maintenance depots or on the locomotive—wherever practical demonstrations are being given—5 trainees should be the maximum limit per instructor.

6.9 Examinations should consist of written paper practicals and interviews. Supervisors, running staff and artisans should be preferably given objective questions. Samples are given in Annexure 6.9. These cover more ground, and are much better suited to test the trainees grasp rather than his power of expression.

6.10 In conclusion, the necessity of selecting the *best* and *most experienced* men for the training establishment is reiterated. The functioning of this organisation makes or mars the entire maintenance performance.



ANNEXURE 6.1

FOUNDATION COURSE FOR ENGINEER/OFFICER

Duration—30 weeks (Sandwich)

Syllabus—theoretical at IRIM&EE (16 weeks)

1. Development of diesel traction on Indian Railways.
2. Appreciation of diesel, steam and electric traction and their relative economics.
3. Heat engines with particular reference to the diesel cycle, combustion etc.
4. Super charging, Rootes blowers and special reference to turbo supercharger as used on diesel locomotive in India. Matching of turbo supercharger to a power pack.
5. Components of standard diesel locomotives in the country and thorough familiarisation with their design, maintenance problems, drawings, heat treatment and metallurgy.
6. Thorough appreciation of the fuel system of the standard type of diesel locomotives, trouble shooting.
7. Lube oil system, typical test data, trouble shooting.
8. Water system with details as given above.
9. Laboratory control on fuel, lube and water complete with spectrograph analysis.
10. Thorough appreciation of handling fuel and lube at servicing installation
11. Design of large fuelling installation, safety precautions, mandatory stipulations, storage, handling and dispensing of HSD oil.
12. Same as above for lubricating oil inclusive of re-refining of used lube oil.

13. Air filtration in diesel engines inclusive of inertial system.
14. Transmission—various types.
15. Electric transmissions and controls.
16. Heavy repair of electrical rotating equipment.
17. Hydro dynamic transmissions
18. Air compressor/vacuum exhauster, maintenance techniques, spares, testing and trouble shooting.
19. Brake system inclusive of vigilance control devices.
20. Maintenance of auxiliaries such as batteries & other machines.
21. Governors.
22. Voltage regulators
23. Safety devices.
24. Load testing.
25. Lay out of standard diesel shed.
26. Appreciation of management of maintenance giving performance targets.
27. Operational management of diesel locomotives—load factor, out-station servicing points.

Syllabus—practical

Selected motive power shed—8 weeks

Thorough familiarisation with all schedules.

Production units DLW/CLW/POH Shops (6 weeks).

ANNEXURE 6.2

REORIENTATION COURSE FOR ADMINISTRATIVE GRADE OFFICERS

Duration — 6 weeks.

Location — IRIME&E

1. A thorough appreciation of relative costs of the various modes of traction.
2. The principal features, advantages and limitations of the various types of diesel units available.
3. Basic planning for diesel traction on a railway system.
4. Lay out of running shed and equipment.
5. Control of maintenance of diesel locomotives, indices of performance and how they are monitored.
6. Procurement of spares.

ANNEXURE 6.3

SYLLABUS FOR CONVERSION OF STEAM SUPERVISORS TO DIESEL MAINTENANCE SUPERVISORS. (WDS4 LOCOMOTIVES)

Duration of training—7 months

Theory—16 weeks in nominated system Training

Establishment of Railway. 4 weeks Nominated Field Training Establishment in a Diesel shed

Practical—10 weeks.

6.3.1 Theoretical :

Introduction—different types of traction. Advantages and disadvantages of diesel traction as compared to steam and Electric.

6.3.1.2 Internal combustion—Compression ignition as compared to spark ignition engine. Two stroke and four stroke engines.

6.3.1.2.1 Normally aspirated and super-charged engines.

6.3.1.3 Combustion :

6.3.1.3.1 Process of combustion. 3 phases of combustion.

6.3.1.3.2 Brief description of different types of combustion chamber.

6.3.1.4 Tools :

6.3.1.4.1 Introduction to special tools, name of different hand tools. Specification of sizes. Correct use.

6.3.1.4.2 Use of Torque wrenches, Torque multipliers and Elongation gauges.

6.3.1.4.3 Dial gauges — Plain and Internal Bore type. Different possibilities of application.

6.3.1.4.4 Use of Vernier callipers and Micro meter screw gauges-internal and external.

6.3.1.5 Basic Electricity :

6.3.1.5.1 Generators, Motors and Transformers—Functions.

6.3.1.5.2 Relays, Contractors, Switches and Rectifiers—Functions.

6.3.1.5.3 Electrical measuring instruments i.e. Volt meter, Ammeter, KWH Meter etc.

6.3.1.5.4 Battery—Care and maintenance.

6.3.1.6 Engine and Locomotives :

6.3.1.6.1 Lay out of WDS4 and WDM2 locomotives and their datas.

6.3.1.6.2 WDS4 MAK diesel engines.

6.3.1.6.3 Engine base, Cylinder block, Constructions, Inspection, Matching of base and cylinder block.

6.3.1.6.4 Cylinder liner, Piston, Connecting rod, Crank shaft—Manufacture, Inspection, Dismantling and assembly.

6.3.1.6.5 Fuel oil system.

6.3.1.6.6 Inspection of cylinder head, Dressing of valve seats. Hydrostatic test. Grinding of valves, Inspection of valve springs, Refitting of valves in cylinder heads, Nozzle, Ferrule, Yoke guides etc.

6.3.1.6.7 Cam shafts and cam gear. Dismantling, Inspection and assembly. Valve timing diagram and valve lever mechanism, Adjustment of Tappet and timing.

6.3.1.6.8 Main bearings, Connecting rod bearings and various types of bearings. Types of defects in bearings.

6.3.1.7 Charge air system :

6.3.1.7.1 Charge air system on the MAK engines as compared to 251B ALCO Engines.

6.3.1.7.2 Turbo Supercharger—Dismantling, overhaul, Inspection and assembly both MAK and ALCO engines.

6.3.1.7.3 After cooler, Overhaul — Their installation and maintenance.

6.3.1.7.4 Air filtration.

6.3.1.8 Fuel Injection system :

6.3.1.8.1 Lay out of fuel Injection system.

6.3.1.8.2 Fuel Injection pump—Overhaul, calibration and Installation.

6.3.1.8.3 Nozzles—types, overhaul, testing and installation.

6.3.1.8.4 High pressure liner to Cyl. heads.

6.3.1.8.5 Smoke on diesel engines, colour and indication. Phasing of fuel injection pump and spill out off.

6.3.1.9 Speed control :

6.3.1.9.1 Hydro Electrical governor.

6.3.1.9.2 Mechanical governor—its overhaul and maintenance.

6.3.1.9.3 Suri Reverse governor—its characteristic, maintenance and overhaul.

6.3.1.9.4 Testing of various types of governors.

6.3.1.10 Lubrication :

6.3.1.10.1 Layout.

6.3.1.10.2 Lub oil system on MAK engines. Its overhaul and maintenance.

6.3.1.10.3 Importance of filtration of lub oil.

6.3.1.10.4 General maintenance.

6.3.1.10.5 Heat Exchangers.

6.3.1.10.6 Relief valve, Regulating valve, Pressure gauges in lub oil system.

6.3.1.11 Water cooling system :

6.3.1.11.1 Lay out of cooling water in MAK engines.

6.3.1.11.2 Water temperature control.

6.3.1.11.3 Radiators—Maintenance and overhaul, Hydrostatic Radiation Fan drive

6.3.1.11.4 Water pump—Overhaul and maintenance.

6.3.1.12 Transmission :

6.3.1.12.1 Necessity of transmission, types of transmission.

6.3.1.12.2 Brief introduction of Mechanical, Hydraulic, Hydro-mechanical and Electrical transmission.

6.3.1.12.3 Principles of Hydro-dynamics, Torque Convertors.

6.3.1.12.4 Voith transmission—installation and testing.

6.3.1.12.5 Suri transmission—Overhauling, Trouble shooting, installation and testing.

6.3.1.12.6 Reverse gear box in WDS4 locomotives. Shunting and main line gears.

6.3.1.12.7 Cardan shaft—Installation, overhaul and inspection.

6.3.1.13 Electrical system :

6.3.1.13.1 General Electrical system in WDS4 loco motives.

6.3.1.14 Air system :

6.3.1.14.1 Installation, overhaul and maintenance of WDS4 compressor.

6.3.1.14.2 Installation, overhaul and maintenance of Exhauster.

6.3.1.14.3 Construction, Installation and overhaul of WDM2 Expressor.

6.3.1.14.4 Air braking system on WDS4 locomotives.

6.3.1.15 Wheels and Axles, Axle box—maintenance.

6.3.1.16 General :

6.3.1.16.1 Rubber items.

6.3.1.16.2 Trimetal and Bimetal bearings.

6.3.2 Practical :

6.3.2.1 CLW—4 weeks.

6.3.2.2 Diesel shed—2 weeks.

6.3.2.3 DLW—2 weeks (Piping only).

ANNEXURE 6.4**CONVERSION/FOUNDATION COURSE FOR SUPERVISORS FOR DIESEL ELECTRIC UNITS**

Duration—30 weeks.

The syllabus continues the same as in Annexure 6.3 except that the emphasis is on the DLW built diesel

electric locomotives and instead of the hydraulic transmission the accent is on electric transmission, controls, heavy repair of electric rotating machinery and trouble shooting.

ANNEXURE 6.5**FOUNDATION COURSE FOR TRAINEE SUPERVISORS FOR HANDLING THE ELECTRIC TRANSMISSION AND CONTROLS. (ELECTRICAL EQUIPMENT)**

Duration—30 weeks.

1. Basic knowledge regarding the power pack.

2. Detailed knowledge of the transmission and control systems subdivided as follows :

2.1 Traction generator, design, control, running repair and heavy repair inclusive of rewinding.

2.2 Same as above for traction motor.

2.3 Excitation control system.

4. Governor.

5. Propulsion control system.

6. Lighting and other circuit.

7. Cabling, preparing new wiring harnesses and a thorough understanding of the wiring diagrams and the physical layouts.

8. All switch gears and circuit breakers.

9. Trouble shooting.

10. Load testing.

11. A special course on semi conductors, magnetic amplifiers etc.

12. Maintenance of batteries and voltage regulators.

13. The theoretical course is suitably sandwich with practical training in the sheds and production units.

ANNEXURE 6.6

CONVERSION COURSE OF STEAM FITTERS TO DIESEL MECHANICS (WDS4 LOCOMOTIVES)

Duration—26 weeks (Sandwich) 14 6 6

SYLLABUS :

Theoretical

1. Preliminaries :

1.1 Liner dimensions, various types of measuring instruments and their use on diesel locomotives.

1.2 Special tools used on diesel locomotives.

2. Theory, engine and locomotive :

2.01 Introduction—Internal combustion engines. Brief explanation of compression ignition as compared to spark ignition. Two stroke and four stroke cycles.

2.02 Lay-out of WDS4 locomotives.

2.03 Various components of MAK diesel engines, their functions relative to one another.

2.04 Valve lever mechanism on MAK engines. Tappet and timing adjustment.

2.05 Charge air system on MAK diesel engines and a brief comparison with the 2518 engine system. Various components their maintenance, overhaul, Inspection and assembly.

2.06 Turbo superchargers. Its overhaul and maintenance in detail for both ALLO and MAK engines.

2.07 Fuel oil system. Line diagram. Its various components. Overhaul and maintenance on MAK engines.

2.08 Fuel Injection system—General principles, overhaul and calibration.

2.09 Blow by test and its utility.

2.10 Necessity of engine governor. Suri reverse Governor and its working.

2.11 Lubricating oil system on MAK engines. Overhaul.

2.12 Cooling water system on MAK engines—various components and overhaul.

2.14 Pre-lubrication, Starting, Pre-run and testing.

2.15 Hydraulic transmission — Suri system — Working, overhaul and maintenance.

2.16 Reverser Gear box of WDS4 locomotives.

2.17 Air system of WDS4 locomotives.

2.18 Air and vacuum brakes of WDS4 locomotives.

2.19 Expressor on WDM1 and WDM2 locomotives.

2.20 Air compressor and rotary exhaustor of WDS4 locomotives — Overhaul and maintenance.

2.21 CO-CO bogies of WDM2 locomotives and WDM1 locomotives — Maintenance, overhaul and assembly.

2.22 Rigid frame and wheel arrangements WDS4 locomotives — Overhaul and maintenance.

3. Electrical Equipments :

3.01 Various electrical components of WDS4 locomotives.

3.02 Safety device and alarm of WDS4 locomotives.

3.03 WDM1 and WDM2 Traction motor — Repairs required in shops, Axle Tap, Housing, Frame, Head. Gear case.

Break up of Theoretical training

	Duration
(1) Theory	4 weeks
(2) Visit to BGA*	1 week
(3) Theory	4 weeks
(4) Visit to BGA**	1 week
(5) Theory	2 weeks
(6) Visit to PTRU**	1 week
(7) Theory	1 week
	14 weeks

Examination : To be passed before next stage starts.

Practical Training (in weeks)

	CLW	DLW	BGA*	PT-RU**	JM-P***
Engine	6	..	—	—	6
Transmission	2	—	4	—	6
Elec. Equipments	4	..	4	—	4
Governor	2	..	..	—	10
Turbo (MAK)	2	..	4	..	6
Turbo (ALCO)	..	..	..	2	10
Tracks (ALCO)	..	3	..	..	9
Frame & wheels WDS4	3	..	..	..	9
Air compressor & Rotor exhaustor	..	..	..	..	10
Expressor	..	..	..	2	10
Air & Vacuum brake	..	2	3	..	7
		(Piping)			

*Any nominated shed homing WDS4 locomotives with adequate facilities for shop floor training and with instructor etc. to guide and monitor the trainees.

**Any nominated shed homing diesel electric locomotives with adequate facilities for shop floor training and with instructors etc. to guide and monitor the Boar

***At a nominated Control Training Establishment of the railway. These should be developed around diesel shops.

ANNEXURE 6.7

ARTISANS FOR DIESEL ELECTRIC UNITS WITH PARTICULAR EMPHASIS ON HANDLING THE ELECTRICAL EQUIPMENT

Duration — 26 weeks.

Course is basically similar in format as Annexure 6.6 but the subjects are as in Annexure 6.5.

ANNEXURE 6.8

EQUIPMENT REQUIRED FOR WDS4 MODEL ROOM

1. A fully wired, piped, control stand brake system suitably laid out on an enlarged scale to permit access and space for trainees to study.
2. A suitable sectioned power pack, transmission and gear box.
3. Components as listed below.
 - 3.1 **Rev. Gear Box :**
 - 3.1.1 Housing
 - 3.1.2 Reverser Shaft & Gears
 - 3.1.3 Speed shaft and Gears.
 - 3.1.4 Reverser Gear Pump.
 - 3.1.5 Control Cylinders
 - 3.4 **Miscellaneous Items :**
 - 3.4.1 Cardon Shaft Eng. to Transmission
 - 3.4.2 Cardon Shaft Transmission to Int. Gear Box.
 - 3.4.3 Cardon Shaft Cooling Fan.
 - 3.4.4 Vulcan coupling.
 - 3.4.5 Axle Box with Bearing (Floating type).
 - 3.4.6 Axle Box with Bearings (Standard).
 - 3.5 **Cooling System :**
 - 3.5.1 Behr Fan Pump.
 - 3.5.2 Behr Fan Motor.
 - 3.5.3 Thermostatic Governor.
 - 3.5.4 Radiators.
 - 3.6 **Compressor :**
 - 3.6.1 Crank Case.
 - 3.6.2 Crank Shaft.
 - 3.6.3 Liner L.P.
 - 3.6.4 Liner H.P.
 - 3.6.5 Piston L.P.
 - 3.6.6 Piston H.P.
 - 3.6.7 Piston Ring.
 - 3.6.8 Cyl. Head.
 - 3.6.9 Valve Inlet & Discharge.
 - 3.6.10 Con. Rod L.P.
 - 3.6.11 Con. Rod H.P.
 - 3.6.12 Inter Cooler.
 - 3.6.13 Pulley.
 - 3.6.14 Bearings Main & Big End.
 - 3.6.15 Lub Oil Pump.
 - 3.7 **Exhauster :**
 - 3.7.1 Casing.
 - 3.7.2 Rotor.
 - 3.7.3 Rotor Blades.
 - 3.7.4 Bearings.
 - 3.8 **Intermediate Gear Box :**
 - 3.8.1 Casing.
 - 3.8.2 Gears with shaft—3 Nos
 - 3.9 **Air Brake System :**
 - 3.9.1 N.S 16 Governor.
 - 3.9.2 Unloader valve.
 - 3.9.3 Safety valve — 8 kgs.
 - 3.9.4 Dr. Brake valve.
 - 3.9.5 Pressure limiting valve.
 - 3.9.6 Brake cylinders.
 - 3.10 **Vacuum System :**
 - 3.10.1 Vac. Brake Valve.
 - 3.10.2 Limiting valve.
 - 3.10.3 All types of joints
 - 3.11 **Auxiliaries :**
 - 3.11.1 Starter.
 - 3.11.2 Dynamo.
 - 3.11.3 Lub. Oil Priming Pump.
 - 3.11.4 Batteries.
 - 3.11.5 All types of Relays.
 - 3.11.6 All types of voltage regulators.
 - 3.11.7 All indicators, safety devices such as low water switch etc.
 - 3.12 **Literature, Charts, Diagrams :**
 - 3.12.1 Maintenance manuals of all equipments.
 - 3.12.2 Part lists of all equipment.
 - 3.12.3 Charts and diagrams illustrating.
 - 3.12.3.1 Engine.
 - 3.12.3.2 Transmission & Gear box.
 - 3.12.3.3 Systems such as.
 - 3.12.3.3.1 Controls — all.
 - 3.12.3.3.2 Lube oil, fuel, water.
 - 3.12.3.3.3 Radiator fan drive & control.
 - 3.12.3.3.4 Air & vacuum.
 - 3.12.3.3.5 Wiring diagrams physical and schematic.
 - 3.12.3.3.6 Locomotive layout with controls and components suitably identified.

ANNEXURE 6.9

SAMPLE OBJECTIVE QUESTION PAPER

QUESTION PAPER FOR ADVANCED COURSE NO. 11

(Conversion Course For Steam Operating Supervisors to Diesel)

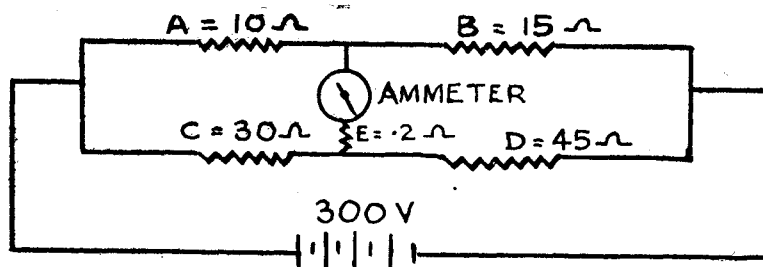
Date: 7-10-1971

Time: Two Hours.

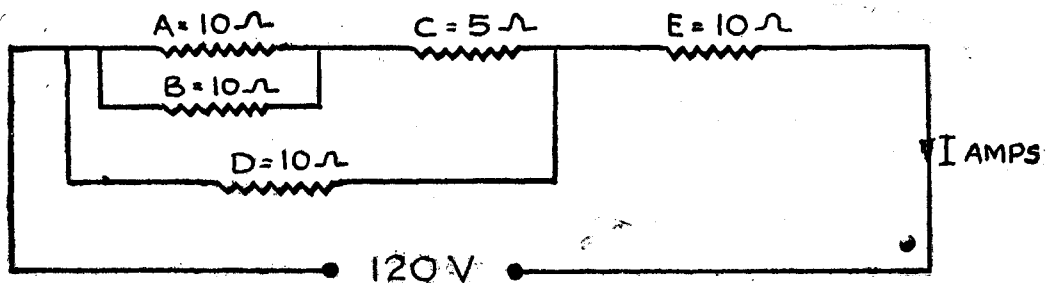
Note: All questions carry equal marks and are to be answered. One third mark is deducted for an incorrect answer. Fill in the blank or tick off the correct answer in each question. The question paper is your answer book.

1. The mixed or the dual combustion cycle is more efficient than the Diesel cycle — True, False.
2. The mixed or the dual combustion cycle is more efficient than the Otto cycle — True, False.
3. The efficiency of the Diesel cycle is solely dependent on the compression ratio — True, False.
4. Fuels with low cetane rating are likely to give high peak firing pressures in a diesel engine — True, False.
5. The Otto cycle engine is heavier in weight as compared to an engine working on the Diesel cycle and developing the same horse power — True, False.
6. Immediately after combustion starts in a Diesel engine there is an increase in pressure followed by a decrease and then a further increase rising to the peak firing pressure — True, False.
7. Diesel engines have better combustion if there is a high degree of turbulence inside the cylinder — True, False.
8. Engines with precombustion chambers have better cold starting characteristics — True, False.
9. A well designed, sturdy, supercharged diesel engine weighs approximately 10 lbs/hp, 15 lbs/hp, 30 lbs/hp, 30 lbs/hp, 45 lbs/hp.
10. After cooling increases the efficiency of the turbo-supercharger — True, False.
11. Torque converters have high efficiency at start which falls off with increase of speed of the locomotive — True, False.
12. The horse power transmitted by a fluid coupling is proportional to the rpm, $(rpm)^2$, $(rpm)^3$, $(rpm)^4$.
13. A series generator cannot build up full voltage unless there is an external load connected across it — True, False.
14. Iron losses in traction motors can be substantially reduced by using laminated armature cores — True, False.
15. Traction motors cannot be loaded to full horse power at start as the copper losses cannot be handled — True, False.
16. Mechanical transmissions are more efficient than electric or hydraulic transmissions — True, False.
17. The three field and the split pole excitation control system achieves similar generator controls as the static type at lower costs and lesser number of components — True, False.
18. Between transitions traction motors are made to operate between the current limit and voltage limit of the traction generator and along the constant horse power curve — True, False.
19. The loadmotor is to the diesel electric transmission as the temperature gauge of the transmission oil is to the diesel hydraulic transmission.
20. A torque converter with a free wheeling stator can efficiently operate over a wider speed range as compared to a conventional torque converter — True, False.
21. At eight notch the lube oil pressure gauge of the WDM/2 locomotive indicates the settling of the regulating valve — True, False.
22. In the event of fuel pressure dropping to 2 kg/cm² on higher notches driver should be advised to reduce the load on the fuel booster pump by working at lower notches — True, False.
23. Air lock in the fuel booster pump should be removed by opening the dummy cap on the suction tee of the pump, pouring in some fuel, and closing the dummy and starting the pump — True, False.
24. If the linkage between the governor and the fuel racks uncouple the engine is likely to overspeed as the governor loses control on the fuel delivered per stroke — True, False.
25. In the event of weak governor action in a WDM/2 locomotive temporary repairs can be effected on road by cleaning the governor strainer with clean fuel oil and filling clean fuel oil in the governor — True, False.
26. During dynamic braking the traction generator in the WDM/2 loco is both separately excited and differentially compounded — True, False.
27. Calculate the brake horsepower developed by a typical diesel engine from the following data:
Mean effective pressure — 192 psi.
Diameter of the piston — 9".
Stroke — 10½".
Specific fuel consumption — 163 gm/bhp. hr.
Specific gravity of fuel — 0.8.
Traction generator efficiency — 94%.
Traction motor efficiency with gears — 90%.
Fuel consumed per hour — 489 litres.
BHP developed — 2400.

28. A WDM/2 engine is not cranking. Tick off the items that are relevant and you will check on road — Governor oil pressure, lube oil filter drain cocks open or closed, battery knife switch, AGF breaker, overspeed trip, Fuel pressure.
29. In the event of a WDM/2 locomotive indicating continuous wheelslip immediately after moving from dynamic braking to normal traction it is essential to examine the interlocks of BKT for foreign objects — True, False.
30. For better combustion it is necessary to have high relative velocity between the fuel droplets and air in the cylinder — True, False.
31. Water in HSD oil is likely to cause seizure of fuel injection pumps — True, False.
32. Chromate in the cooling water system is primarily intended to prevent rusting of engine block — True, False.
33. A Vee engine is preferred to a straight in line engine as the crankshaft is shorter and sturdier — True, False.
34. The vibration dampers in the WDM/2 engine are of the friction/hydraulic type.
35. In the event of erratic engine speeds with GF off check the following items (tick the correct items) tachogenerator amphenol plug, acceleration control device, ESR fingers, LCR open circuited.
36. An engine with a rigid crankshaft and a short stroke will give higher torque for the same swept volume mean effective pressure as compared to a long stroke engine — True, False.
37. The short stroke engine described in Q. 36 will give higher bhp as compared to the long stroke engine — True, False.
38. The traction generator is connected to the engine through a flexible coupling — True, False.
39. Lubricating oil is fed to the valve levers through push rods — True, False.
40. If the diesel engine tends to bog down at a road speed of 10 km/h the current limit appears to have been set to high — True, False.
41. The governor of the WDM/2 locomotive does not 'fail safe' as in the event of speed pilot coil open circuited the governor will attempt to move fuel racks to the maximum fuel position — True, False.
42. High speed engines are lighter than slow speed engines for the same horsepower — True, False.
43. The BKIV coil prevents application of dynamic brake in the event of emergency application of air brakes on the locomotive — True, False.
44. The VA-1 release valve is always open on a lead/trail locomotive in a multiple unit consist.
45. Release of locomotive brake is effected through the 28 VB valve during dynamic braking — True, False.
46. Air brakes are used on locomotives as they are more powerful than vacuum brakes — True, False.
47. The selector valve converts a lead locomotive to a trail locomotive in the event of parting in a multiple unit consist — True, False.
48. The J filter assists in removing moisture from the air brake system using centrifugal force to spin out water — True, False.
49. Supercharging reduces the percentage of friction horse power losses in a diesel engine — True, False.
50. In the event of low vacuum check the 28 VB valve — True, False.
51. What will be the current registered on the ammeter —

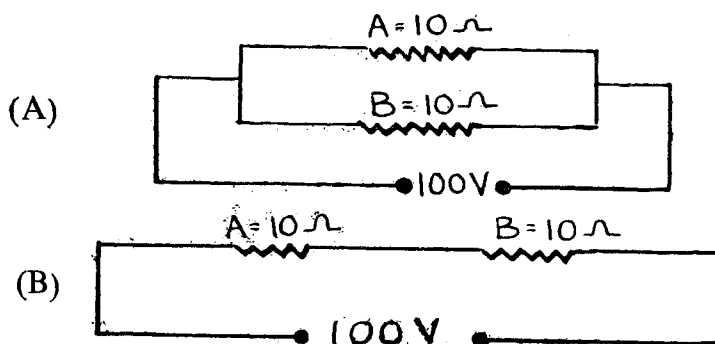


52.



Calculate the value of I —→

53



Which combination (A) or (B) will produce more heat

54. An internal combustion engine using pressure charging by 'Ram' effect increases in efficiency as the speed of the vehicle increases — True, False.
55. Wheel slip during traction can be controlled by a careful application of loco air brakes — True, False.
56. The EI transition gets better performance out of an electric transmission as compared to a road speed based transition — True, False.
57. Grounds in the control circuit can be detected by ground relay action in the WDM/2 locomotive only when cranking the engine — True, False.
58. Air Brake cylinder pressures in the WDM/2 brake system increase as the A9 is moved from Service to Emergency position during conjunctive working — True, False.
59. Presence of lube oil in the expansion tank indicates that the cylinder liner gaskets have perished — True, False.
60. A locomotive is experiencing fuel pressure trouble. The vacuum in the suction pipe line of the fuel booster pump is found to be 25" of Hg and is excessive. The fuel pump should be changed — True, False.
61. Defective gasket in the secondary fuel filter is likely to give persistent trouble due to airlock — True, False.
62. In the event of the fuel connection to the regulating valve breaking on road, the locomotive can be worked onwards by dummieing the same and setting the relief valve pressure lower — True, False.
63. In the event of hot engine alarm the engine should be run at idle rpm so as to reduce the thermal load on the cooling system — True, False.
64. The WDM/2 locomotive with a trimount truck has better riding qualities than the WDM/4 locomotive — True, False.
65. Weight transfer increases axle load and assists in giving better adhesion — True, False.
66. The average load on the nose suspension bearing on the axle increases with locomotive speed — True, False.
67. High horse power diesel hydraulic locomotives usually require larger water cooling systems as compared to diesel electric locomotives — True, False.
68. 17000 series of locomotives can be trailed merely by making the necessary MU connections for all hose pipes and setting the MU 2B valve at trail — True, False.
69. In an expressor throwing oil badly check for stuck or carbonised vac. check valve — True, False.
70. A single stage centrifugal pump would have been a more practicable proposition instead of a gear pump in the WDM/2 fuel booster pump — True, False.
71. The minimum reduction position in the A9 brake valve is to prevent glazing of brake blocks — True, False.
72. Given the following data—
Gradient resistance of the train and loco — 30000 lb.
Rolling resistance of the train and loco — 3000 lb.
Train is required to negotiate the gradient at a speed of 1000 ft/minutes.
Calculate the hp required 1000 hp.
73. A typical diesel engine with a radiator water cooled lube oil cooler has the following heat balance:
Heat employed in useful work 30%.
Heat in the exhaust 35%.
Heat given to cooling water in cylinder liner and cylinder head 25%.
Heat given to piston cooling lubricating oil — 10%.
The engine develops 1500 hp. Calculate the horsepower that has to be dissipated by the radiator used for cooling the water 1750.
74. Extra radiator capacity is required to dissipate the heat generated during dynamic breaking in a diesel locomotive — True, False.
75. Calculate the total current drawn when 72 volt d.c. is applied across two resistors of 18 ohms each connected in parallel with a capacitor of 100 microfarad and an inductance of 10 henries with the resistance of 18 ohms. 12.
76. Calculate the current drawn in the circuit of Q. 75 if the capacitor is removed 12.

77. Locomotives with hydraulic and electric transmissions impose less shock loads on the crankshaft as compared to mechanical transmission while working at a similar horsepower — True, False.
78. All the power contactors are repeatedly dropping off immediately after starting a WDM/2 locomotive. Tick the relevant items that should be checked — Control air pressure, Ground relay, LWS, GF switch.
79. In the event of a driver passing signal at danger list the 4 most important cocks/valves you will check in the airbrake.
A9 SA9 MU2B A9 C/ococks.
80. In the event of repeated power ground without explosive sound the traction generator commutator should be checked — True, False.
81. At lower ambient temperatures and altitudes diesel engines develop higher horsepowers — True, False.
82. Water in HSD oil is tested by crackling on a hot plate — True, False.
83. In the event of air brakes not releasing even after closing cut out cocks of the truck and the air supply pipe disconnected the C2 relay valve should be opened and attended — True, False.
84. In the event of continuous wheel slip being experienced WSR should be examined for open circuit in the operating coils — True, False.
85. Oil resistant rubber gaskets should be used in the air brake system of the locomotive — True, False.
86. Blotter spot test assists in examining the ability of the lube oil to hold dirt in suspension — True, False.
87. Lubricating oil with low Ph value is acidic/basic.
88. In service the chromate content of the cooling water of a well maintained locomotive gradually comes down and has to be attended during schedules — True, False.
89. In the event of starting ground experienced on the locomotive the ground relay switch should be opened and the locomotive failed and worked light to base shed for attention — True, False.
90. Crankcase vacuum in the WDM/2 engine is highest at full power at 8 notch — True, False.
91. Normal peak firing pressures in the WDM/2 locomotive is approximately 1600 kg/cm², 500psi, 1600psi, 1400 kg/cm².
92. Locomotive shuts down due to fuel pressure coming to zero whenever it reaches a water temperature of 74°C.
Tick the circuits you will check :
LWS, SAR, Radiator fan OPS, expressor governor fuel pump contactor.
93. In the event of WDM/2 axle boxes running warm, the old grease should be removed and the boxes fully filled with fresh grease — True, False.
94. The engine block is resiliently mounted on the WDM/2 locomotive so as to reduce engine vibrations — True, False.
95. Hydraulic dampers are more rugged and maintenance free and are therefore more suitable for locomotive use — True, False.
96. The TSC of a WDM/2 at full power runs approximately at 1200.
97. The expressor of a WDM/2 at full power runs at approximately 1200 rpm, 1400 rpm, 1000 rpm.
98. To increase the maximum speed of the locomotive the number of teeth in the traction motor pinion will have to be increased — True, False.
99. Engine Valves should be carefully lapped with the valve seats so as to get proper colour match for perfect sealing — True, False.
100. During dynamic braking wheel slip is prevented by the series motor characteristics of the traction motors — True, False.
- Name
- Designation
- HQS

CHAPTER 7

STORES

7.1 Diesel Store Organisation.

7.1.1 Every diesel shed/shop shall have a Stores Depot attached to it. The Stores Depot shall be under the Stores Department. The intention is that the Foreman of the Diesel Shed/Shop is not saddled with the custody, chasing and procurement of the Stores so that he can concentrate on maintenance of the locomotives.

7.1.2 There should be no imprest or any other type of Store under the control of Foreman.

7.1.3 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 — I (enclosed), wherein the word 'Subward' 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.

7.1.4 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 its day to day working. He shall also assist the Mechanical Officer in-charge of the shed/shop in making casual purchases. He shall also follow up the purchases initiated by the Mechanical Officer in-charge of the shed/shop with the Controller of Stores.

7.2 Inventory Control.

7.2.1 Pricing of items and consumption.

Each supervisor of a section shall maintain a record in which the cost of various items used in his section and their normal consumption is entered. The supervisor should maintain close liaison with the Stores to ensure that pricing of the materials is done correctly and that the prices are revised to keep them current from time to time. One of the Foreman in the shed will be responsible for ensuring the accuracy and correctness of the record maintained by the supervisors. This will ensure "cost consciousness" on the part of the supervisors. The Mechanical Officer in-charge of the shed/shop will make periodical checks of the same.

7.2.2 Estimated Annual Requirements:

The stock position, consumption trends and the estimated annual requirements should be reviewed periodically (not later than once in 6 months) jointly by the Mechanical and Stores Officer concerned at each depot. This periodical review will have to be strictly ensured and Estimated Annual Requirement revised regularly based on consumption trends.

7.2.3 Inactive items.

7.2.3.1 Firstly dead-stock items should be segregated i.e. items which are not at all required in the foreseeable future due to obsolescence, change in design etc. These items should be put up before the Survey Committee and disposed of and advised to the Controller of Stores for disposal.

7.2.3.2 Secondly items which are damaged due to storage handling etc., borne in books should be surveyed and suitably disposed of according to the recommendations of the Survey Committee.

7.2.3.3 Thirdly items which are not likely to be required in the near future should be offered for stock assistance to other Railways and Production Units.

7.2.3.4 Finally, every endeavour should be made by the Mechanical Officer in-charge of the shed/shop to utilise the existing stock by making suitable modifications to the extent possible. This exercise will have to be carefully gone into at the DME/WM level after obtaining CME's approval, since detailed technical appreciation and knowledge will be called for of the pros and cons.

7.2.4 Emergency items.

With regard to emergency items, only such items which will warrant replacement as a result of unforeseeable reasons such as accident, fire, etc. should be considered as emergency spares. Such items should be identified by the Mechanical Officer in-charge and one No. or one locoset of such items according to the nature of the item should be stocked centrally in one place in the respective zonal Railway system. Emergency items so identified should not be stocked in each and every shed/shop.

7.2.5 Control over consumption.

The Mechanical Officer in-charge of the shed should identify specific items, for the renewal of which, the supervisor-in-charge of the section will have to seek approval from the Foreman/Maintenance Inspector before effecting replacement who will personally check the item before authorising such replacement. As regards the shops, inspection and replacement will be authorised specifically by either Shop Superintendent (Mechanical) or shop Superintendent (Electrical) only.

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 officer. A monthly review of the consumption of the fast moving items should be effected at the shed/depot level. Each chargeman should maintain a record in which he should enter the stock position of the materials affecting the day to day working. This record will help the Shed Engineer stores officer to pin-point the items to be dealt with on priority. Specimen proforma for entries to be made in this record which may be called "Chasing Register" is shown below :—

Ser. 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 Chargemen in his work should be entered in this register and not items which are freely available.

7.2.7 Recoupment of stock.

7.2.7.1 Whenever recoupment sheet/Balance Return is placed by the Stores Officer of the depot, it should be got vetted by the shed engineer before submitting the same to Head Quarters Office for procurement. It will ensure :

- (i) that the Estimated Annual Requirement/Average Annual Consumption based on which procurement section is proposed is correct and current;
- (ii) that subsequent to a design change or modification done since the time of last review, no obsolescence of the product has resulted;
- (iii) selective procurement possible in times of financial stringency based on realistic technical appreciation of the requirements;

- (iv) For proprietary, items, necessary certificate duly signed by engineer-in-charge, shall accompany the recoupment sheet/balance return.

7.2.7.2 The Recoupment Sheet/Balance Return on receipt in Headquarters shall be routed through the CME, who shall attach the requisite number of drawings and specifications. Enquiries will, thereafter, be sent by C.O.S. only to the list of firms duly approved by DLW/CLW. The quotations received shall be sent to the C.M.E. for technical scrutiny and recommendations for acceptance on receipt of which C.O.S. shall place Purchase Order duly examining the procedural and other related aspects involved.

7.3 Procedure for procurement of materials.

7.3.1 All items which are of recurring nature in their demand irrespective of monetary value shall be made "stock items" in Stores.

7.3.2 Items which are occasionally required and generally not recurring in nature shall only 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. Such items will be directly consigned to Diesel Stores Depot in-charge.

7.3.3 The stock items will be classified into :

- (a) Items to be procured through import.
- (b) Items to be obtained from BHEL.
- (c) DLW—manufactured items.
- (d) Items to be manufactured in Railways' own workshops.
- (e) Items to be procured from Trade :

(a) *Items to be procured through import :*

These items will be indented on DLW by the Railways on an annual basis keeping 18/24 months requirements as the limits.

(b) *Items to be obtained from BHEL.*

Same as above observing 12/18 months requirements as limits.

(c) *DLW manufactured items :*

Same as above keeping 12/18 months requirements as the limits.

(d) *Items to be manufactured in Railways' own workshops :*

These shall be recouped on 6 monthly intervals keeping 6/9 months requirements as the limit.

(e) Items to be procured from Trade :

These items shall be recouped keeping 12/12 months requirements as the limit.

7.4 Procedure regarding approved suppliers of indigenous Spares.

7.4.1 Procurement of indigenous spares will be normally made from the list of suppliers approved by DLW/CLW.

7.4.2 Whenever Zonal Railways develop any additional sources of supply, these should be intimated to DLW/CLW for their approval.

7.4.3. Performance review of indigenous suppliers should be conducted periodically by the Zonal Railways and wherever warranted, recommendations should be sent to DLW/CLW.

7.4.4 During the stages of development/trial of new indigenised items of spares or constant deterioration in quality of supply of a proven product, DLW/CLW shall resort to balancing import.

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 ACOS/Diesel on the procedural side and Foreman/MIO on the technical side. The functions of the Foreman/M.I.O. is described at Annexure II.

7.6 Trial Orders.

Procedure for Placement of Trial Orders is indicated in para 2 Chapter 11. After trial orders have been found successful. When the bulk order is processed, only 10% of the requirement shall be placed on the newly approved source whose trial order is found to be successful and this shall also to be treated as outside the normal requirement, the bulk order still being placed on the previously approved sources. Only after compliance of this 10% of the bulk order by the new source, the firm appear on the approved list of DLW/CLW suppliers for this particular item. It is very essential

that the procedure be rigidly followed so as to avoid dilution in quality likely to arise from the multiplicity of sources developed in haste.

7.7 Cash Imprest.

7.7.1 A cash imprest of minimum Rs. 10,000/- shall be provided with the officer in-charge of the Diesel Stores Depot.

7.7.2 Stores/Mechanical Officer in-charge shall have powers for emergency purchase of single items costing upto Rs. 1,000/- at a time from the cash imprest without going through the formalities for calling for quotations etc. They will also have powers to purchase directly the items anywhere in the country from imprest cash.

7.7.3 A cash imprest of Rs. 5,000/- shall be provided with the Engineer in-charge of the shed, for repairs/reclamation of machinery and plant, tools and Diesel Loco components.

7.8 Emergency/purchase

7.8.1 Mechanical/Stores Officer in-charge shall make emergent purchase of one single item costing Rs. 10,000/- at a time duly calling for quotations.

7.8.2 Purchases exceeding the above limits will be done by the C.O.S.

7.8.3 The stores officer attached to the diesel shed shall have powers of purchase of a Senior Stores Officer.

7.9 Works Contracts.

7.9.1 The Mechanical Officer in-charge of the shed/shop shall have power for entering into Works Contract for repairs to Rolling Stock, Machinery and Tools for repair works costing upto Rs. 10,000. For repairs costing less than Rs. 500 per item, the Mechanical Officer shall have the powers to let out the work on a single tender basis, and for works costing more than Rs. 500 and less than Rs. 10,000 per item, quotations should be obtained from not less than three firms who in his opinion have the necessary capacity to undertake the work. Works costing more than Rs. 10,000 shall be processed with the sanction of C.M.E. /C.W.E.

• • •

ANNEXURE I

1. The Diesel Stores Depots 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 Stores.*—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 sheds.
4. *Forecast Schedules of Stores Required.*—Forecast Schedules (S. 1508) of all stores, tools, assemblies and fittings and component parts required by the workshops for periodical 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 D.M.E. Such forecasts should not be issued piecemeal, but one consolidated forecast should be made out for the Locomotive expected to be overhauled/serviced in the month.
5. *Advance Lists of materials.*—Chargeman 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 scrutinised and countersigned by the Foreman concerned and copies thereof furnished to the Ward-keeper whose duty it 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. Date.

Index Number of Chargeman

Shop

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 Chargemen provided the items appearing therein have already been included in the advance lists approved by the foreman (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 foreman of the shop concerned.
9. Issue tickets for items of stores which do not appear in the forecast schedule should be signed by a gazetted officer or by a senior selected subordinate specially given powers by the Chief Mechanical Engineer to countersign such tickets.

ANNEXURE II

FUNCTIONS OF THE FOREMAN M.I.O. FOR ASSISTING DME/DIESEL ON THE STORES MATTERS

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 attached to this FOREMAN/M.I.O. are indicated in Annexure IV — Chapter 3 — Responsibilities of M.I.O./M.)

CHAPTER 8

DIESEL — FUEL

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.

8.1.2 The fuel injection equipment on a diesel locomotive 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 running shed staff to see that fuel is not contaminated in any way with water, dust, sand and dirt etc., during its handling in the shed.

8.2 Fuel Oil Servicing Facilities :

8.2.1 Fuel oil servicing facilities usually consist of :—

- Unloading facilities.
- Storage facilities.
- Pumping facilities.
- Distribution facilities.
- Facilities for delivery to locomotives.
- Fire protection arrangements.

8.3 Fuel Oil Unloading Facilities :

8.3.1 Diesel fuel oil may be supplied to the running sheds or other fuelling points in railway tank wagons only as far as possible. Supply of HSD by road tankers shall be resorted to only where tank wagon supply is not available or in case of emergency. The fuel unloading facilities should be provided at a convenient place which can be approached by rail and/or road depending upon how the supplies have to be received.

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 of the overhead unloading facilities being accommodated in the space available.

8.3.3 Bottom Unloading :

8.3.3.1 The number of decanting sumps to be provided, depends upon the number of tank wagons required to be unloaded at any one times. 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. Arrangements 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, and 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 utilised, 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 running sheds.

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 largest 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 underground 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 disadvantages of this type of fuel tank are that, even though roofed over the excavation 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 of easier inspection for leaks and corrosion, and de-sludging arrangements more satisfactory.

8.4.3.2 Generally in the running sheds 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.

8.4.3.3 The cylindrical tanks of the type most commonly used in locomotive sheds, should be provided with a fall of about 4-5 cm per metre 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 undertaken 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 brick or concrete or at much less cost, it may be simply buried. 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 fuelling of the locomotives.

8.4.4 Water Drain off Sump and Valve :

A small sump at the bottom of vertical type tank 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 from about 20 cm above bottom of the tank thus allowing space for collection of water and sludge.

8.4.6 Internal Check 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 in to the tank.

8.4.8 Level indicators :

Several types of level indicators are used. These 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 or zinc chromate primer. After erection at the site, the tank should receive a second coat of primer followed by the finishing coat. Aluminium 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.

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. It is considered desirable to inspect the tanks for collection of sludge and condition of plates once in about 3 years. The cleaning of tank should, preferably be done at the end of every six years. 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—

Vent pipes.

Man holes to facilitate interior cleaning and inspection.

Weather proof filler cap and suction valves.

Sludge drainage cocks and pumps.

Fuel level indicators.

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 pressures 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.

8.5.1.3 A hand pump to meet with all emergencies should be provided for use when electric pumps fail.

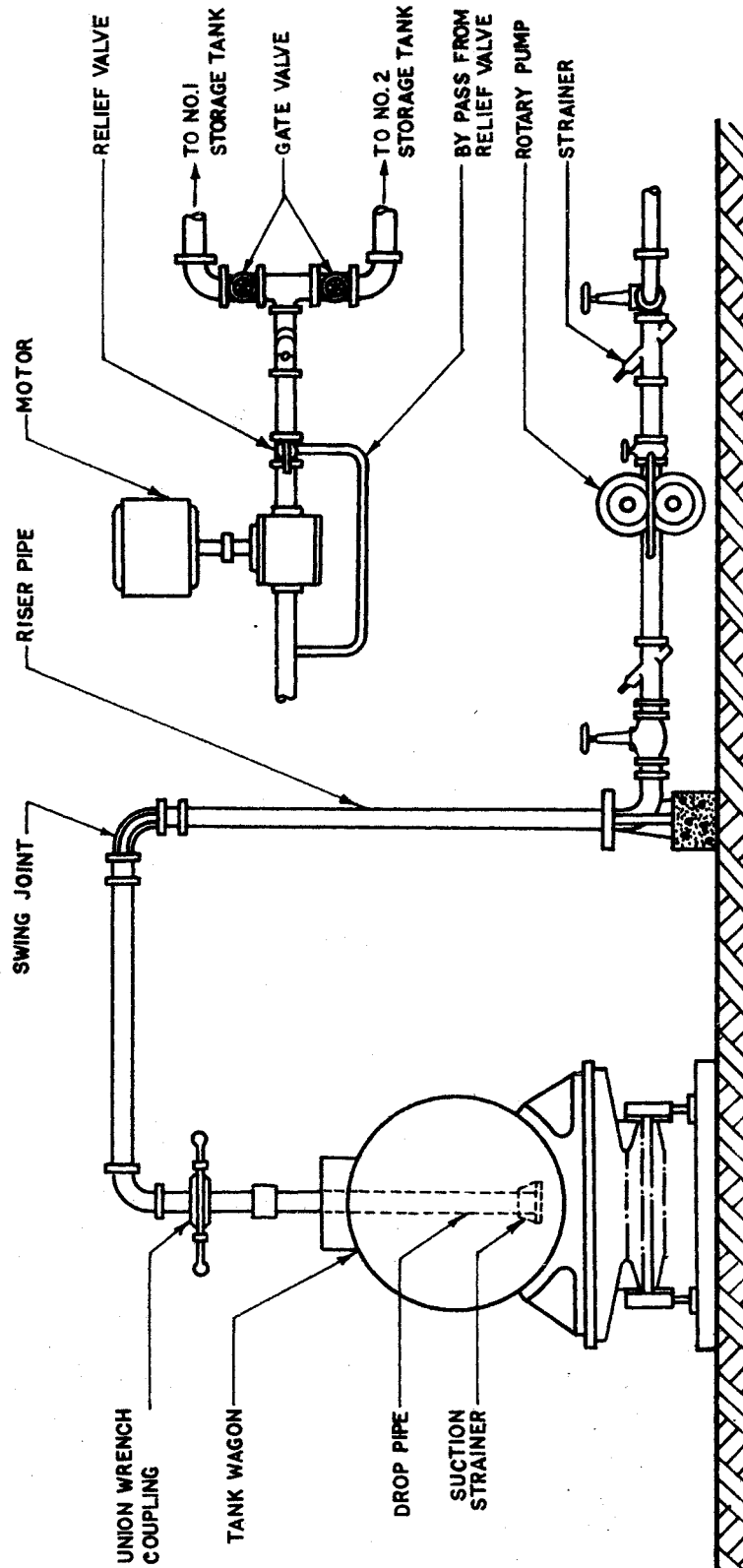
8.5.2 Pump Capacity :

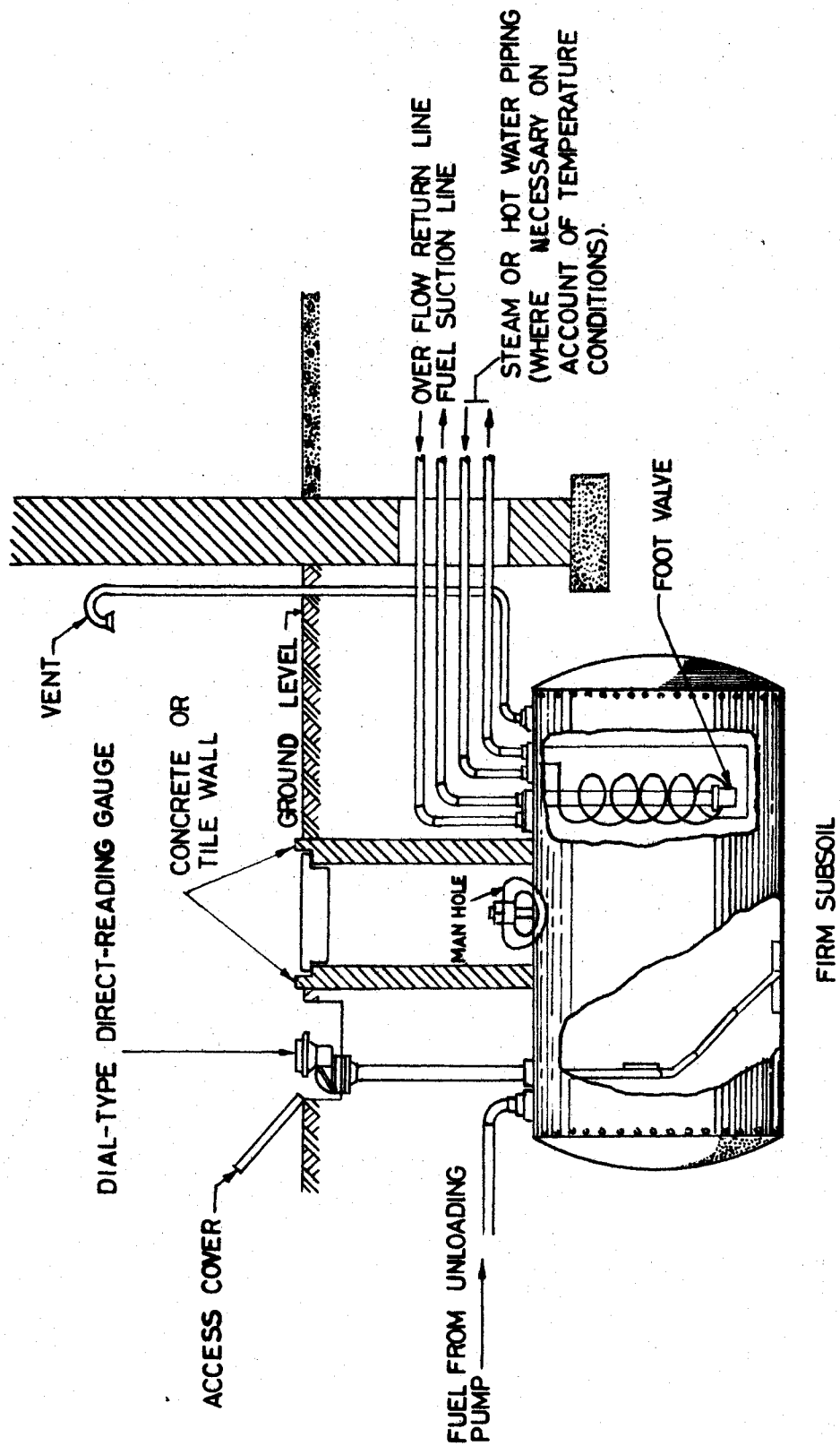
The following capacities are recommended :

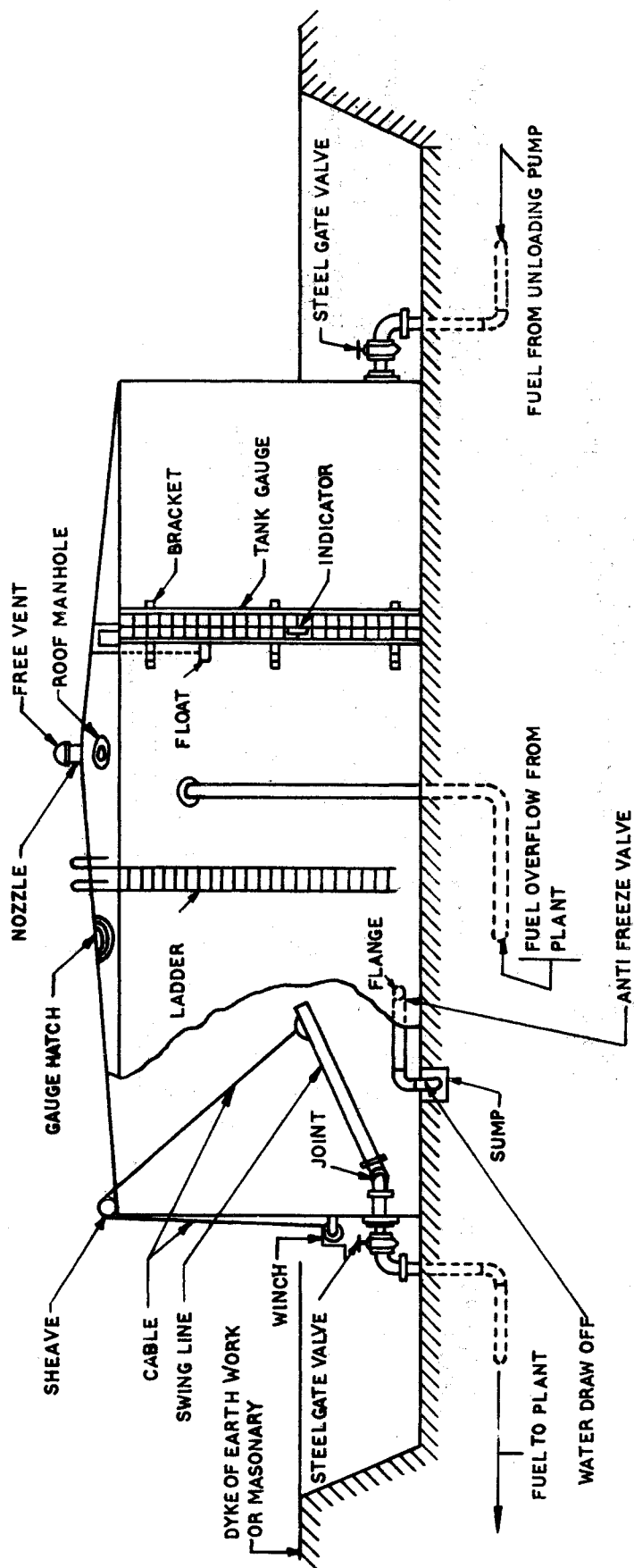
- 1000-1500 litres per minute at major running sheds and mainline servicing points where fast fuelling rates are required.
- 250-500 litres per minutes for smaller running sheds and shunting loco fuelling points.

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 locomotives 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 running sheds, separate pumping units would be justified, at small consumption fuelling points one unit to serve both the purposes is all that is needed.







8.5.4 Housing of Pumping Equipment :

Pumping equipment should be protected against bad weather and also unnecessary meddling by unauthorised persons. The pump house should also have accommodation for the installation incharge and for keeping records concerning the fuelling installation.

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 :

8.5.5.2.1 These are necessary to gauge the amount of fuel oil supplied each time. A fuel meter should be placed in the line between the tank wagon and the storage tanks to record the amount of fuel received in the depot. Another fuel meter is necessary between the storage tanks and the locomotive being fuelled to record the fuel supply made to each individual diesel locomotive. Since there may be more than one fuel feeding point depending upon the number of locomotives required to be fuelled simultaneously, each of these fuelling points should be provided with fuel metering arrangements. The fuel flow-meters 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 :

8.5.5.3.1 Fillers 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.

8.5.5.3.2 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 (2) when it is pumped from storage tanks to the locomotives.

8.5.5.3.3 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, upto a certain point, the filtering performance will be better.

8.5.5.4 Air eliminators :

8.5.5.4.1 When fuel oil is to be pumped through 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 purposes 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.

8.5.5.4.2 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.

8.5.5.4.3 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 under ground. 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 :

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 and 150 mm dia. pipes are used for pumping rates of 500, 1000, 1500 litres 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 cm 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 50 mm 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 work 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 metres apart and may be constructed of rail or reinforced concrete. The total expansion/contraction due to changes in temperature may be arranged for by the use of conventional methods such as the provision of loops, swing joints and expansion joints etc.

8.7 Fuel Deliveries to Locomotives :

8.7.1 In a shed, diesel locomotives may be fuelled either at the time of their entrance or at the time of their exit from the shed. In the case of locomotives 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 :

- Under gearing washing.
- Body cleaning and washing.
- Sanding.
- Fuelling.
- Schedule inspection
- Departure.

8.7.2 In the case of locomotives requiring heavy schedule inspection or necessitating the emptying of fuel tanks, it is preferable to fuel the locomotives 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 locomotive fuel tank to avoid spillage during the fuelling operation.

8.7.4 The fuel hose constructed of oil-resistant material and provided with special fittings and couplings on the outlet end to match the connecting arrangements on the locomotive 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 metres. 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 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 locomotive or railcar. 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.

8.8 Fire Protection :

8.8.1 The inherent danger of fire around a diesel fuelling installation is due to the formation of inflammable vapour 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 minimised 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.

8.8.2 The following will help to minimise oil leakage and spillage and thus safeguard against fire hazards :

Welded pipe joints in fuel lines reduce oil leakage.

Air vents should terminate in open atmosphere outside the pump house.

Pressure relief valves should be piped back into the storage system and not discharged to atmosphere.

Fuel pumps should be equipped with proper seals to safeguard against fuel oil leakages.

Areas around fuel installations should be paved so that if any oil is spilled, it is possible to clean it easily. Concrete platform paving with proper slope to provide quick drainage into sumps or drains is recommended.

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.

8.8.3 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.

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 Divisions should work out the requirements of HSD oil for the depots/diesel sheds/fuel points in their jurisdiction. These should take into account anticipated variation in the train operation during the next financial year. Arrangements for new/additional storage capacity (normally being 15 days consumption plus lead time)/pumping should be reviewed and specific proposals alongwith the requirements of next financial year sent to fuel branch. Fuel branch will forward the requirements of HSD oil and new/additional storage capacity alongwith details of direct demanding officers to Controller of Stores for arranging procurement.

In case of placement of rate/running contracts, COS will advise fuel branch of the Railway and

all Divisions and depots/diesel sheds/fuelling point incharges.

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 tank trucks. A close watch on the trend of consumption vis-a-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 :

- (1) Tank wagon number/lorry number
- (2) Carrying capacity.
- (3) Net quantity loaded in litres
- (4) Date of loading.
- (5) Loading station code.

Copies of the loading advice will be simultaneously despatched by postal dak to the FA&CAO and fuel branch.

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. This 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 :

- (1) Tank wagon No./Lorry No.
- (2) Full booking particulars.
- (3) Supplier's name.
- (4) Consignee's name and station booked to.
- (5) Quantity loaded in litres as per RR at temperature _____ °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 Shed :

8.13.1 On arrival of HSD Tank wagon/wagons at the destination, the same will be taken delivery of by the official-in-charge of the shed/installation/fuelling point 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. Dip measurements taken and damage deficiencies message 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 preferred on the supplying oil Company within 30 days of the receipt of the tank wagons. A copy of this claim should be endorsed to the DGS&D 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.

8.13.3 Placement Mema :

The placement of tanks in the shed will be supported by placement mema in Form No. 3 which will be produced before Official-in-charge of the shed by the representative of Transportation Department, similar to the practice followed in respect of coal wagons. The placement mema will be prepared in four copies which will be distributed as under :

One copy for station record,

Three copies of the official-in-charge of the shed.

The official-in-charge of the shed will take receipt of the oil tanks with the placement mema and return one copy of the placement mema 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 DAO concerned alongwith the periodical receipt return.

8.13.4 No tank wagon shall be decanted after sun set except 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 atleast 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 :

- (1) Visible suspended impurities and sludge.
- (2) Crackle Test :

This will indicate a water free sample. Silent but audible crackling sound indicates traces of water. Vigorous crackling sound indicates appreciable water.

- (3) Colour Test :

Colour comparison with a 2% solution of potassium bi-carbonate in water should be made. Samples with dark colours should be further analysed for gum content according to ASTM-D-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 :

- (1) Fuel oil samples from primary fuel oil filter casing should be drawn atleast 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 locomotive fuel tank.
- (2) The ground storage tanks should be drained of water atleast once in a week.
- (3) Atleast two 1-litre samples (drawn from incoming tank wagons/storage tanks) per month from each fuelling point should be sent to Director General (M&C)/RDSO Lucknow, for carrying out Cetane No. test
- (4) Atleast 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 sheds to Fuel Branch of the Railway and RDSO.

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 drawing out approximately 20 litres of HSD oil. This will drain in bottom sludge for contamination. 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 telegraphically or 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 cases where HSD oil is suspected to be contaminated with water, the following procedure should be adopted :

- (a) Immediately re-seal the tank wagon.
- (b) Buy wire from the nearest suppliers. Depot should be advised to fix 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 drainings and testings 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 supplier's representative and the ACM/Loco Representative.

"We hereby certify that.....litres of contaminated oil were drained out from Tank Wagon No.....booked ex..... to..... under R.R. No..... datedbefore 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 Shed Incharge to the Pay & Accounts Officer, Parliament Street, New Delhi, one copy to FA&CAO (Stores)/COG 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 tank 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.

- (f) If after the settling period 24 hours, the samples from the top is found still 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 ofshed athours onhas 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 Locomotives and Tank Wagon is ordered to be re-sealed and re-booked to the base station the freight being on supplier's account.

Sd/- Loco Representative
with Designation

Sd/- Supplier's Representative
with Designation.

- (g) The disposal of five copies of the above certificate will be as under :
 - (1) Original to Pay and Accounts Officer, New Delhi requesting deduction for this wagon from bills of the supplier.
 - (2) Second copy to FA&CAO requesting further pursuance with Pay and Accounts Officer.
 - (3) Third copy to Fuel Branch, Headquarters Office.
 - (4) Fourth copy to Division concerned.
 - (5) To be retained as office copy.

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 etc. charges 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 be within the stipulated overall 0.2% limit of handling losses etc. it is essential that flow meters used should have an accuracy of $\pm 0.02\%$. This should be checked by calibration at six monthly intervals.

8.18 Tank Wagons Register :

8.18.1 Official incharge 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 informations :

- (1) Date of receipt.
- (2) Tank wagon No.
- (3) Time of placement, release and time of making over the Tank Wagon to Traffic.
- (4) Initial of the Traffic Representative.

8.18.2 Except in case of contaminated Tank Wagons the invoiced quantity should be taken for all accountal purposes at receipts. In the case of partially contaminated wagons 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 incharge will ensure that the Storage Installations is operated by authorised Railway Staff and that issues are made either on the basis of Flow Meter Reading (where flow meters have been provided) or on the basis of Fuel Gauge readings on the locomotives. Such issues to running engines will be made on the Form 6 which is to be serially numbered. Oil issues to individual running engines will be shown in the Form 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 Drivers to whom the oil is issued on Form 6. This should be prepared in *three copies* one for submission to Divisional Accounts Office as a supporting voucher for issues with Form 7, one for the Driver and one as office copy. All the oil received during the month and issued to running engines as per Form 6 should be entered daily in Form 7. Balance should be struck at the end of each day and Form 7 sent to DAO daily alongwith Form 6.

8.18.4 The Official Incharge of the Shed/Fuelling point will fill up the columns 14 and 15 in Form 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 sheds, the shed official will prepare Form 8 and also make an endorsement in Column No. 16 of Form 1 against the entry of the particular wagon.

8.19 Missing Tank Wagons :

8.19.1 A separate statement in Form 9 (month's 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 No. 1 to 4.

8.19.2 Cases of Tank Wagons reported "not received but subsequently received should be reported on the same Form 9 by filling in Columns No. 5 to 10.

8.20 Oil Tank Wagons Diverted to other sheds :

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 8 in quadruplicate. The original is to be sent to FA&CAO (Stores) and duplicate and triplicate to the new consignee concerned retaining one copy with the original consignees. 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 Form 10 should be prepared by the sheds showing the receipts during 10 day period i.e. 1st to 10th, 11th to 20th and 21st to the last day of the month in the Form 10 as per coal accountal prior to 1-8-66. This should be prepared in 5 copies and distribute as under :

- (1) Office copy.
- (2) One copy to HQ Fuel Accounts Officer.
- (3) 2 copies to DAO (One for posting the price ledger and the other for linking of receipts with payment).
- (4) 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 shed and sent alongwith the 10 day receipt statement of the last period of the month. The receipts will be accounted for by the sheds in the 10 day returns on the basis of the invoiced quantity.

8.22 Issues to Engines of other Railways :

8.22.1 The shed staff should prepare an issue Note in Form 11 and obtain the signature of the driver of the engine with complete particulars regarding the name of the driver, engine No. quantity issued etc. At the end of each month two copies of such issue notes duly acknowledged by the driver of the foreign railway engine should be sent to the DAO concerned to enable him to raise debit against Foreign Railway concerned.

8.22.2 In respect of Zonal Railways engine working for other Railway system, the basis of adjustment is 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 operating (fuel) branch of the zonal Railway to FA&CAO of the Railway.

8.23 Supply of Pumping Stations :

8.23.1 Supplies to Pumping Stations should be made by the shed incharge against proper requisition. Proper account of receipts and issues by the pumping stations should also be maintained by the shed concerned in the stock ledger.

8.24 Issue to other departments of the Railways :

8.24.1 Issues to other departments of the Railway should be authorised by the official incharge of the shed and acknowledgement obtained on the copies of the requisition which are received from the departments. Such requisitions should be submitted in original to the DAO concerned in support of the issues accounted for in the monthly accounts. Official incharge of the shed should ensure that the head of account to which the quantity supplied to the department is debit-able has been shown on such requisition so that the DAO can make necessary adjustments.

8.25 Schedules of Issues :

8.25.1 Based on the Issue Notes in *Form 6* and Daily classified summary of issues to other than locomotives purposes (*Form 12*) the sheds should prepare a Monthly Schedule of Issues.

8.25.2 *Form 13* showing the consolidated monthly issues separately for locomotives and other than locomotive purposes, will be prepared in triplicate and distributed as under :—

- (1) Divisional Accounts Office.
- (2) Divisional Fuel Branch.
- (3) Office Record.

Before submission of monthly schedule of issues, the same should be reconciled with the total issues recorded in the stock ledger.

8.26 Stock Registers :

8.26.1 Tank Register : A Tank Register should be maintained for each tank of oil installed at the consuming shed similar to the stock register for each stock of coal in *Form 14*. All the receipts shown in this Register will be accounted for according to the invoiced quantity.

8.26.2 The receiving sheds should check receipts by "DIPs" with the help of calibration charts of the tank wagons. If the invoice is received before the arrival of the tank, the quan-

tity 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.

8.27 Stock ledger :

8.27.1 The sheds will maintain a stock ledger in *Form 15* which will be posted from tank register so far as receipts are concerned, and the issues, from the issue notes *Form 11* and from summaries of issues for other than locomotives purposes *Form 12*. The total issues posted in the Stock Ledger will also be proved with issues as appearing in the Tank Register *Form 14*.

8.28 Monthly HSD Oil Account :

8.28.1 The sheds will prepare monthly HSD Oil Account on *Form 16* showing the opening balance, total receipts, 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 locomotives of other Railways will be shown separately. This will be prepared in three copies and distributed as under :—

- (1) Divisional Accounts Office.
- (2) Divisional Fuel Branch.
- (3) Office Record.

8.29 Manning of the Installations :

To ensure adequate quality control and correct accountal fuel oil, installations should be adequately manned. The following general guide lines are prescribed :

8.29.1 Quality Control :

One CMA Gr. 210-425 (AS) in base shed for testing of fuel oil samples received from storage tanks and various fuelling points.

8.29.2 For supervision accountal and upkeep of the installation :

Category of Diesel Oil Installations	Average daily issues	F. I (in highest grade)	Senior Clerk Grade Rs. 130—300	Junior Clerk Grade Rs. 110—180	Mechanics Grade Rs. 110—180	Khallasi Grade Rs. 70—85
Major Installations.	30.1 KL & above	1	1	4	3+1 R.G.	6+1 R.G.
Medium Installations.	15.1 to 30 KLS	1	1	3	3+1 R.G.	3+1 R.G.
Minor Installations.	Up to 15 KL	1	1	1	2	2

ANNEXURE 1

NOMOGRAPH FOR VOLUME AND GRAVITY CORRECTIONS

The accompanying chart for estimating approximate volume correction factors and API gravities at 60°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°F and the volume correction factor to 60°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°F of 1000 gal. of oil of 37 API gravity at 90°F?

Horizontal line AP is drawn between the 90°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°F gravity lines 34 and 36.

By inspection the volume correction factor is estimated at 0.9866 and the API gravity at 60°F is estimated to be 35. Therefore, at 60°F the volume would be approximately 986.6 gal. of oil of 35 API gravity.

*ASTM Designation D 1250, Standard ASTM—IP Petroleum Measurement Tables.

Serial No. _____

Date : _____ Statement showing the wagon details for the quantity of HSD oil supplied _____

C.O.S. Order No.	Date	Bill		Qty. billed for in (litres)		Loading Advice		Tank Wagon No./Lorry	Invoice		Booked		Date of receipt in full	Qty. as per mea- surement (Litres)	Remarks
		No.	Date	No.	Date	No.	Date		No.	Date	From	To			
1	2	3	4	5		6	7	8	9	10	12	13	14	15	16

This should be prepared by the suppliers, separately for each bill and serially numbered for each consignor. The S.No. and date of this form should be indicated in the III 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 shed.

Signature of Supplier

Signature of Shed Official

Monthly statement showing the enroute supplies in Oil Tank Wagons measured in the Presence of Traffic Representatives.

Date of receipt	Tank No. Lorry	Wa- gon No.	Invoice		Invoiced quantity	Booked From	Booked To	Qty. as per measurement	Difference between Col. 5 & 8	Initials of	
			No.	Dt.						Loco Representative	Traffic 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 Installation.

Railway

(To be returned to the Station Master at the time of release of wagons by Dept. Incharge)

H.S.D. Oil Wagon Placement Memorandum

Station _____

Date _____ 19____ Hour _____

Consignee _____

Owning Railway	B.G. Wagon Number	M.G. Wa- gon Numter	Tare weight	Carrying capacity litres	Rebooking Particulars										Actual Qty. as per invoice	Placed hour	R eased hour	Time taken	Re- marks
					To		R.R.		Invoice										
					From		No.	Dt.	No.	Dt.	No.	Dt.							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				

Station Master _____

Depot Incharge _____

Station _____

Depot _____

Statement of Analysis of H.S.D. Oil Sample

Month _____, 197 _____

Railway _____

Sl. No.	Station name in full	Sample drawn from £	Supplier and supply received from*	Date		Colour comparison with 2% Pott. dich. romate solution	ANALYSES					Remarks
				Collected	Tested		Flash pt. in °C @	Kinematic viscosity at 37.8°C in cs.	90% Distillation recovery temp. in °C	Carbon residue Rams Bottom (% by wt.)	Total sulphur (% by wt.)	
..												

* T.W. .. Tank Wagon

T.L. .. Tank Lorry

U.G.S.T. ... Under Ground Storage Tank

S.T. .. Storage Tank

L.T. .. Locomotive 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 despatched.

@ Abel's method should be used if flash point is lower than 49°C and P.M. method if it is higher than 49°C

Register of Oil Tank Wagons received and dealt with at..... during the month of..... 19.....

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. Mst.	Decanted storage Tank No.	Remarks	Initials of the representatives 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 DAO/.....

Official in-charge of Installation.

Issue Voucher for H.S.D. Oil

Serial No.....

Date.....

Outgoing Driver..... Train No..... Date.....

From..... To..... Station.....

Incoming Train No. & Date.....

Issued from Tank No.....

Loco Oil Tank Balance left by the incoming driver (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 Driver.

This should be prepared in Triplicate.

Duplicate retained for record and the

Original sent to DAO with Form No. 6.

Triplicate to the outgoing Driver.

Railway

Form No. 7

Statement showing the daily issued of H.S.D. Oil

Date.....

Reference to issue voucher		Engine No.	Service	Train		Tank No. from which fuelled	Quantity fuelled in litres	Remarks
No.	Date			No.	Date			

Total

Stock

Summary of Issues

Abstract

Tank No.

(a) Opening Balance

(b) Receipts during the day

(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 DAO/.....Concerned along with Form No. 6.

Official in charge of the Installations.

Railway

Form No. 8

Advice Note No.....

Quadruplicate

From.....To FA & CAO

Date.....

Issue Note for diverted HSD Oil Tank Wagons

The undermentioned HSD Oil Tank Wagons received from.....is rebooked to you on.....and the particulars are as follows :

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 the 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 sent to FA & CAO (Stores).

Duplicate & Triplicate to the consignee concerned and Quadruplicate or office record.

Signature of the Official-in-charge
(Rebooking the Wagon).

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, Head quarters Office and CAO.....19....

Date.....(To be prepared in 4 foils)

Signature of Shed-in-charge.

Name of the Firm.....

Statement showing particulars of H.S.D. Oil Wagons received at.....Depot during the period.

From.....to.....

S. No.	Date of receipt	Particulars of		Original Booking Particulars				Railway Receipt		Invoice		Re-booking Particulars		Remarks
		Wagon		Name of despatching station	Actual quality of HSD Oil as per invoice	Supply order No.	Forwarding Note No.	No.	Dt.	No.	Dt.	Re-booking invoice	Particulars of Wagon if extents transhiped into W.G. Wagons	
		Owning Rly.	No.											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Total quantity

No.

Dated.....]

To be prepared in quintuplicate :

Station.....

Forwarded to the DAO.....in duplicate (one for posting the priced ledger and the other for lading of receipts with payments).

.....Depot in charge.

FA & CAO (Fuel)

.....Depot.

Fuel Branch, Headquarters Office.

.....
.....

RailwayForm No. 11*Memo of High Speed Diesel Oil issued to Drivers of..... Depot on..... 19.....*

No.	Engine Class	Train No.	H.S.D. Oil for the running engines litres	Driver's Signature
1	2	3	4	5

Station..... No..... Dated.....

Forwarded to the DAO/DS (Fuel)..... Division for disposal.

..... Subordinate in charge of Depot.

RailwayForm No. 12*Daily classified summary of issues of High Speed Diesel Oil for non-locomotive purposes at.....*

Depot for..... 19.....

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 depots		
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

..... Depot.

Railway

Frm No.13

Monthly Schedule of issues for the month of 19..... 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 onto 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 DAO/DS(Fuel)

Signature of Shed Incharge.....

Shed.....

Railway

Form No. 14

ReceiptsTank RegisterIssues

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 Quan- tity	Total daily receipt litres	Date of issue	Parti- culars of issues	Quan- tity issued litres	Total issued daily litres	Balance on hand	Re- marks
	B.G.	M.G.										
1	2	3	4	5	6	7	8	9	10	11	12	13

Signature of Shed-incharge.....

Shed..... :

Stock Ledger

Date	Daily receipt as per			Total Daily Receipt	Date	Daily issues				Total daily issue litres	Balance on hand litres
	Invoice No. or index statement litres	Transfer Issue Notes litres	Without Advice litres			Home Shed Engines litres	Pump etc. Miscellaneous litres	Other shed engines litres	Other Departments & Rlys. litres		
1	2	3	4	5	6	7	8	9	10	11	12

Signature of Shed incharge.....

Shed.....

Name of Shed

Railway

Form No. 16

Monthly Statement showing opening balance, receipts and issues for the month of.....

S.No.	Location of installation	Opening Balance	Receipts	Issues

Total.....

No.

Dated.....

Station.....

..... Depot Incharge.

..... Depot.

To be prepared in triplicate

Forwarded to

Divisional Accounts Office

Divisional Fuel Branch

CHAPTER 9

LUBRICANTS

9.1 Characteristics of lubricants :

The following are the main characteristics usually considered in the context of use of lubricants on diesel locomotives :

9.1.1 Viscosity :

This is the most important single property of a 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.

9.1.1.1 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°C (100°F), 54.5°C (130°F) or 98.9°C (210°F). Viscosity at 37.7°C is indicative of conditions such as when starting an engine after a long shut down.

9.1.1.2 As is well known, oils thin out rapidly when heated and thicken when cooled. If viscosity at two temperatures such as at 37.7°C and 98.9°C has been determined, viscosity at any other temperature can be determined from the Temperature-Viscosity chart.

9.1.2 Viscosity Index :

9.1.2.1 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.

9.1.2.2 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.

9.1.3 Flash Points :

9.1.3.1 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 a specification it is necessary to state which instrument is intended to be used.

9.1.3.2 Lubricating oils, usually, have closed flash points above 150°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.

9.1.4 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.

9.1.5 Pour Point :

This is the temperature below which it is impossible to pour the oil. The pour point is usually about 5°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.

9.1.6 Carbon residue :

This is the solid residue obtained when the oil is heated to complete vaporisation. 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.

9.1.7 Insolubles :

9.1.7.1 Insolubles have a 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 a 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 solubles 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.

9.1.7.2 '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 a dirty oil may indicate a clean engine. This is particularly so with detergent oils, which can hold high percentages of insolubles without precipitation.

9.1.8 Neutralisation Number :

9.1.8.1 This is a measure of the alkali required to neutralise one gram of the oil. The higher the neutralisation number, larger the acid content. A 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.

9.1.8.2 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 of KDH. This characteristic is called the 'Total Base Number'. In course of service the TBN has a tendency to fall.

9.1.9 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.

9.1.10 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 a 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.

9.2 Diesel Engine Lubricating Oil Additives :

9.2.1 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—

- the nature of the crude from which they originate;
- the method by which they are refined;
- the types of the additives which they may contain.

9.2.2 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.

9.2.3 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 improved lubricant. It decreases the cost of refining and widens the scope of crude oil selection.

9.2.4 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 suitability for other applications. The different classes of additives used in modern engine lubricants are given below :

9.2.4.1 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) They may terminate oil oxidation by breaking the reaction chains, (2) form a passivating film on the metal surface which acts as a catalyst during oxidation.

9.2.4.2 *Anti wear :*

Anti wear agents are also 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.

9.2.4.3 *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 a suspended state and their precipitation to form deposits is prevented.

9.2.4.4 *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.

9.2.4.5 *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.

9.2.4.6 *Anti rust :*

Anti rust compounds may be sulphonates, Amines fatty oils, oxidized waxes etc. They pre-

vent rusting of metal parts by being preferentially absorbed on the metal surface and this film repels water and neutralises corrosive acids.

9.2.4.7 *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.

9.2.4.8 *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.

9.2.4.9 *V. I. Improver :*

Viscosity Index improvers are polymerised olefines 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°C more in proportion than at 37.8°C owing to the change in solubilities.

9.2.4.10 *Pour point depressant :*

Pour point depressants are high molecular weight compounds such as wax alkylated naphthenes 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.

9.2.4.11 *Mild extreme pressure : Agents :*

Mild EP agents are organic compounds like phosphates, Napthenates of Lead, alkyl thio phosphates, 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.

9.2.4.12 *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.

9.2.4.13 Emulsifiers :

Emulsifiers are certain soaps of fatty acids, sulphonic acids or Napthenic acids. They emulsify the oil with water and provide a 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.

9.2.5 Contamination of lubricating oil in service and loss of additives :

9.2.5.1 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—

- the type of oil;
- the nature and condition of the engine;
- the operating variables and service conditions.

9.2.5.2 Loss of additives through lubricating oil filters is unavoidable. In diesel locomotives, 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.

9.2.5.3 Also important are contaminating materials formed as a result of deterioration of lubricating oil due to oxidation, polymerisation 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.

9.2.5.4 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 varnish-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 and rust and scale.	Abrasive wear. Speed-up oxidation of 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. Lowers resistance of lubricating oil to oxidation. Rusting.

9.3 Transmission Oils :

9.3.1 In hydraulic transmissions, an oil is used as a power transmission medium (in the torque converters 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.

9.3.2 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 non-corrosive to transmission components made of steel, cast iron, malleable cast iron, brass, copper, aluminium etc. The additives should remain uniformly dissolved or dispersed upto temperatures of the order of 150°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°C-130°C and the air separation properties should be extensively good.

9.3.3 Apart from the general requirements, a transmission oil must pass a severe test for 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.

9.3.4 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.

9.3.5 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.

9.4 Greases :

9.4.1 Greases are semi-solids or solids at room temperature but provide fluid lubrication in the bearing. They are of two kinds:

- (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.
- (2) The second type, 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 the bearing and acting, in effect as a thick oil. The composition of most greases is 65 to 90 per cent 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.

9.4.2 Greases are normally classified according to the type of soap used. The main types are as follows:

9.4.2.1 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 conditions 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°C. These greases are used for general lubrication purposes such as plain shaft bearings and guideways.

9.4.2.2 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 up to and beyond their melting point. The sodium soap used is soluble in water and a 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.

9.4.2.3 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°C to 120°C or higher. The proportion of lime soap is normally very low, so that the characteristics are substantially those of a soda grease.

9.4.2.4 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 locomotives. 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.

9.4.2.5 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°C to 150°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 anti-friction bearing lubrication.

9.4.2.6 Aluminium-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.

9.4.2.7 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 breakdown 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°C. It is suitable for anti-friction bearing use.

9.5 Storage, Handling and Dispensing of Lubricants in Running Sheds :

9.5.1 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 the handling and dispensing of lubricants which are the very life of diesel engines and locomotive components.

9.5.2 Storage of oils received in Drums :

9.5.2.1 The drums should be stored preferably under proper cover.

9.5.2.2 If storage in the open is unavoidable, the following precautions should be taken:

- (1) Drums should be stored on their sides or bilges.
- (2) Wooden dunnage should be used to keep them clear of the ground and to prevent rusting of the underside.
- (3) Drums should never be stacked directly on a surface containing clinker, as this particularly corrosive to metal.
- (4) The drums at each end of the stack must be securely wedged to prevent movement.
- (5) Drums can be stored either in a single layer or in tiers with wooden battens between the layers, but three layers is the maximum.
- (6) Drums of different brands of oils should be stored at separate places marked for each brand.

9.5.3 Storage of Smaller Packages :

9.5.3.1 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.

9.5.3.2 Packages of different brands of lubricants should be stored separately at places marked for each brand.

9.5.4 Dimensioning of Lubricating Oils :

9.5.4.1 Out of the various oils used in a diesel locomotive, engine lubricating oil has the maximum and a sizeable consumption. This oil is issued for the following two purposes:

- (1) For renewing engine lubricating oil, which requires comparatively large quantities at a time.
- (2) For topping up, requiring a few litres each time.

9.5.4.2 Renewing the Engine lubricating oil for large consumptions:

In sheds where locomotives 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:

- (1) 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.
- (2) Tank should be made of steel and not galvanised iron as oil may react with zinc.
- (3) The bottom of the tank should be slightly sloping to allow easy cleaning.
- (4) The tank should have the following fittings:
 - (a) a gauge glass, calibrated in litres ;
 - (b) a vent at the top to take care of breathing ;
 - (c) a drain plug at the lowest level at the bottom ;
 - (d) a dust proof man-hole at the top ; and
 - (e) an outlet pipe about one inch above the bottom.
- (5) 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.
- (6) The pipe lines at the platforms may be connected at two or three places (depending upon the number of locomotives 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.
- (7) 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.

- (8) 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.

9.5.4.3 *Renewing the Engine Lubricating Oil :*

(Alternative method for smaller consumptions).

In sheds, which have less than 20 locomotives or different makes of diesel engines using different brands of oils, so that the consumption of each brand of oil is small, the following should be adopted:

- (1) 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.
- (2) Separate trollies should be used for each brand of engine oil.
- (3) The trollies should be painted with distinguishing colour and the brand of oil should be written over the trollies.
- (4) 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.

9.5.5 *Lubricants for topping up or for small consumptions :*

9.5.5.1 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 split oil can be easily removed. The room should be dust-proof to the extent possible.

9.5.5.2 In this oil room, one drum of each brand of oil should be placed on a wooden or steel cradle.

9.5.5.3 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.

9.5.5.4 The drums should be fitted with drum taps.

9.5.5.5 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.

9.5.5.6 For each oil two or three measuring cans capacity 2.5, 5 and 10 litres, and having flap covers should be provided. The cans must also be painted from 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.

9.5.5.7 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.

9.5.5.8 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.

9.5.5.9 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.

9.5.5.10 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.

9.5.6 *Greases :*

9.5.6.1 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.

9.5.6.2 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.

9.5.6.3 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.

9.5.6.4 One large metal spoon, preferably of stainless steel, should be kept inside each drum or container for taking out grease from it.

9.5.6.5 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.

9.5.6.6 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 locomotives 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.

9.5.7 General Instructions :

9.5.7.1 All oil and grease drums and other containers must never be left with their lids off.

9.5.7.2 All oil dispensing equipment 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.

9.5.7.3 The oil storage tank should also be cleaned once in six months by flushing with kerosene and removing the same completely before re-filling.

9.5.7.4 Cotton wastes or woollen rags should never be used by those handling lubricants, as these tend to leave behind fibrous particles which eventually find their way into the diesel engines and impair circulation of oil.

9.5.7.5 Oil soaked rags should never be allowed to accumulate in the oil room, as they are liable to give rise to spontaneous combustion.

9.5.7.6 Fire extinguishing equipment should be provided inside as well as outside the oil room, in consultation with the fire fighting authorities.

9.5.7.7 Lubrication charts should be hung on the walls in the shed, giving the type of lubricants and the parts of the locomotives in which they are used.

9.5.7.8 Each storage drum, tank, etc. and the dispensing equipment should be painted according to the STANDARD colour scheme to avoid mixing of the lubricants

9.5.7.9 A system of rotation should be used as a safeguard against the accumulation of old stock.

9.5.8 Storage of Used Engine Lubricating Oil :

9.5.8.1 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 a 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 :

- (1) 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.
- (2) 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.
- (3) 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 lubrication of carriage and wagon axles. This process of segregation will also increase the efficiency of the re-refining process.

9.6 Testing of used Engine Lubricating Oils :

9.6.1 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 physico-chemical analysis of samples of the oil at regular interval in service.

9.6.2 Some of the test methods employed and their significance are given below :

9.6.2.1 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.

9.6.2.2 Viscosity : Viscosity of the oil is affected by both physical factors (i.e. contamination) and chemical factors (oxidation). Contamination by unburnt fuel lowers the viscosity while particular contaminants tend to increase it. 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

9.6.2.3 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 unburnt fuel condensed on the walls or through blowby. 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.

9.6.2.4 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.

9.6.2.5 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 temp. 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 has also 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).

9.6.2.6 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 pH 4, which is indicative of negligible presence of strong acids. Strong acids are harmful to the bearings and cause troublesome engine deposits.

9.6.2.7 TBN: TBN of the lube oil is a measure of the potential of the oil to neutralise 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 overbased Calcium/Barium sulphonate type of additives. High TBN oils are also found to minimise 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".

9.6.2.8 Oil Insolubles: The suspended and partly dissolved contaminating matter in the oil contributed by air borne dust, fuel carbon, highly carbonised 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 for the diesel engines using higher detergency oils such as MIL-L-2104 B level oils:

Hexane/Pentane isolubles	— upto 3.5%
Benzene insolubles	— upto 2.5%
Resins	— 0.5%

However, these limits have to be specified separately for each oil and the engine in which it is used.

9.6.2.9 Blotter Spot Test:

- (1) There is no dispensancy 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 the oil and the entrained carbon particles will have diffused into the pores of the filter paper. An examination of the oil spot shows:
 - (a) A central zone with light or dark centre called the drop core.
 - (b) A dark HALO surrounding the central zone (drop core).
 - (c) A zone of diffusion outside the halo.
 - (d) A translucent area soaked with oil outside the diffusion zone.
- (2) The information is particularly useful when the blotter spot tests are carried out on a regular interval.
 - (a) Contamination with the insolubles (primarily combustion spot) is judged by the lightness or darkness of the Central Zone.
 - (b) 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.
 - (c) 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).
 - (d) The presence of fuel oil in the lube oil is indicated by divergent and irregular drop core. The out zone is also comparatively dark.
 - (e) Water has the effect of imparting a clearly defined boundry to the Central Zone. The size of the drop halo is smaller than normal. The centre is heavy block.

9.6.2.10 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.

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 Loco Foreman 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.

9.6.3 Procedure for Drawing Samples of Engine Lubricating Oils :

9.6.3.1 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 sampling and it should only be undertaken by persons who are specially trained in it and with the proper equipment.

9.6.3.2 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.

9.6.3.3 The following points should be rigidly observed while taking sample :

- (1) 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.
- (2) Flush the syringe by filling and discharging it back into the sump at twice before drawing the final sample.
- (3) Use a clean and dry container for the sample and only fill it 2/3rd full, so as to facilitate shaking of the oil prior to testing.
- (4) 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.
- (5) The sampling operation **MUST** be carried out before the addition of topping-up oil.
- (6) For ease of identification, each container must be properly marked with locomotive number, date sample drawn etc.

● ● ●

CHAPTER 10

SAFETY—SCOPE, ORGANISATION, PREVENTION OF FIRE, ROAD ACCIDENTS, SALVAGE PROCEDURES

10. Safety

10.1 Scope—This chapter covers.

10.1.1 Industrial safety as applicable within the shed boundaries.

10.1.2 Industrial safety as applicable on the diesel units.

10.1.3 Safety posting units for repairs, movement within shed boundaries.

10.1.4 Procedures of dealing with road accidents.

10.2 While running sheds do not work under the purview of the Factories Act but it is preferable to use the guide lines of this act for observing industrial safety. The provisions regarding guarding belt drivers, securely fencing off rotating equipment, use of protective equipment, proper ventilation, in handling solvents, acids etc. should be scrupulously observed.

10.3 It will be the duty of each section-in-charge to ensure that protective equipment and safe practises are observed within his section. For this purpose he will be carefully briefed in organised training courses as to what are the special precautions that he has to take. He will be able to draw assistance from the Millwright for protective fencing, guards etc. Lifting equipment should be correctly used and periodically attended and tested as per regulations on the railway. The supervisor and some of his men should be trained in firefighting, first aid etc. Periodic refresher courses should be used to keep them in readiness.

10.4 Prevention of Fire.

The fire prevention and fire fighting officer of the operating division will be responsible for the provision, maintenance and operation of the fire prevention and fire fighting equipment and organisation in the Diesel maintenance depots. Some of the important features are listed below.

10.4.1 One or more mobile units, fully equipped to deal with B class fires, should be manned round the clock.

10.4.2 A proper network of approach roads, static tanks at suitable locations should be available. If not included in the original plan

these measures should be designed and completed as early as possible.

10.4.3 Equipment, maintained in good order, regularly tested should be available at selected locations.

10.4.4 Apart from the regular fire fighting staff of ASO (Fire), shed supervisors and a nucleus of staff in every section should be trained to handle B Class fires. Regular refresher courses should be arranged.

10.4.5 The ASO (Fire) and his nominated inspector should make periodic inspection of the premises to check correct working practises, particularly stocking of combustible material and suitably guide the shed organisation.

10.5 Fire fighting equipment suitable for B Class equipment have to be provided on locomotives. While these will be maintained by shed staff but the ASO(Fires) organisation will oversee that correct practices are being followed.

10.6 The large stocks of combustibles such as HSD oil, lubricants, solvents in typical maintenance depots are a special responsibility of the ASO (Fire). He should be fully associated in the construction stage and follow up through regular works progress to update the stocking and handling facilities.

10.7 Operational safety in spotting, moving units for servicing and repairs are a special responsibility of the shed ALF. This is ensured by clearly demarkating areas and allotting one shunter per nominated area. Long experience has proved out this practise. No movement within the prescribed area is permitted except when the nominated shunter is operating the unit. Drivers must be invariably piloted by the nominated shunter of the area when inside shed boundaries. Actual operation of the unit should be entrusted to this shunter.

10.8 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 maintenance depots for isolating traction motors etc. Each maintenance depot should have an arrangement by which nominated inspector, supervisor and staff with correct equipment can be washed out by the ALF when required.

● ● ●

CHAPTER 11

MISCELLANEOUS—MODIFICATIONS AND TRIALS

11.1 Modifications

11.1.1 All modifications for Diesel Locos shall be carried out only with the authorisation of CME.

11.1.2 The modification carried out by the Railway shall be advised to RDSO and shall be discussed in the ensuing DMG Meeting after which the modification if found beneficial under the varying conditions of service existing on all Indian Railways, will be standardised by RDSO. Board also will consider and on approval, will advise DLW to effect modification on their builds. If, however, the utility of modification is concerned to the respective Railway according to the varying conditions of service, the said modification need not be generalised and will continue in that particular Railway as authorised by CME.

11.1.3 All modifications shall be serially numbered and entered in a modification register maintained in CME's office. A card shall be opened for each modification wherein the description of the modification, drawing No., Reasons for modification, when to be carried out, individual Loco Number and date modified and class of loco shall be made available. A specimen card is also enclosed at Annexure I.

11.2 Trials :

11.2.1 All Developmental items must be put on trial before their suitability is established. Developmental orders should be placed by COS in consultation with CME and a copy of the Purchase Order in respect of these items is to be forwarded to CME's Office. In case sheds desire that a particular component is to be tried out on locomotives, the sheds concerned shall approach CME for placing a developmental order and on no account sheds are authorised to initiate trials without the prior approval of CME in writing. No free samples offered by the firm are to be accepted for trials by sheds/Shops without the prior approval of CME/COS. A particular shed will be nominated by CME for placing indents in respect of the developmental fitting, proposed to be undertaken for trial. Necessary advice will be sent from CME's office for the distribution of trial fittings to the sheds, on receipt of the Purchase Order and the shed concerned shall advise CME's office on receipt of the trial fitting and after distribution to various sheds as called for.

11.2.2 In order to prevent the mix up of the trial fitting with similar components already available in the shed, the trial fittings should not be kept in the same bin and kept separately till such time advice is received from CME's office regarding fitting up of the same in a locomotive.

11.2.3. CME's office shall advise sheds on receipt of information about the supply of trial fittings to provide them on locos depending upon the availability of such components, together with a proforma as per annexure II calling for details such as :

- (i) Loco No. on which the trial fitting is provided.
- (ii) Particulars of trial fitting.
- (iii) Date of fitment.
- (iv) Duration of the trial.
- (v) Frequency for advising for trial report with details of particulars to be watched and advised.
- (vi) Remarks and observations about the component under trial.

11.2.4 Sheds concerned shall report the individual No. of locos provided with the trial fitting to CME's office for following up of the trials ordered.

11.2.5 In respect of shop manufactured items, shops shall provide the trial fittings on locos after obtaining the specific approval of CME and advise concerned sheds and CME's office about the date on which the particular loco has been turned out with the trial fitting so as to issue necessary proforma to sheds for submission of details regarding performance of the trial fitting. A card will also be opened incorporating all the above details in CME's office where the observations of the shed will be entered as and when received. Each trial fitting ordered will be serially numbered and classified under each group to which the component belongs, on both Broad and Metre Gauge. The following example is given for illustration :

Trial No. M/DSL/DE/B or M/1

M—Mechanical Branch.

DSL—Represents Diesel loco.

DE—Group under which the component is classified.

B—B.G.

M—M.G.

11.2.6 In case the components is common for both BG & MG, then 'BM' will be used while allotting the number.

11.2.7 Based on the observations received from sheds from time to time, the final decision regarding the performance of the trial fitting will be taken by the CME, who will also decide about the inclusion of the firm in the list of likely suppliers in consultation with DLW/CLW wherever considered necessary for that particular component tried out, for further procurement. This will be advised to DLW/CLW for incorporating name of the firm in the approved list of suppliers for such components.

11.2.8 The sheds/shops should not advise outside bodies directly regarding the results of the trial. When a component procured against developmental order is under trial, further procurement of the same item from the same source, should not normally be undertaken till such time the performance of the trial fitting is assessed.

A cell will be constituted in CME's office.

11.3 Pre-commissioning checks on new locos received from DLW.

A new locomotive received from DLW shall be thoroughly examined before commissioning and release for traffic.

The important items to be checked and adjusted are shown in Annexure III and Annexure IV.

11.4 Checks to be carried out in shed for a loco turned out after POH.

A locomotive turned out from POH is shops shall require minimum check and adjustments in shed before releasing for traffic.

The important items to be checked and adjusted are shown in Annexure V and Annexure VI.

Normally one day may be allowed for the diesel shed for carrying out the above checks and releasing for traffic.

● ● ●

RAILWAY

MODIFICATION TO LOCOS

Modification No.

ANNEXURE—I

MODIFICATION TO DIESEL LOCOS						
CLASS OF LOCO.	MODIFICATION No.					
REFERENCE	R.D.S.O. Letter No. G.M. (M)/MAS LETTER No.					
DESCRIPTION OF MODIFICATION						
DRAWING No.	REASON FOR MODIFICATION					
WHEN TO BE CARRIED OUT						
INDIVIDUAL No. AND DATE MODIFIED						

INDIVIDUAL No. AND DATE MODIFIED

--	--	--	--	--	--	--	--

[illegible]

ANNEXURE II

Trial No.

Loco No. on which trial fitting is provided.

Date fitted.

Duration of Trial.

Particulars of the trial fitting.

Details of particulars to be watched.

Remarks & Observations :

M/DSL/TC/

TRIAL REPORT CARD

TRIAL FITTING—DESCRIPTION

TRIAL NO.

LOCO NO.

DATE FITTED

DURATION OF TRIAL

SUBMISSION OF PERIODICAL REPORTS

MONTHLY/QUARTERLY/HALF YEARLY/ANNUALLY

Details of Particulars to be watched

Remarks & observations

Signature

ANNEXURE III

PRE-COMMISSIONING CHECKS TO BE MADE ON LOCOS RECEIVED FROM DLW (MECHANICAL SIDE)

1. Remove valve lever mechanism and examine valve lever seats and push rods.
2. Remove water inlet jumpers with signs of leakage and replace with proper gaskets and set screws.
3. Remove sump covers, and examine con. rods, con. rod bolt split pins and sump cover screws.
4. Remove and overhaul test the plunger in Zyglo before fitment.
5. Examine Glacier bearings. No. 2 and 7 main bearings and refit.
6. Examine the radiators fins and tubes and attend damaged portion if any.
7. Remove one radiator to facilitate welding of angles at the base of the RTTM blower and ensure water entry into traction motor ducts, Prevented.
8. Remove fuel pump supports examine push rod lifter seats etc. and refit.
9. Remove the lube oil pump and remake the front cover and flange joints.
10. Align all lube oil pipe lines and ensure no leakage.
11. Ensure bypass line anchoring brackets are secured properly and weld.
12. Align properly RTTM blower.
13. Remove lube oil relief and regulating valve. Check the settings and test before fitment.
14. Examine the universal shafts in position and grease.
15. Check for proper operation of LWS float.
16. Remove all the Fuel injection pumps. check calibration.
17. Remove fuel injection nozzles and test for proper functioning.
18. Replace brass adapters of cross over pipe by steel adapters.
19. Examine needle bearing in Fuel pump linkage and renew if necessary.
20. Examine the Governor output shaft for bend etc. renew if necessary.
21. Remove turbo, overhaul, and examine the condition of bearings.
22. Drain the fuel oil completely, flush the tank to remove sludge and foreign material.
23. Remove fuel booster pump, overhaul, test and fit.
24. Remove fuel relief and regulating valves, test and fit.
25. Remove copper pipes in fuel system, examine anneal and fit.
26. Secure fuel filling strainers properly and weld in position with suitable adapter for fuelling.
27. Open all the brake cylinders and examine piston cups for proper greasing.
28. Check and modify the brake block keys fitted at DLW if necessary.
29. Examine axle journals in position. Remove suspension bearings in case of flaking of bearing metal. Ensure proper sealing of wickpads.
30. Examine the roller bearings in position and grease.
31. Modify the compensating beam bolt.
32. Remove VAIB, 28 VB, A9, SA9, C2 relay HD5, H5A overhaul and refit.
33. Remove wind shields viper assembly and vigilance valves, overhaul and refit.
34. Check Ni reducing valve and renew if necessary.
35. Remove acceleration control device overhaul and refit. Renew diaphragms if necessary.
36. Test and match the air brake system gauges.
37. Examine the expressor sump, chain, counter-weight etc.
38. Check expressor valves and ensure for its proper condition.
39. Regrease fast couplings.
40. Ensure ladders, cab fittings and door locks are welded in position.
41. Check mechanical speedometer drive and speedometer condition.

ANNEXURE IV

PRE-COMMISSIONING CHECKS ON LOCOS RECEIVED FROM DLW (ELECT.)

Electrical

1. Attention to Traction Motors

- (a) Check Tr. Motor cables connections for correct shoe crimping, proper layout, check brush gear and the tie pigtails, blow out, and attend, check banding.

2. Traction Generator

- (a) Check all connections and banding, check correct staggering. Apply Araldite to V Ring band. Blow out, clean and attend air cure.

3. Major Auxiliaries (Ex. Gen. Aux. Gen. BK. BL. & ECC)

- (a) Unload Aux. Gen. and Ex. Gen. for brush gear modification and load back.
- (b) Check up grids, Blower motor and ECC.

4. Governor

- (a) Unload Governor, test in test stand and refit.
- (b) Remove Gov. Pump, modify, test and refit.
- (c) Check Gov., hose pipe, Amp. plug, oil filling up.

5. Minor Auxiliaries (CCB-Motor, FPM, TG, Ax. Alt.)

- (a) Unload all the above, over haul, test in test stand and fit back.

6. Batteries

- (a) Unload, correct Elec. level and sp. gravity.
- (b) Give booster charge and reload.

7. Control compartment

- (a) Strip out from loco power contractor, magnetic contractors, relays, panels, meters, overhaul, test, calibrate and refit to loco.
- (b) Modify interlock fingers by applying araldite to springs.
- (c) Test 'E' type cards in testing panel.
- (d) Remove Master control and provide stopper pin for master control.
- (e) Strip out power contactors air engine and clean the rusty surface.
- (f) Clean ultrasonically all rusted interlocks, shuts etc.
- (g) Check for proper crimping of all control and power cables.
- (h) Shift stops to control compartment.
- (i) Modify Gauge lights to 75V.
- (j) Relocate load ammeter resistance.

8. Testing Take IR value.

Sequence checking, cranking, testing and adjusting to be carried in order. Test in Load box before and after precommissioning check.

ANNEXURE V

PRE-COMMISSIONING CHECKS ON LOCOS RECEIVED AFTER POH (MECH. SIDE)

1. Check tappet clearance.

2. Examine the engine sump.

3. Check water inlet jumper for leak and renew if necessary.

4. Examine OST plunger and fit.

5. Check water pump performance.

6. Check fuel system with bleed kit and pipe line etc. for proper maintenance of pressure.

7. Check and grease universal shafts and fast coupling.

8. Examine expressor sump, pump chain and counter weight etc.

9. Remove the wickpad and examine the journals. If any metal flanking etc. renew suspension bearings.

10. Examine axle roller bearings in position and grease if necessary.

11. Remove Air brake valves VAIB, 28 VB, C2 relay, RB5 and H5A overhaul and refit.

ANNEXURE VI

PRE-COMMISSIONING CHECKS ON LOCOS RECEIVED AFTER POH (ELECT. SIDE)

1. *Traction Motor*
 - (a) Check enables, cable layout, cable shoes etc.
 - (b) Check proper cable supporting cleats.
 - (c) Tie up pig tails of carbon brushes.
 - (d) Check up the tightness of cable connections.
2. *Traction Generator*
 - (a) General examination and tightness checking.
 - (b) Check up brush gears and staggering.
 - (c) Record IR value.
 - (d) Air cure.
3. *Major Auxiliaries*
 - (a) Unload grids and check up the condition.
 - (b) Check up grid connections and continuity of the grid cables.
 - (c) General check up for Aux. Gen., Ex. Gen., ECCRKBL and their connections.
 - (d) Record IR value of all the above.
4. *Batteries*

Blow out, clean, record Electrolyte level and Sp. gravity correct if necessary.
5. *Control Equipment.*
 - (a) Remove all meters, calibrate and fit back.
 - (b) Remove OPS, PCS, LWS, calibrate and fit back.
 - (c) Check up all the control cable shoes for proper crimping.
 - (d) Check up all power cables, Rev. & BKT connections for full tightness.
 - (e) Remove WSR 1, 2 & 3, GR & SAR. Check calibration and fit back.
 - (f) Remove RP, check calibration and fit back.
 - (g) Remove DMR and GF contactor — check for Araldite application at the seating of wipe spring. Test and fit back.
 - (h) Check up IR value of both power and control circuits.
 - (i) Check sequence of operation.
 - (j) Crank the engine and check up transition settings and DB calibration.
 - (k) Check up of settings of TS1, TS2 & ETS.
 - (l) Check up WSR drop.
 - (m) Load test and check the curve setting.

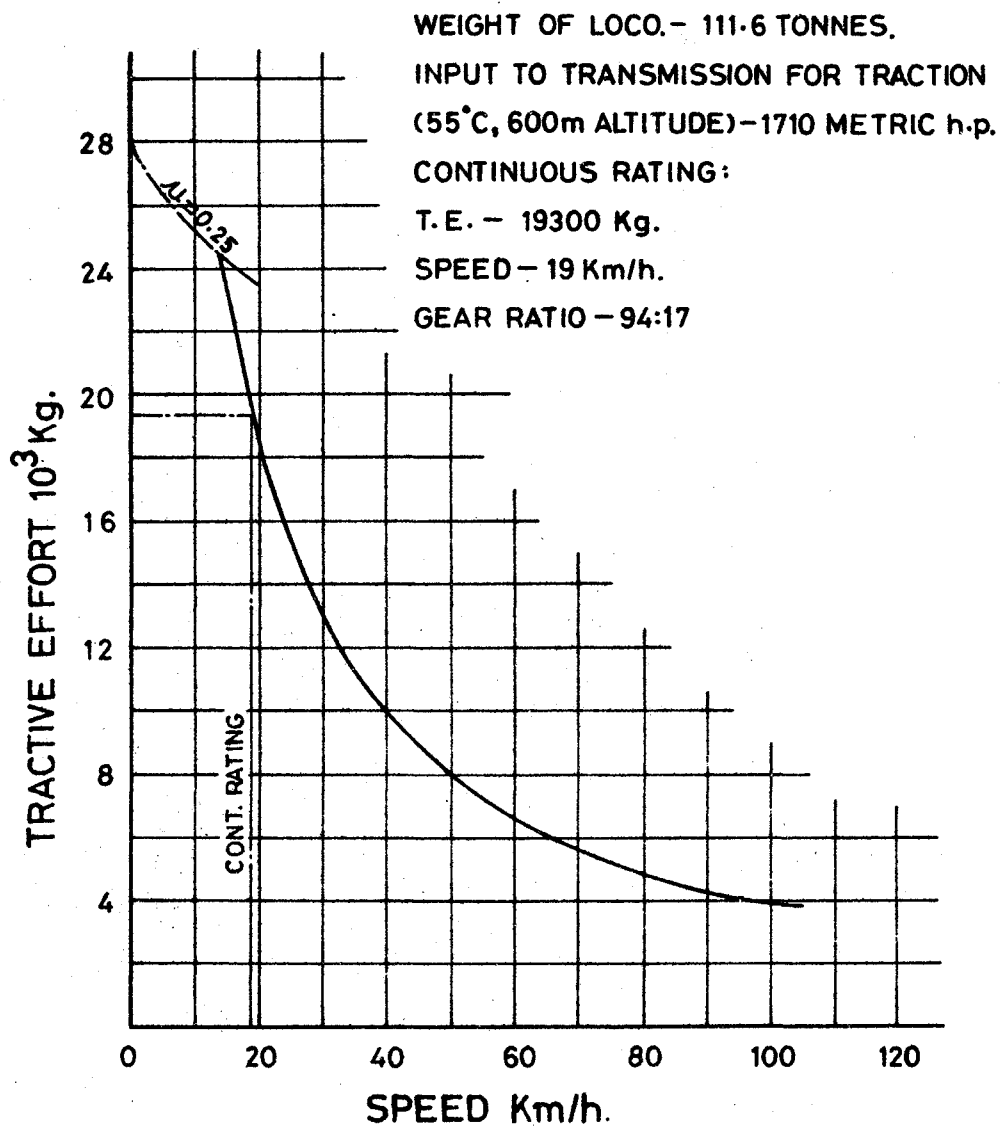
CHAPTER 12

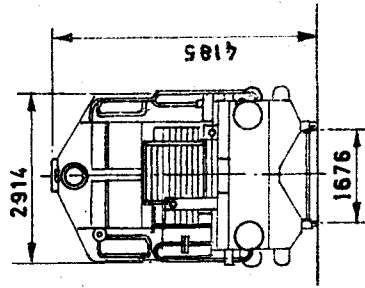
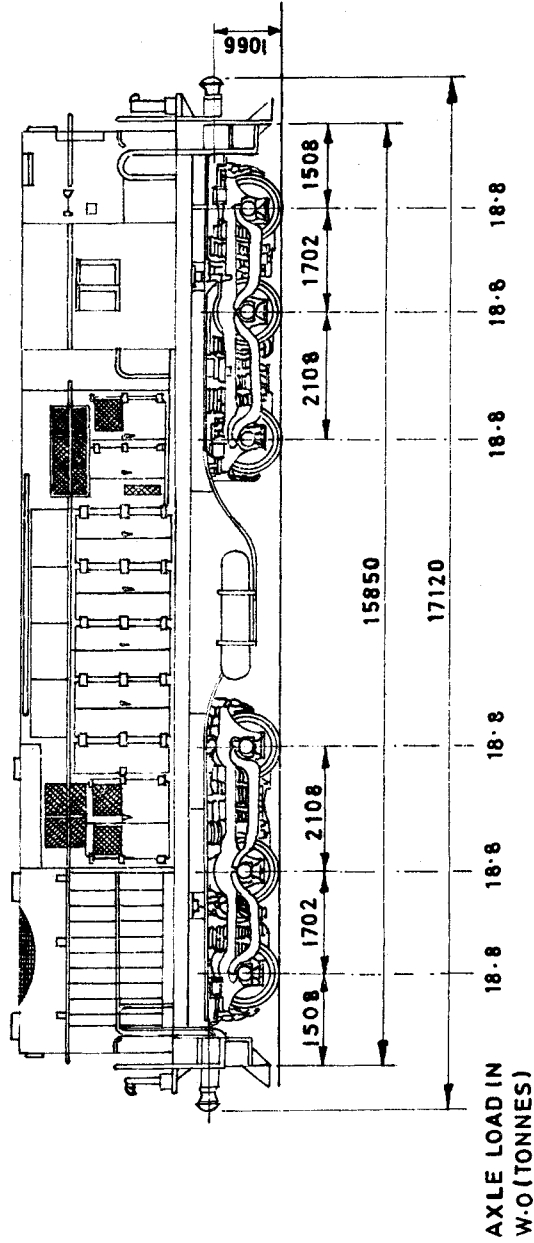
LOCOMOTIVE DATA



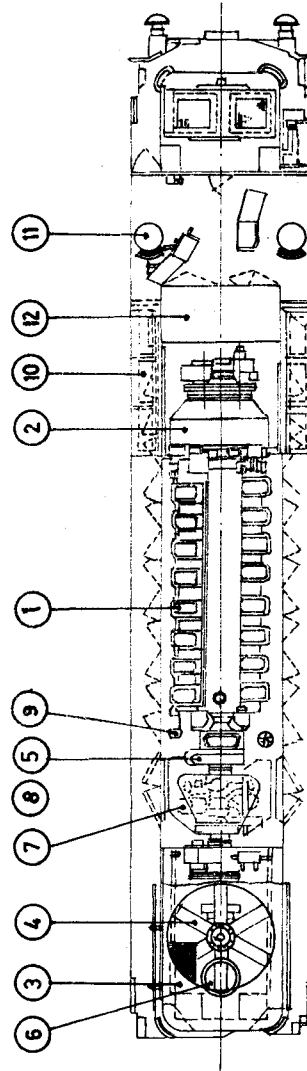
WDM₁

TRACTION EFFORT Vs SPEED CURVE.





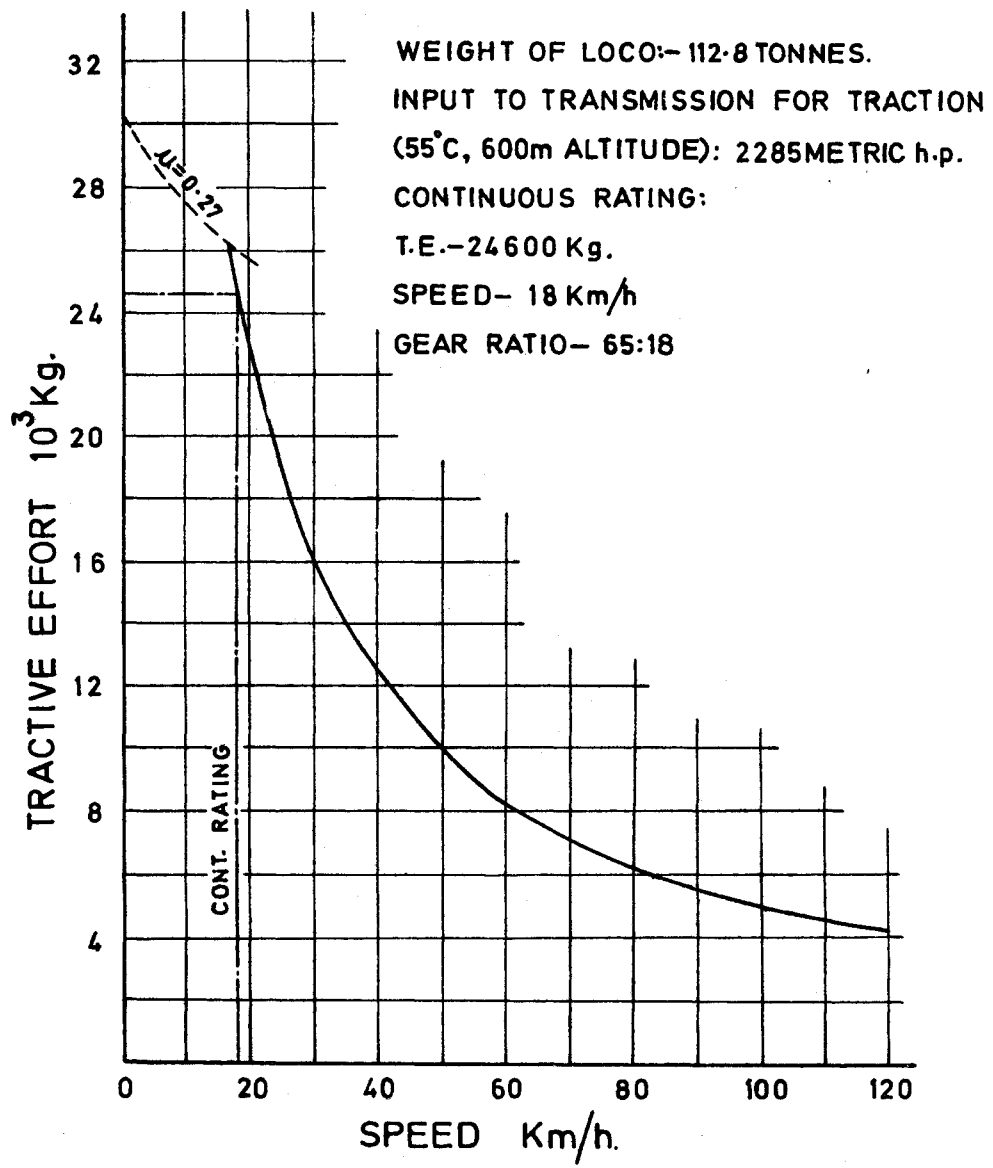
1. ENGINE
2. MAIN GENERATOR
3. RADIATOR
4. RADIATOR FAN
5. SUPER CHARGER
6. LUBE OIL FILTER
7. COMPRESSOR
8. EXHAUSTER
9. FUEL OIL FILTER
10. BATTERIES
11. DRIVER'S SEAT
12. CONTROL EQUIPMENT



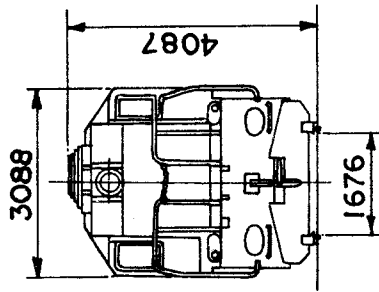
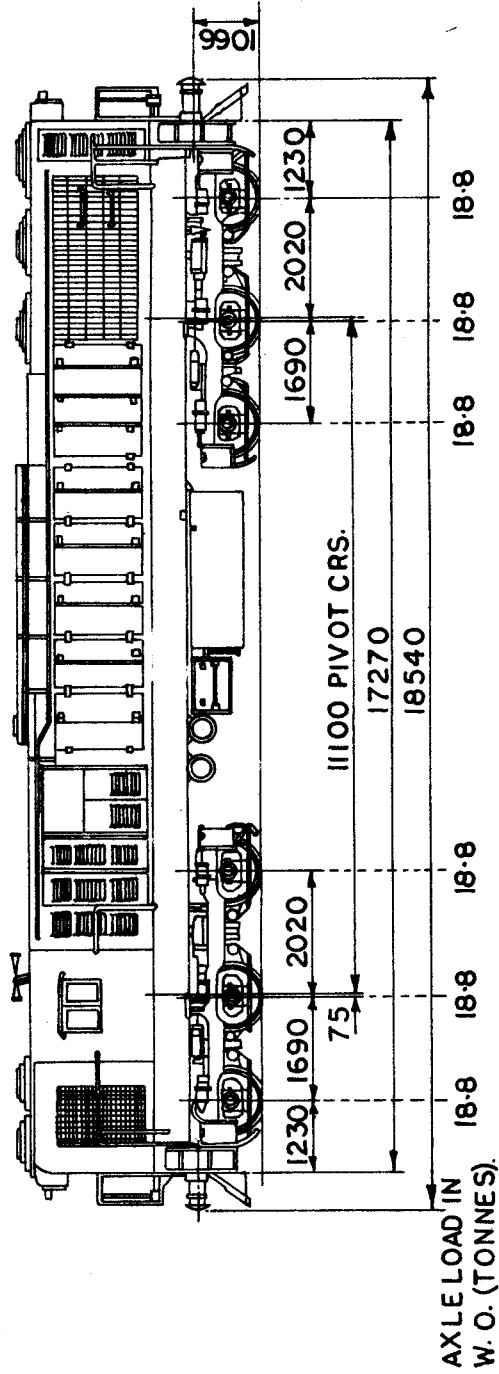
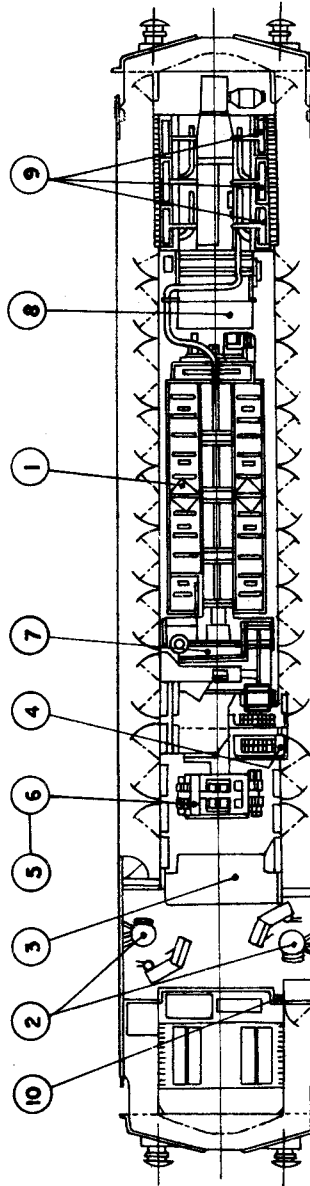
WDM₂ LOCOMOTIVE

WDM₂

TRACTIVE EFFORT VS. SPEED CURVE.



REF. DE/G-949.

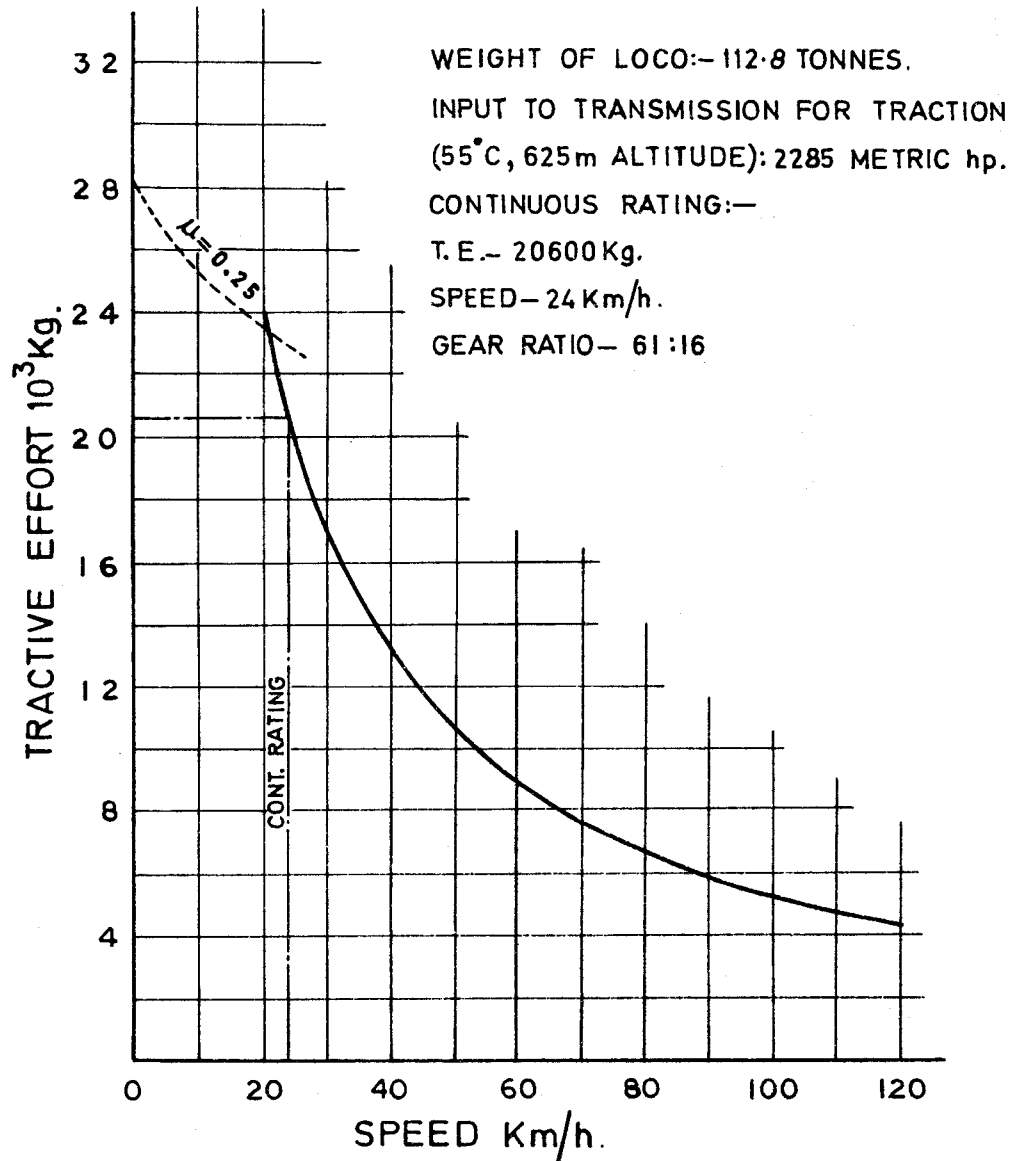


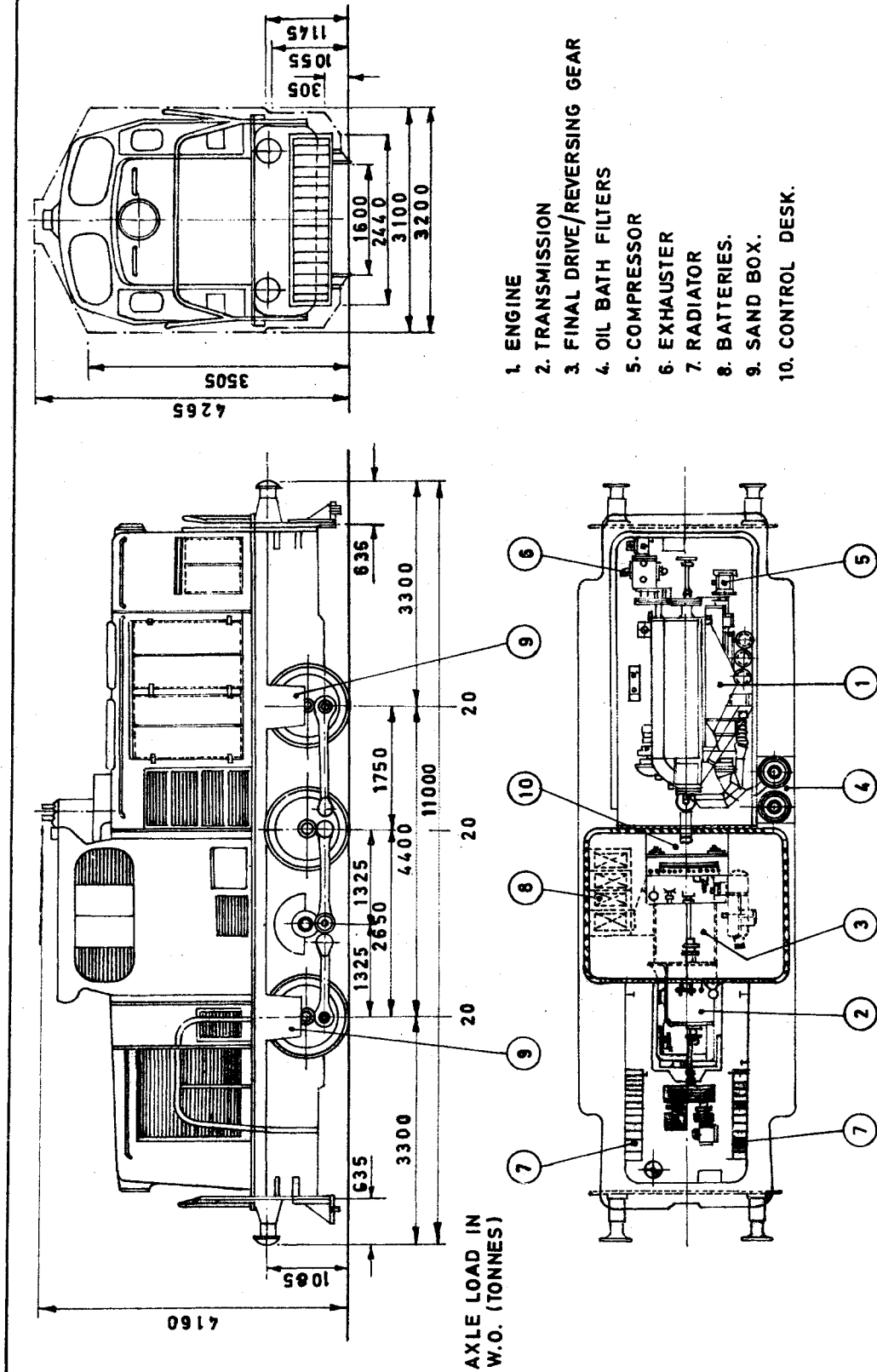
1. ENGINE.
2. DRIVER'S SEAT.
3. CONTROL EQUIPMENT ELECT.
4. TRACTION MOTOR BLOWER.
5. COMPRESSOR & EXHAUSTER.
6. SUPER CHARGER.
7. LUBE OIL FILTER.
8. RADIATORS.
9. HAND BRAKE.
- 10.

WDM₄ LOCOMOTIVE

WDM4

TRACTION EFFORT VS. SPEED CURVE





WDS4B LOCOMOTIVE

WDS4B

TRACTION EFFORT Vs. SPEED CURVE

WEIGHT OF LOCO:- 60 TONNES

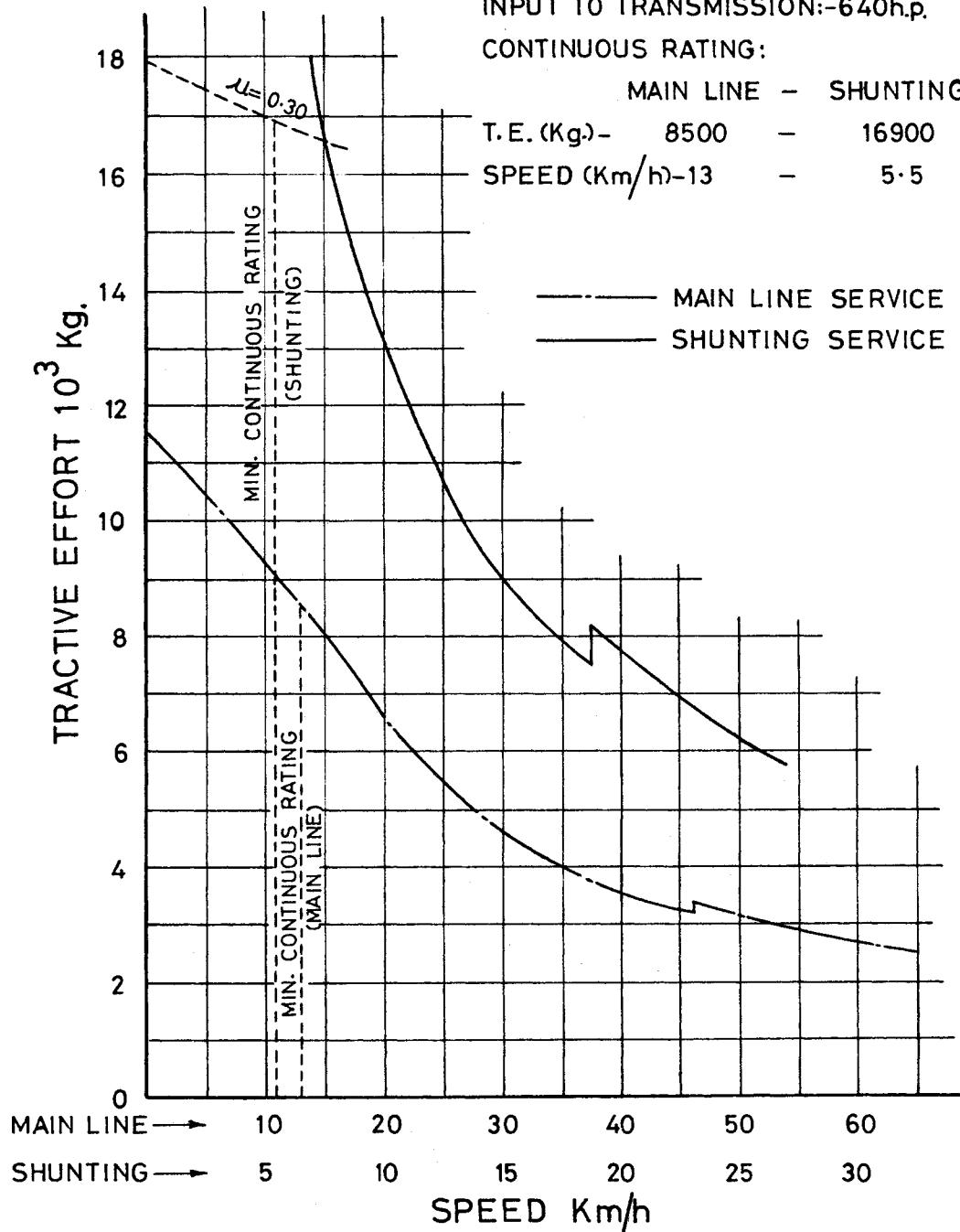
INPUT TO TRANSMISSION:- 640 h.p.

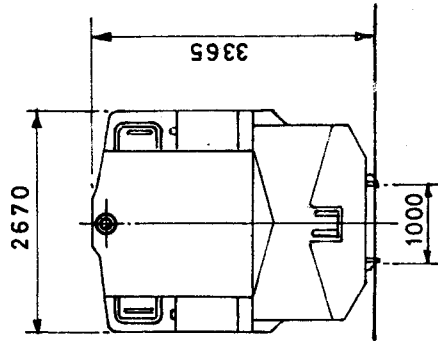
CONTINUOUS RATING:

MAIN LINE - SHUNTING

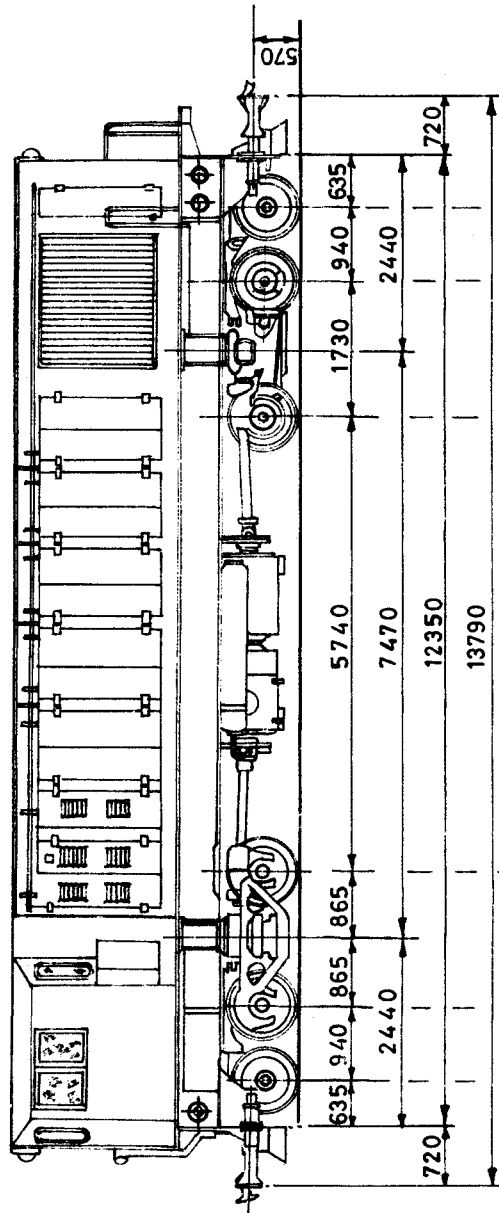
T. E. (Kg.) - 8500 - 16900

SPEED (Km/h) - 13 - 5.5

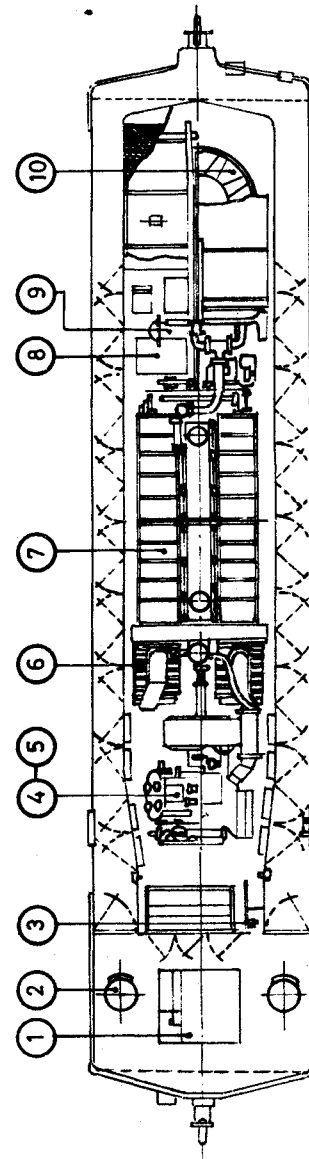




- 1 CONTROL EQUIPMENT
- 2 DRIVER'S SEAT
- 3 HAND BRAKE
- 4 COMPRESSOR
- 5 EXHAUSTER
- 6 SUPER CHARGER
- 7 ENGINE
- 8 ENGINE WATER TANK
- 9 LUBE OIL COOLER
- 10 RADIATOR FAN



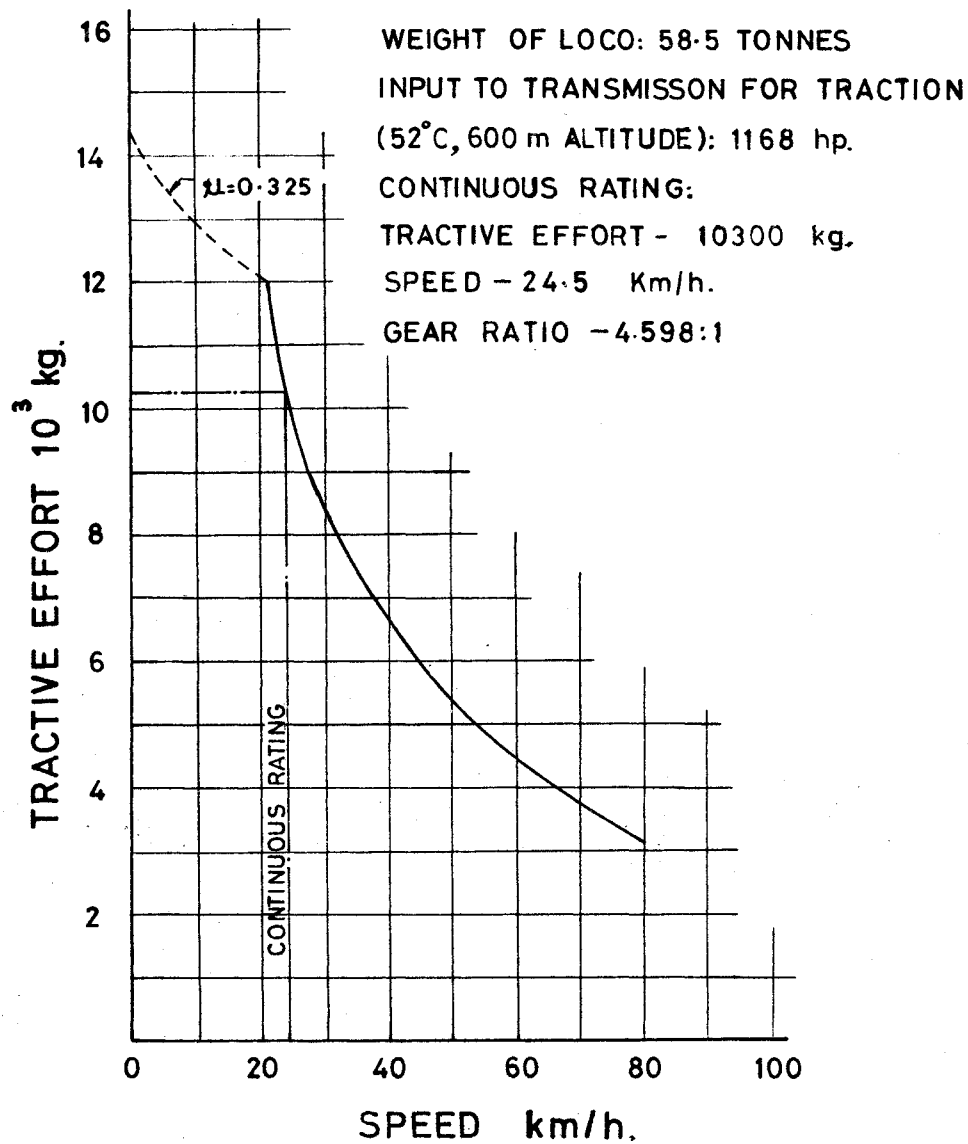
AXLE LOAD IN
W.O.(TONNES)

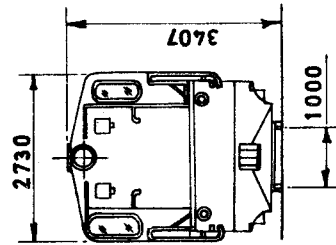


YDM3 LOCOMOTIVE

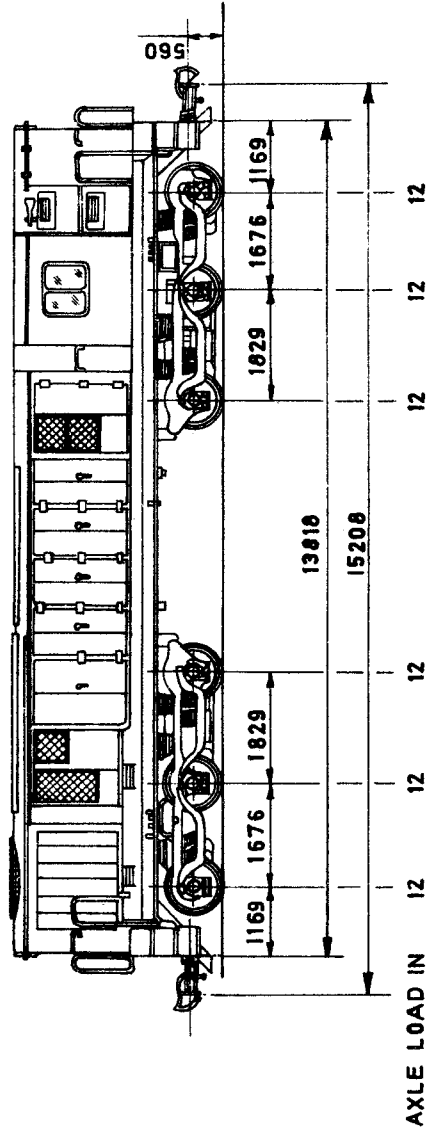
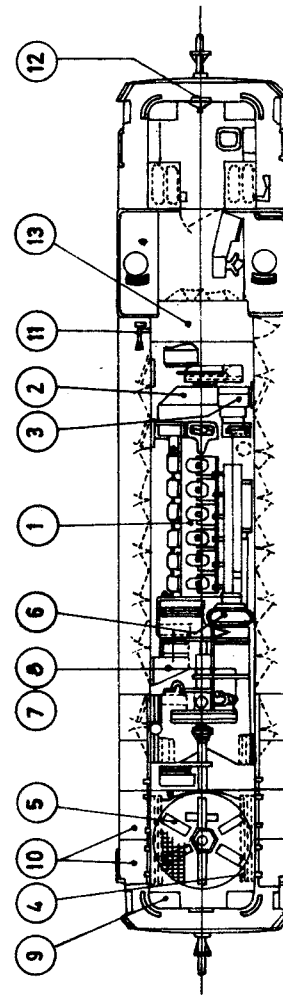
YDM₃

TRACTION EFFORT VS. SPEED CURVE





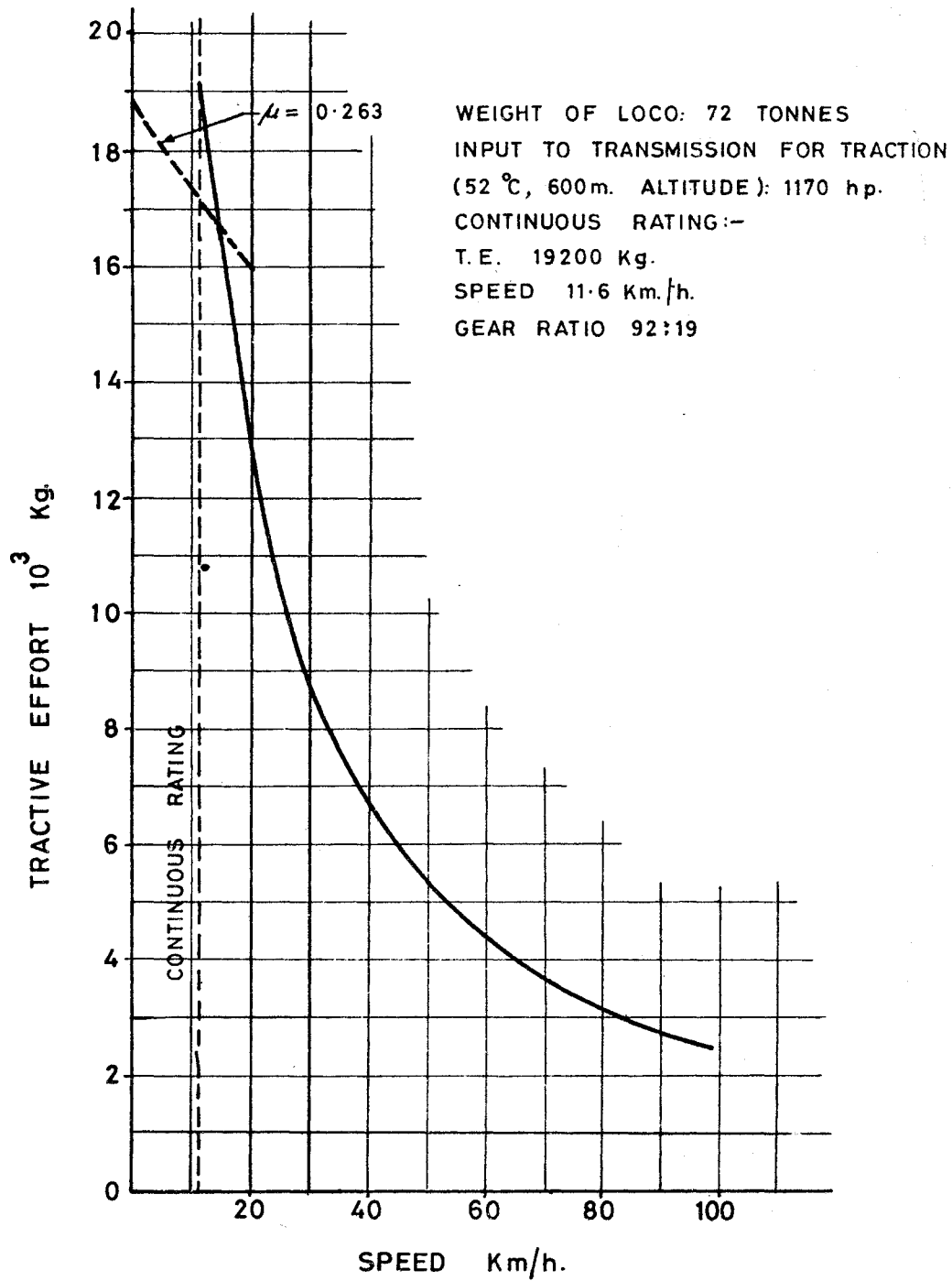
1. ENGINE
2. MAIN GENERATOR
3. EXCITER
4. RADIATOR
5. RADIATOR FAN
6. SUPER CHARGER
7. COMPRESSOR-EXHAUSTER
8. SAND BOX
9. BATTERIES
10. HORN
11. HEAD LIGHT
12. CONTROL EQUIPMENT

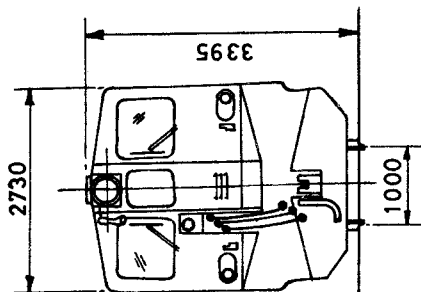


YDM₄ LOCOMOTIVE

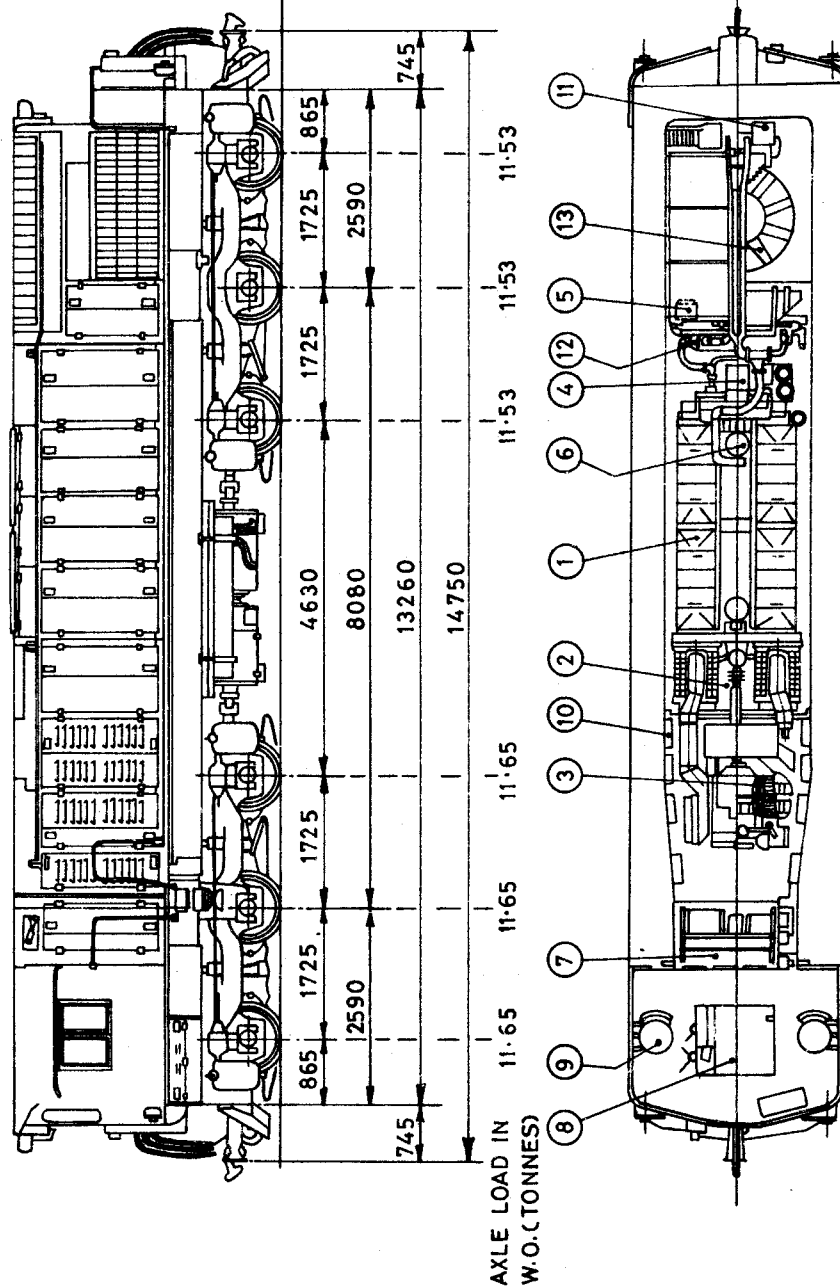
YDM₄

TRACTION EFFORT VS SPEED CURVE





1. ENGINE.
2. MAIN GENERATOR.
3. AIR COMPRESSOR AND EXHAUSTER.
4. ENGINE WATER TANK.
5. LOAD REGULATOR.
6. EXHAUST MANIFOLD.
7. ELECTRICAL CONTROL EQUIPMENT.
8. CONTROL DESK.
9. DRIVER'S SEAT.
10. ENGINE ROOM AIR FILTERS.
11. DYNAMIC BRAKE GRIDS & FAN.
12. LUBE OIL COOLER.
13. COOLING FAN.



YDM5 LOCOMOTIVE

YDM₅

TRACTIVE EFFORT VS. SPEED CURVE

WEIGHT OF LOCO:- 69.18 TONNES.

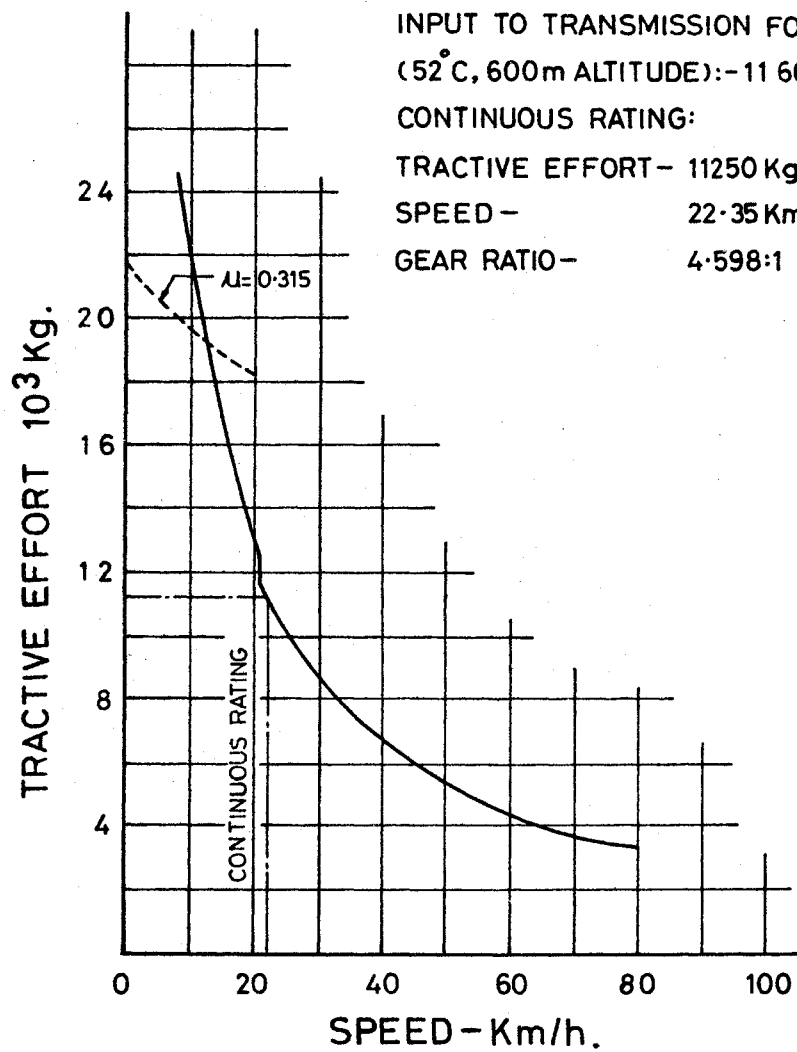
INPUT TO TRANSMISSION FOR TRACTION
(52°C, 600m ALTITUDE):- 11 66 METRIC h.p.

CONTINUOUS RATING:

TRACTIVE EFFORT - 11250 Kg.

SPEED - 22.35 Km/h.

GEAR RATIO - 4.598:1



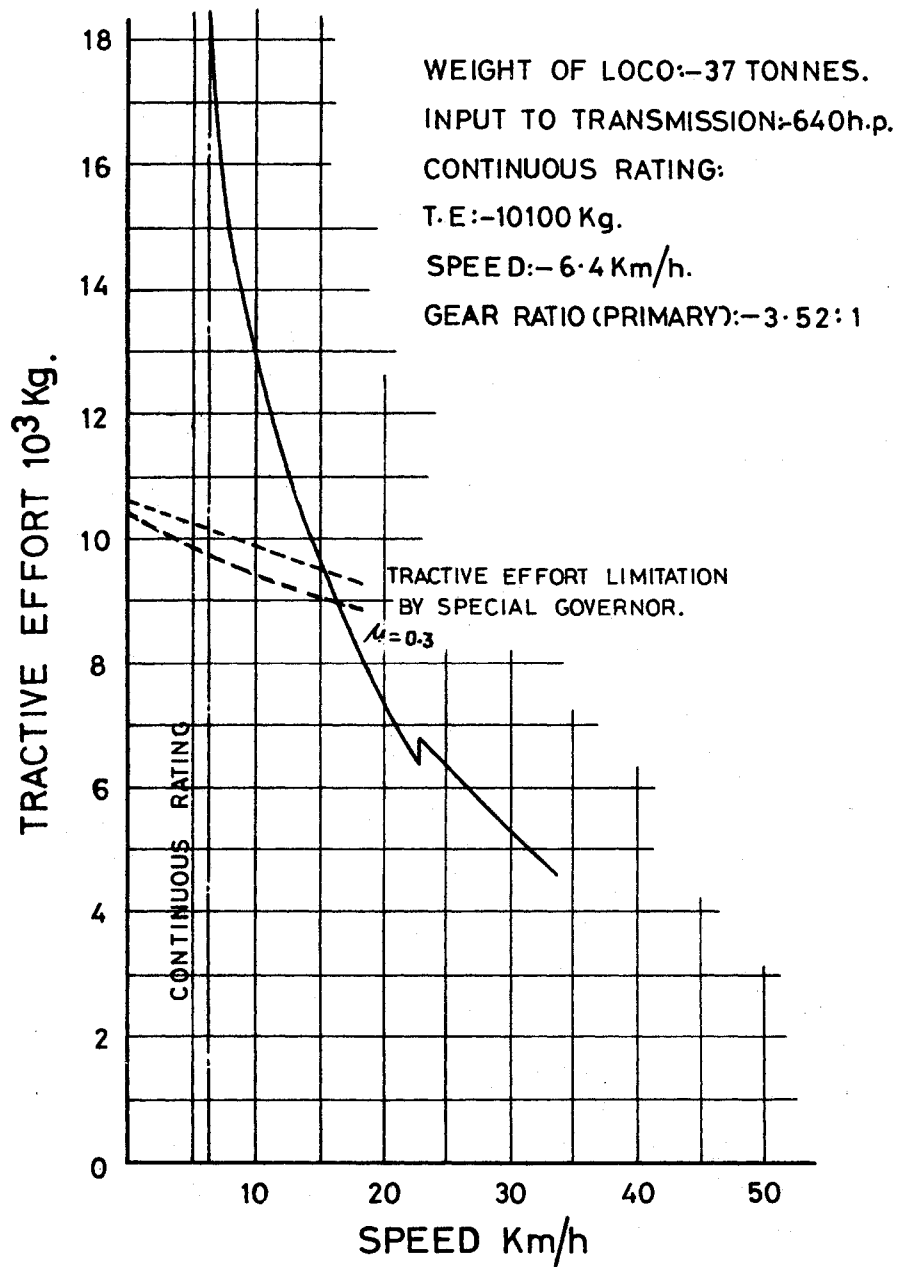
REF:- DE/G-968.

sahai r.p.⁷⁷



ZDM₃

TRACTIVE EFFORT Vs. SPEED CURVE



B.G. MAIN LINE

CLASS OF LOCO.		WDM	WDM ₂	WDM ₃	WDM ₄
MAIN PARTICULARS.					
NO. OF LOCOS.	AS ON 31-12-76	98	969	8	72
YEAR PUT ON LINE		1958/59	1962 Onwards	1970	1962/63
BUILDER		ALCO	ALCO/DLW	HENSCHEL	G.M., U.S.A.
WHEEL ARRANGEMENT		Co—Co	Co—Co	B'—B'	Co—Co
WT. IN WORKING ORDER (t)		111.6	112.8	76	112.8
MAX. AXLE LOAD (t)		18.6	18.8	19	18.8
LENGTH OVER HEAD STOCK (mm)		16777	15850	14800	17270
BOGIE WHEEL BASE (mm)		4191	3810	2800	3710
LOCO. WHEEL BASE (mm)		13392	12834	11400	14810
TRACTION EFFORT	MAXIMUM (Kg)	27900 (25% Adh.)	30450 (27% Adh.)	HSG : 22000 LSG : 25080 (33% Adh.)	28200 (25% Adh.)
	CONTINUOUS (Kg)	19300	24600	HSG : 14000 LSG : 20000	20600
SPEED Km/h	MAXIMUM	104	120	HSG : 120 LSG : 80	120
	CONTINUOUS	19	18	HSG : 28 LSG : 18.5	24
DIESEL ENGINE	MAKE	ALCO	ALCO/DLW	MTU	GM
	TYPE	251B—12 Cyl. 45°V	251 B—16 Cyl. 45°V	MD—108CZ 20CYI. 60°V	567 D3—16 Cyl. 45°V
	h.p.	1977 (15.6°C, SL)	2636 (15.6°C, SL)	2500 (UIC) at 1500 rpm	2636 (15.6°C, SL)
		1856 (55°C, 600m)	2430 (55°C, 600 m)	2440 (40°C, 1000m, 100% RH)	2434 (55°C, 625 m)
	R.P.M.	1000	1000	1600	835
		400	400	600	275
	SUPERCHARGER	ALCO—520	ALCO 710&720	MTUI Agl. 104	EMD, T-16
	WEIGHT DRY (Kg)	14682	19026	9250	15454
	TRANSMISSION	ELECTRIC	ELECTRIC	HYDRAULIC (2 Locos) HYD. MECH. (6 Locos)	ELECTRIC
	MAKE	GE	GE/HEIL	MTU	EMD, D-22
BRAKE	LOCO.	AIR, HAND & DYNAMIC	AIR, HAND & DYNAMIC	AIR, HAND & HYDRO- DYNAMIC	AIR, HAND & DYNAMIC
	TRAIN	VACUUM	VACUUM	AIR/VACUUM	VACUUM
MAIN PARTICULARS OF DIESEL LOCOMOTIVES ON INDIAN RAILWAYS					RDSO CH.DP.- 146
					SHEET 1 OF 5

B. G. SHUNTING

CLASS OF LOCO		WDS ₁	WDS ₂	WDS ₃	WDS ₄	
MAIN PARTICULARS						
NO. OF LOCOS. AS ON 31-12-76		15	30	7	28	
YEAR PUT ON LINE		1945	1954	1961	1969-70—72	
BUILDER		IGE, USA	KRAUSS MAFFE I W. GERMANY	MAK	CLW	
WHEEL ARRANGEMENT		BO—BO	O—C—O	O—C—O	O—C—O	
WT. IN WORKING ORDER (t)		46.2	51.4	57	60	
MAX. AXLE LOAD (t)		11.55 (in W.O.)	17.32 (in W.O.)	19	20	
LENGTH OVER HEAD STOCK (mm)		9061	7265	9430	9730	
BOGIE/RIGID FRAME WHEEL BASE (mm)		2083	1600/1600	2650/1750	2650/1750	
LOCO. WHEEL BASE (mm)		7723	3200	4400	4400	
TRACTION EFFORT	MAXIMUM (Kg)	11500 (25% Adh.)	ML : 9200 SH : 15420 (30% Adh.)	ML : 10400 SH : 17100 (30% Adh.)	ML : 9500 SH : 18000 (30% Adh.)	
	CONTINUOUS (Kg)	5000	ML : 7300 SH : 14750	ML : 7500 SH : 18000	ML : 6500 SH : 15800	
SPEED Km/h	MAXIMUM	56	ML : 54 SH : 27.6	ML : 65 SH : 27	ML : 65 SH : 27	
	CONTINUOUS	10	ML : 7.55 SH : 3.86	ML : 12 SH : 4	ML : 14.3 SH : 5.9	
DIESEL ENGINE	MAKE		CATERPILLAR (2 per loco.)	MAN	MAYBACH	MAK
	TYPE		D-17000 8Cyl. V	WBV, 17.5/22A 8Cyl. IN LINE	MD 435 8 Cyl. 60 V	6M 282 A (K) 6 Cyl. IN LINE
	h.p.	STANDARD	193 hp (15.6°C, SL)	440 hp (20°C, SL)	—	600 hp (20°C, SL)
		SITE	152hp	400 hp (43.5°C, 600 m)	618 hp (45°C, 150 m)	600 hp 55°C
	R.P.M.	MAXIMUM	1000	1000	1600	1000
		IDLE	400	—	700	440
	SUPERCHARGER			BROWN BOVERI VTR 200/45	MAYBACH AGL.85	BROWN BOVERI VTR 250
	WEIGHT DRY (Kg.)		3182	3526	3850	7150
TRANSMISSION		ELECTRIC (2 per loco.)	HYDRAULIC	HYD.-MECH.- SURI	HYD.-MECH. SURI	
MAKE		GE. CT 555 A1	VOITH L-37-V	MAK	MAK	
BRAKE	LOCO.	AIR, HAND	AIR, HAND	AIR, HAND	AIR, HAND	
	TRAIN	VACUUM	VACUUM	VACUUM	VACUUM	
MAIN PARTICULARS OF DIESEL LOCOMOTIVES ON INDIAN RAILWAYS.					RDSO CH. DP-146	
					SHEET 20F 5	

B.G. SHUNTING

MAIN PARTICULARS, CLASS OF LOCO.		WDS 4A	WDS 4B	WDS 5	WDS 6
NO. OF LOCOS.	AS ON 31-12-76	5	151	21	51 (on order)
YEAR PUT ON LINE		1968	1970 Onwards	1967-68	1974 Onwards
BUILDER		CLW	CLW	ALCO	DLW
WHEEL ARRANGEMENT		O—C—O	O—C—O	Co—Co	Co—Co
WT. IN WORKING ORDER (t)		60	60	126	126
MAX. AXLE LOAD (t)		20	20	21	21
LENGTH OVER HEAD STOCK (mm)		9730	9730	15240	15290
BOGIE/RIGID FRAME WHEEL BASE (mm)		2650/1750	2650/1750	3810	3810
LOCO. WHEEL BASE (mm)		4400	4400	12224	12224
TRACTION EFFORT	MAXIMUM (Kg)	ML : 16700 SH : 18000 (30% Adh.)	ML : 11500 SH : 18000 (30% Adh.)	31500 (25% Adh.)	34000 (27% Adh.)
	CONTINUOUS (Kg)	ML : 12400 SH : 17000	ML : 8500 SH : 16900	32300	30300/26600
SPEED Km/h	MAXIMUM	ML : 65 SH : 38	ML : 65 SH : 27	109	62.5/71
	CONTINUOUS	ML : 8 SH : 5	ML : 13 SH : 5.5	3.2	6.9/7.85
DIESEL ENGINE	MAKE	MAK	MAK	ALCO	ALCO/DLW
	TYPE	6 M 282 A (K) 6 Cyl. IN LINE	6 M 282 A (K) 6 Cyl. IN LINE	251 B-6 Cyl. IN LINE	251 D 6 CYL. IN LINE
	h. p.	STANDARD	660 hp (20°C, SL)	700hp (20°C, SL)	1065 hp (15.6°C, SL)
		SITE	660 hp 55°C	700hp 55°C	994 hp (55°C, 1000 m)
	R.P.M.	MAXIMUM	920	1000	1025
		IDLE	440	440	375
	SUPERCHARGER	BROWN BOVERI VTR 250	BROWN BOVERI VTR 250	ALCO 320F	ALCO 350B/350C
	WEIGHT DRY (kg.)	7150	7150	10000	10818
	TRANSMISSION	HYDRAULIC	HYDRO- MECH(SURI) or HYDRAULIC	ELECTRIC	ELECTRIC
	MAKE	VOITH L-217 U	MAK	GE	HEIL
BRAKE	LOCO.	AIR, HAND	AIR, HAND	AIR, HAND	AIR, HAND
	TRAIN	VACUUM	VACUUM	VACUUM	VACUUM
MAIN PARTICULARS OF DIESEL LOCOMOTIVES ON INDIAN RAILWAYS.					RDSO CH. D.P.-146
					SHEET 3 OF 5

CLASS OF LOCO		YDM ₁	YDM ₂	YDM ₄	YDM ₄ A
MAIN PARTICULARS.					
NO. OF LOCOS. AS ON 31-12-76		20	30	228	99
YEAR PUT ON LINE		1955-56	1962	1962-64	1964-68-69
BUILDER		N.B.L.CO.	GM	ALCO/DLW	MLW
WHEEL ARRANGMENT		B'—B'	1 B'—B'1	Co—Co	Co—Cc
WT. IN WORKING ORDER (t)		43.68	58.5	72	72
MAX. AXLE LOAD (t)		11.03	11	12	12
LENGTH OVERHEAD STOCK (mm)		16630	12350	13818	13818
BOGIE WHEEL BASE (mm)		2134	1730	3505	3505
LOCO. WHEEL BASE (mm)		7544	11080	11480	11480
TRAC-TIVE EFFORT	MAXIMUM (Kg)	10920 (25% Adh.)	14300 (32.5% Adh.)	18935 (26.3% Adh.)	16935 (26.3% Adh.)
	CONTINUOUS (Kg.)	8230	10300	19200	19200
SPEED Km/h	MAXIMUM	88	80	96	96
	CONTINUOUS	12	24.5	11.6	11.6
DIESEL ENGINE	MAKE	PAXMAN	GM	ALCO/DLW	MIW
	TYPE	12 RPH XL/II (12 Cyl. 60 V)	12—567 C (12 Cyl. 45 V)	251D (6 Cyl. IN LINE)	251D (6 Cyl. IN LINE)
	h. p.	634 (29.4°C, 152 m)	1390 (15.6°C, SL)	1400 (20°C, SL)	1400 (20°C, SL)
	SITE	542 (48°C, 200 m)	1259 (52°C, 600 m)	1300 (52°C, 600 m)	1300 (52°C, 600 m)
	RMP	1250	800	1106	1100
	IDLE	525	275	400	400
	SUPERCHARGER	—	GM ROOTS BLOWER	ALCO 350 B/350 C	ALCO 350 B
	WEIGHT DRY (Kg.)	4540	11200	10818	10532
TRANSMISSION		HYDRAULIC	ELECTRIC	ELECTRIC	ELECTRIC
MAKE		VOITH	EMD, D 25	GE/HEIL	GE (CANADIAN)
BRAKE	LOCO.	AIR, HAND	AIR, HAND	AIR, HAND & DYNAMIC	AIR, HAND & DYNAMIC
	TRAIN	VACUUM	VACUUM	VACUUM	VACUUM
MAIN PARTICULARS OF DIESEL LOCOMOTIVES ON INDIAN RAILWAYS					RDSO CH. DP.-146
					SHEET 4 OF 5

M.G.

N.G. LOCOS.

CLASS OF LOCO.		YDM ₁	N/ZDM ₁	ZDM ₁	ZDM ₁
MAIN PARTICULARS.					
NO. OF LOCOS.	AS ON 31-12-76	25	ZDM ₁ —5 NDM ₁ —3	25	20
YEAR PUT ON LINE		1964	1955-56	1964-65	1971
BUILDER		GM	ARN-JUNG	MAK	CLW
WHEEL ARRANGEMENT		C'—C'	B'—B'	B'—B'	B'—B'
WT. IN WORKING ORDER (t)		69.18	29.3	32	37
MAX. AXLE LOAD (t)		11.65	7.35	8	9.25
LENGTH OVERHEAD STOCK (mm)		13260	8400	9120	10300
BOGIE/RIGID FRAME WHEEL BASE (mm)		3450	1500	1590	1590
LOCO. WHEEL BASE (mm)		11530	5700	6510	6990
TRAC- TIVE EFFORT	MAXIMUM (Kg)	21792 (31.5% Adh.)	8790 (30% Adh.)	10560 (33% Adh.)	1 10500 (30% Adh.)
	CONTINUOUS (Kg)	11250	7500	8500	1 9800 (30% Adh.)
SPEED m	MAXIMUM	80	33	50	32
	CONTINUOUS	22.35	5	12.5	6.4
DIESEL ENGINE	MAKE	GM	MWM (2 PER LOCO.)	MAYBACH	MAK
	TYPE	12—567 C 12 Cyl. 45° V	TRHS 518S (6 Cyl. I) LINE	MD 435 8 Cyl. 60° V	6M 282A(K) 6 Cyl. IN LINE
	h.p.	STANDARD	1390 (15.6°C, SL)	700 (20°C, SL)	700
		SITE	1259 (52°C, 600 m)	700 (45°C, 150 m)	700
	R.P.M.	MAXIMUM	800	1700	1000
		IDLE	275	660	440
	SUPERCHARGER	GM ROOTS BLOWER	BROWN- BOVERI VTR 160/26 H	MAYBACH AGL-86	BROWN- BOVERI BBC VTR 250
	WEIGHT DRY (Kg)	11200	1100	3800	7150
TRANSMISSION		ELECTRIC	HYDRAULIC	HYDRO- MECH.	HYDRO- MECH.
BRAKE	MAKE	EMD, D 25	VOITH, L33 U	MaK	Mak
	LOCO.	AIR, HAND & DYNAMIC	AIR, HAND	AIR, HAND	AIR, HAND
	TRAIN	VACUUM	VACUUM	VACUUM	VACUUM
MAIN PARTICULARS OF DIESEL LOCOMOTIVES ON INDIAN RAILWAYS.					RDSO CH. DP-146
					SHEET 5 OF 5

CLASS OF LOCOMOTIVE	LEVEL		1/500		1/2000		1/1000		1/1000		1/500	
	4 WH Wagons	Bogie Wagons	4 WH Wagons	Bogie Wagons	4 WH Wagons	Bogie Wagons	4 WH Wagons	Bogie Wagons	4 WH Wagons	Bogie Wagons	4 WH Wagons	Bogie Wagons
WDM1	>2500	>4500	>2500	3970	>2500	2730	1980	2330	1440	1780	875	1020
WDM2	>2500	>4500	>2500	4260	>2500	2940	2240	2510	1580	1920	950	1110
WDM3 LS HS	>2500 >2500	>4500 >4400	>2500 >2500	3530 3080	2100 1680	2430 2130	1650 1380	2070 1810	1260 1080	1590 1390	800 690	930 810
WDM4	>2500	4500	2500	4000	2500	2720	2000	2320	1440	1770	880	1020
WDS1	>1220	2260	900	1580	710	1090	620	930	510	700	—	—
WDS2 ML SH	>840 >2280	1760 3110	700 1440	1230 2120	540 1020	840 1470	480 340	730 1260	700	550 960	480	555
WDS3 ML SL	>970 >2500	2080 3430	800 1750	1420 2410	630 1190	980 1650	540 1000	840 1410	460 780	630 1080	540	625
WDS4 ML SL	>880 >2500	1860 3600	720 1940	1290 2520	580 1270	880 1730	500 1070	760 1490	840	570 1130	565	660
WDS4A ML SL	>2500	3320	1640	2320	1160	1600	970	1370	760	1050	525	605
WDS4B ML SL ✓	1220	2260	890	1580	700	1090	630	920	500	700	—	—
WDS 5	>2500	>4500	Loads >2500	for shunting service are same as for WDS 3	Loads >2500	for shunting service are same as for WDS 4	2320	2590	1640	1970	970	1135
YDM1	>2000		>1780		>1000		820		600			
YDM3	>2000		>2000		>1490		1200		870		1460	
YDM4/4A	>2000		>2000		>2000		1680		1200		600	
YDM5	>2000		>2000		>2000		2000		1450		705	
ZDM2	>1000		>905		>705		625		510		324(230 on 1 in 33)	
ZDM3	>1140		>930		>720		640		520		325(230 on 1 in 33)	

STARTING LOADS OF DIESEL LOCOMOTIVES—TONNES
GOODS SERVICE—4 WHEELERS/BOGIE WAGONS

DE/T-311

Level Tangent Track									
Class of Locomotives	Load in tonnes at kmph							100	120
	20	30	40	50	60	70	80		
WDM1	>1000						1440	905	
WDM2	>1000							1075	620
WDM3 LS SURI-MEK) HS	>1000							1045	570
WDM4	>1000								755
WDS1	>1000	925	575	360	285 at 55	—	—	—	—
WDS2 ML	>1000	1315	690	575	545 at 53	—	—	—	—
WDS3 „	>1000			905	655	540 at 65	—	—	—
WDS4 „	>1000			985	610	485 at 65	—	—	—
WDS4A „	>1000		1405	895	635	525 at 65	—	—	—
WDS4B „	>1000			1240	840	680 at 65	—	—	—
WDS5	>1000				1045	720	—	—	—
YDM 1	>900		875	585	435	310	215	—	—
YDM 3	>900					815	575	—	—
YDM 4/4A	>900					830	615	340	—
YDM5	>900					760	565	—	—
ZDM2	>900	748	572	435	—	—	—	—	—
ZDM3 LS	>900		905 at 32	—	—	—	—	—	—
ZDM3 40 km/h	>900		690	—	—	—	—	—	—
ZDM3 50 km/h	>900	885	690	485	—	—	—	—	—

HAULAGE CAPACITY OF DIESEL LOCOMOTIVES
PASSENGER SERVICE—ICF COACHES

DE/T-3

Level Tangent Track

Class of Locomotives	Load in tonnes at kmph								
	10	20	30	40	50	60	70	80	100
WDM1	>2500				3090	2205	1580	1180	715
WDM2	>2500					2705	1960	1465	845
WDM3 LS LS (Suri HS Mekydro)	>2500					2730 2575	1955 1865	1400 1345	— 820
WDM4	>2500					2925	2145	1595	955
WDS1	2990	1450	840	505	—	—	—	—	—
WDS2 ML SH	>2500 >2500	1885 1685	1190 1500 at 28	605 —	490 —	— —	— —	— —	— —
WDS3 ML SH	>2500 >2500		1745 2525 at 27	1205 —	775 —	545 —	— —	— —	— —
WDS4 ML SH	>2500 >2500		1840 2520 at 27	1155 —	840 —	510 —	— —	— —	— —
WDS4A ML SH	>2500 >2500		1965 1815	1235 1565* at 38	765 —	525 —	— —	— —	— —
WDS4B ML SH	>2500 >2500		2245 2965 at 27	1445 — —	1060 —	695 —	555 at 65 —	— —	— —
WDS5	>2500			2090	1335	865	580	—	—
YDM1	>2000		1490	905	580	410	—	—	—
YDM3	>2000			2255	1530	1055	720	490	—
YDM4/4A	>2000			2265	1530	1055	735	520	—
YDM5	>2000			2265	1490	990	670	480	—
ZDM2	Same as for passenger service.								
ZDM3	Same as for passenger service.								

HAULAGE CAPACITY OF DIESEL LOCOMOTIVES
GOODS SERVICE—4 WHEELER WAGONS

DE/T—313

Level Tangent Track									
Class of Locomotives	Load in tonnes at kmph								
	10	20	30	40	50	60	70	80	100
WDM1	>4500				4635	3420	2545	1980	1295
WDM2	>4500					4195	3155	2455	1530
WDM3 LS (SURI-MEK.) HS	>4500				5340 5340	4230 3990	3150 3005	2345 2260	— 1490
WDM 4	>4500					4535	3450	2670	1730
WDS1	>4500	2115	1215	735	—	—	—	—	—
WDS2 ML SH	>4500 >4500	2745 2460	1720 2170 at 28	885 —	740 —	— —	— —	— —	— —
WDS3 ML SH SH	>4500 >4500	4400 4015 at 25	2520 3650 at 27	1765 —	1160 —	845 —	695 at 65 —	— —	— —
WDS4 ML SH	>4500		2660 3640 at 27	1690 —	1265 —	785 —	625 at 65 —	— —	— —
WDS4A ML SH	>4500		2845 2625	1805 2280 at 38	1145 —	815 —	675 at 65 —	— —	— —
WDS4B ML SH	>4500		3245 4285 at 27	2115 —	1590 —	1080 —	880 at 65 —	— —	— —
WDS5	>4500			3055	2005	1345	935	—	—
YDM1	>2000		1730	1100	735	545	—	—	—
YDM 3	>2000				1945	1405	995	700	—
YDM4/4A	>2000				1945	1405	1015	745	410
YDM5	>2000				1895	1315	925	690	—
ZDM2	Same as for Passenger service.								
ZDM3	Same as for Passenger service.								

**HAULAGE CAPACITY OF DIESEL LOCOMOTIVES
GOODS SERVICE—BOGIE WAGONS (BOX)**

DE/T-314

