White Board

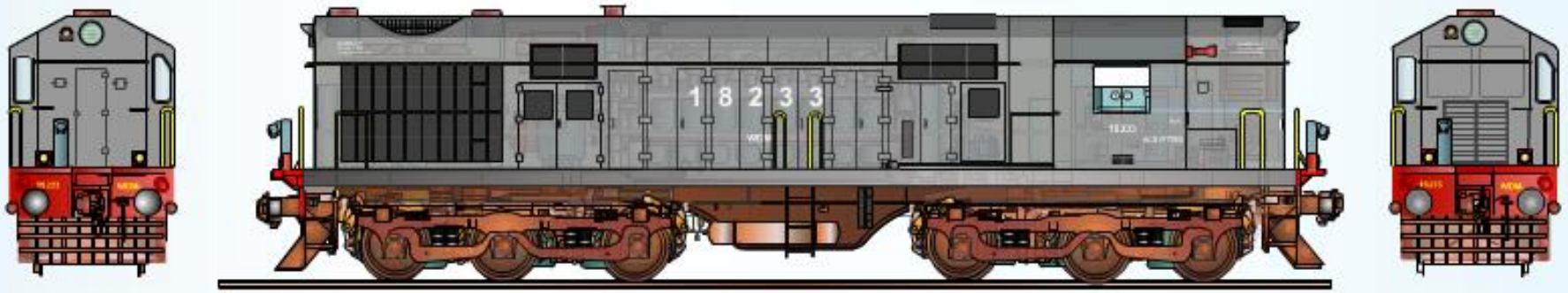
INTRODUCTION TO DIESEL LOCOMOTIVES

Intro of Diesel locos in IR

- In the early 1960, IR began conversion of its mainline from steam to Diesel locomotives. For this conversion, GM and ALCO were asked to submit designs for new diesel locomotives.
- GM (WDM-4/2600)did not agree to the TOT agreement so the ALCO(WDM2) prototype was selected for production.
- However, even before the arrival of WDM2 another type of diesel loco was imported from ALCO beginning in 1957.This loco was classified as WDM1.
- WDM2 was first introduced in 1962 in IR.

Layout of WDM2

INTERACTIVE TECHNICAL DIAGRAM OF WDM2



Select suitable transparency level and move curser over the loco to highlight major components

Engine. Main Generator. Auxilary Generator. Exciter. Control Stand. Control Compartment. Turbo supercharger. Turbo supercharger filters oil bath. Lubricating Oil Strainer. Radiator Radiator Fan Radiator Fan Clutch. Traction Motor Traction Motor Blower. Lubricating Oil Cooler Lubricating Oil Filters. Engine Water tank. Fuel Tank filling connection. Fuel Tank. Expressor Sand Box. Batteries. Air Filters. Dynamic Breake grids. Dynamic Break Blower. Clothes Locker. Generator Exhaust. MU connector Air Reservoir. Head Lamp Aspect Lights. Cow Catcher

Layout of WDM2

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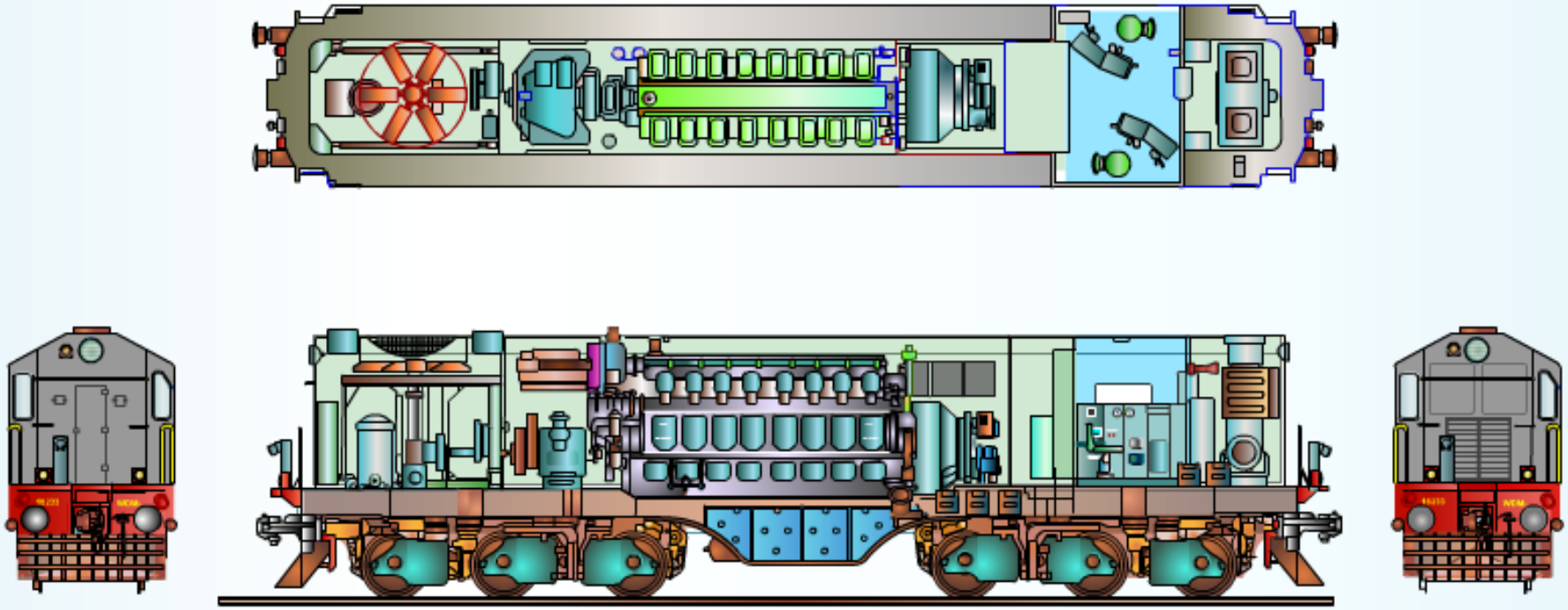

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Layout of Diesel Locos-WDM2

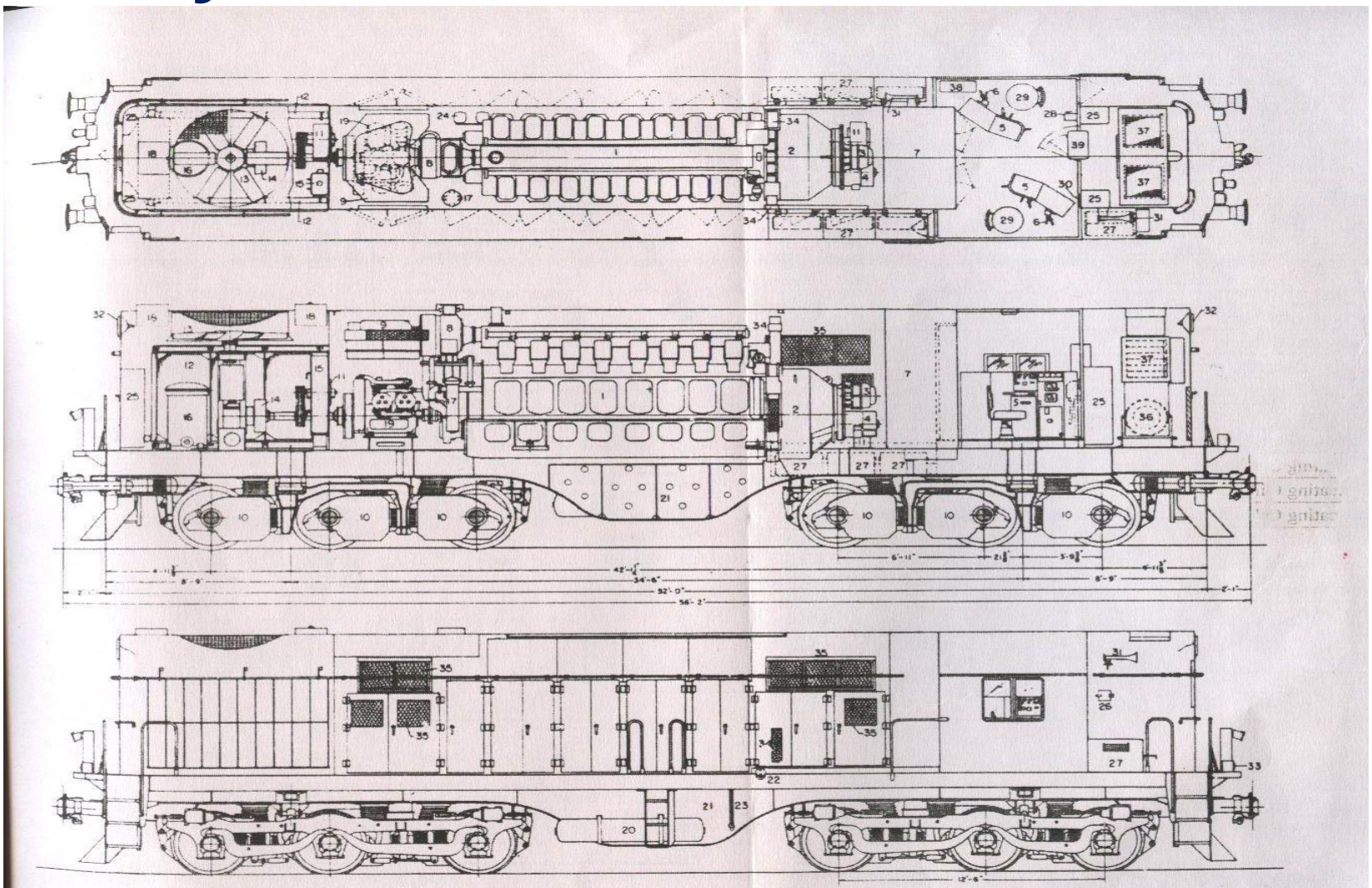


Fig 1.LOCATION OF APPARATUS

LOCO Terminologies

- Nose compt ,Driver's cabin,Control compt ,Radiator rm with Under truck is called as Locomotive.
  - Short hood end
  - Long hood end
  - Right side of locomotives
  - Left side of the locomotive
- Gen.room,Engine room and Expressor room is called as Diesel engine
  - Right side of the engine & Left side of the engine
  - Power take off end & Free end

Various compartments of locos

- A WDM2 is divided in main 8 parts as follows-
  - Nose compartment.
  - Driver’s cabin.
  - Control panel.
  - Tr. Generator compartment.
  - Engine room.
  - Expressor/Compressor compartment
  - Radiator Room .
  - Under truck

1.Nose compartment

- Some important components fitted in Nose compartment are as –
  - Dynamic braking grid resistance
  - Grid cooling Blower & Motor
  - VA1B Control valve
  - A1 Differential pilot air valve
  - GD-80D type oil bath filter(atmosphere)
  - GD-80E type Vac.oil bath filter(for vac.train pipe)
  - Control air reservoir
  - Sand Box etc

Dynamic Braking Grid

- 12 Nos braking grids are fitted.
- These grids get heated up when current passes in these grids during dynamic braking.
- Electrical energy dissipated to the atmosphere in form of heat energy.

Dynamic Braking Blower Motor

- It is DC motor with 02 blower.
- Its cool dynamic braking grids during dynamic braking.
- This machine draws current from traction motor armature while working as generator during dynamic braking.

2.Driver’s Cabin

- Control stand.
  - Air brake control stand .
  - Electrical control stand .
- Gauge panel
  - FOP gauge.
  - BP gauge.
  - LOP gauge
- Driver’s seat.
- Hand brake.

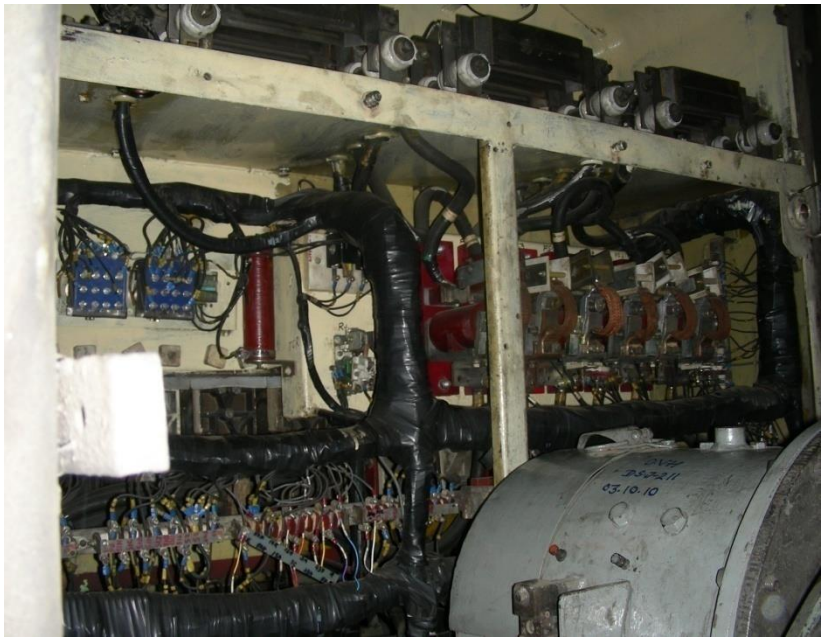
Control stand

- Selector handle.
- Throttle handle.
- Reverser handle.
- A9 V/V handle.
- SA9 V/V handle.
- Indication lamp for Hot engine,Ground relay,Wheel slip.
- Horns (SH&LH).

3.Control panel

- Front control panel
  - ECP ,VRP,
  - Engine control panel.
  - Field control panel
  - CK1&CK2 .
- Back control panel
  - Terminal boards.
  - Various resistance
  - Various contactors etc.

Back control panel

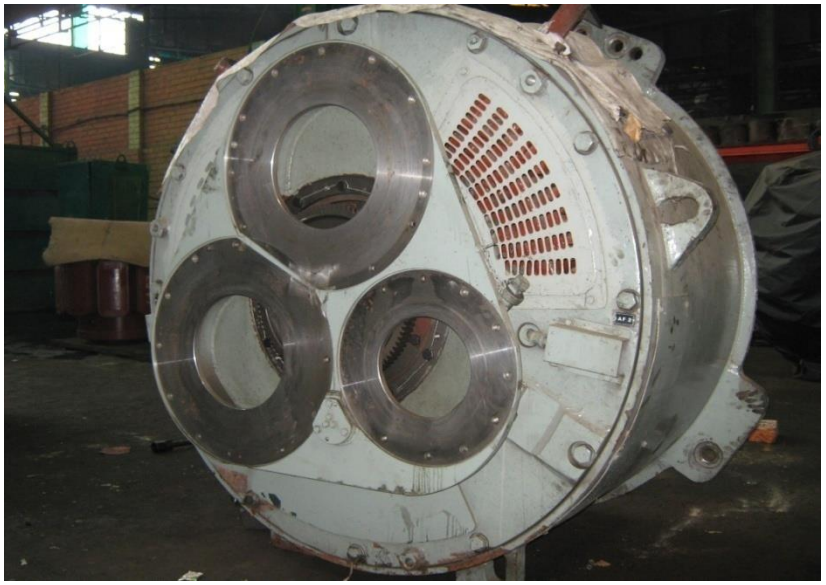


4.Traction Gen. compartment

- The following traction machineries are fitted-
  - Traction Gen/Traction Alternator
  - T.G.Gear box.
  - Excitor
  - Aux.Generator.
  - FTMB

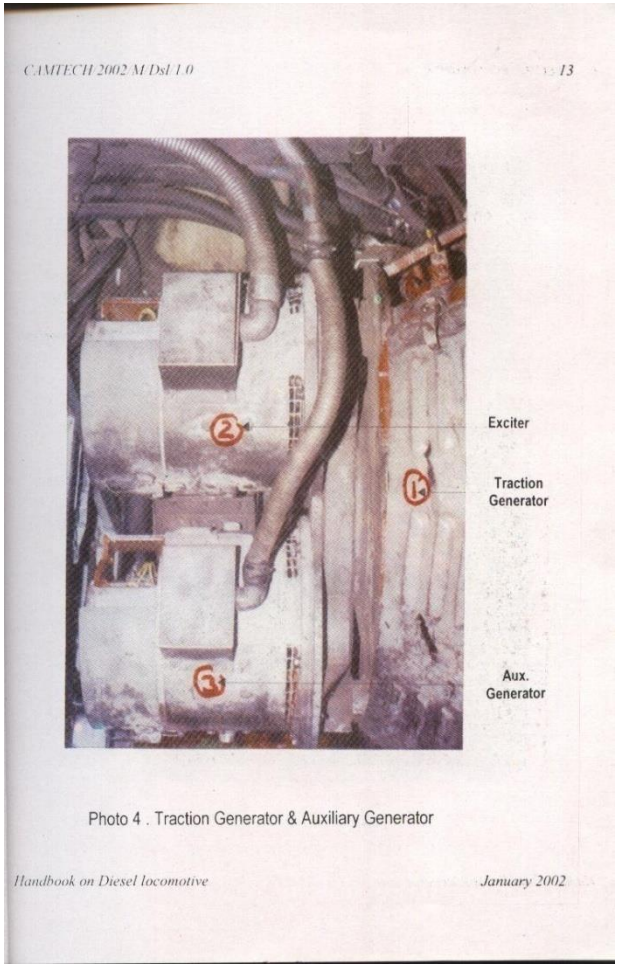
Traction Gen/Traction Alternator

- Traction Generator
  - It produces DC current for operation of all Tr. Motors, its field excitation.
- Traction Alternator
  - In AC/DC locos, TA is provided & it produces AC current.



Aux. Generator

- This is a DC generator.
- It supplies current for batteries charging on loco.
- It supplies current for operation of CC Ex.Motor, Fuel P/P motor, ECC coil assly, Relays and lighting etc.



FTMB

- It is gear driven from the main generator shaft.
- It supplies air to the Tr.motors No-1,2,3 fitted with wheel axle below the driver cabin.

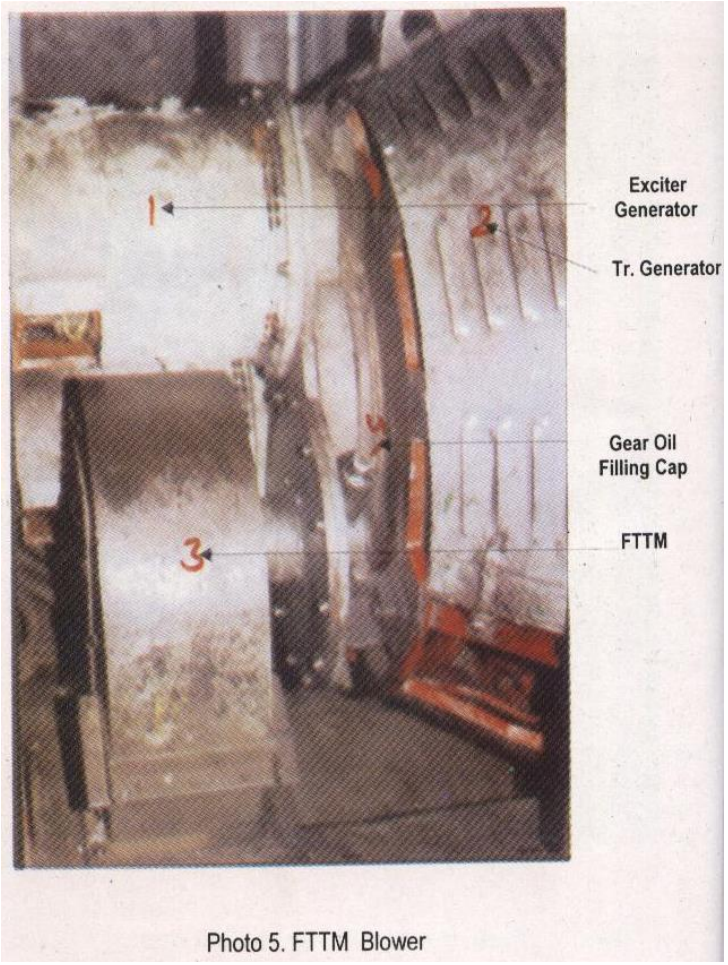


Photo 5. FTTM Blower

5.Engine Room/compartment

- Free end: TSC end of the engine.
- Generator end: Power take off end of engine.
- Engine cylinder are numbered from the free end. Right(1R)and left (1L).
- The following components are fitted -
  - Engine base,Engine block,
  - After cooler,TSC,Exhaust manifold
  - Governor,FIP & support,Cylinder head,
  - C/C Exh.Motor,Lub oil P/P, Water P/P.

ENGINE BLOCK(Cylinder Block)

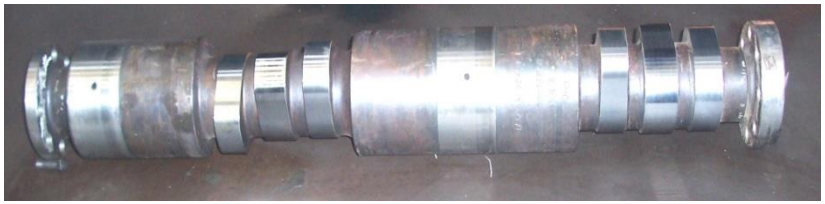
- Engine block houses 8 cylinders in each side in V arrangement.
- In this way ,total 16 cylinders can be fitted in a Engine block.
- In engine block,There is cavity for cooling water circulation.
- Engine block is of steel plate,welded together and mounted on Engine base (Crank case)with the help of nuts and bolts.
- One V type gallery is provided as Air inlet manifold.

CRANK SHAFT

- 16 Cylinder Engine Crankshaft
  - No of Main Bearings- 9
  - Location of Centre Journal- 5
  - No. of Crankpins- 8
    - For Lifting - 2 & 7
    - For Support- 3 and 7

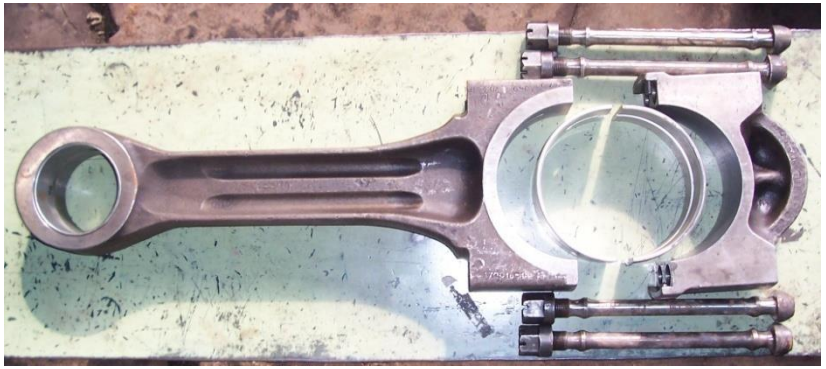
Cam Shaft

- 3 Cams are provided for each Cylinder
- Opening and closing Inlet and Exhaust valves.
- Timely injection of fuel in Cylinder.



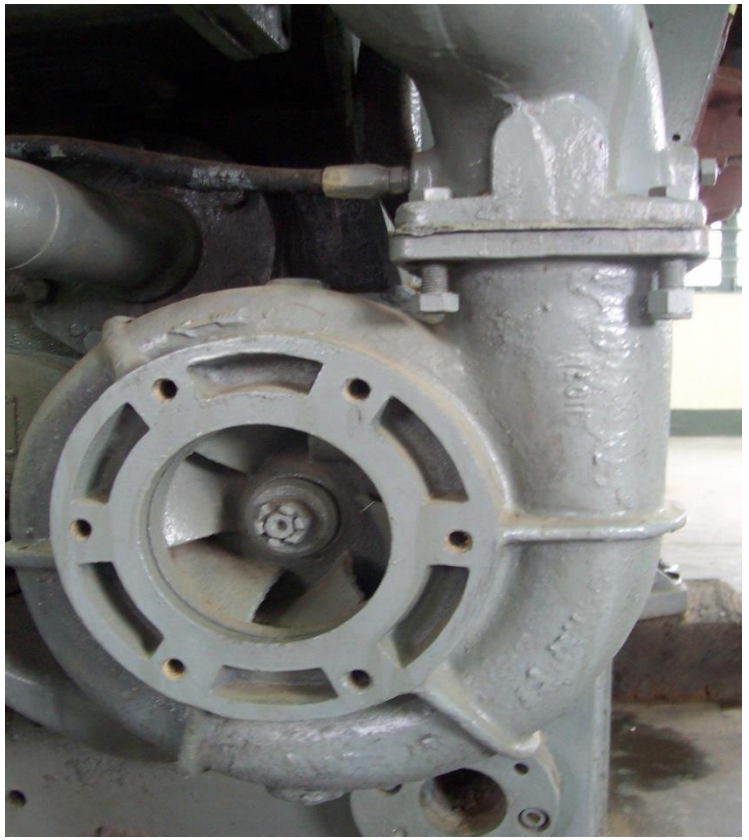
Cylinder head

Piston & connecting rod



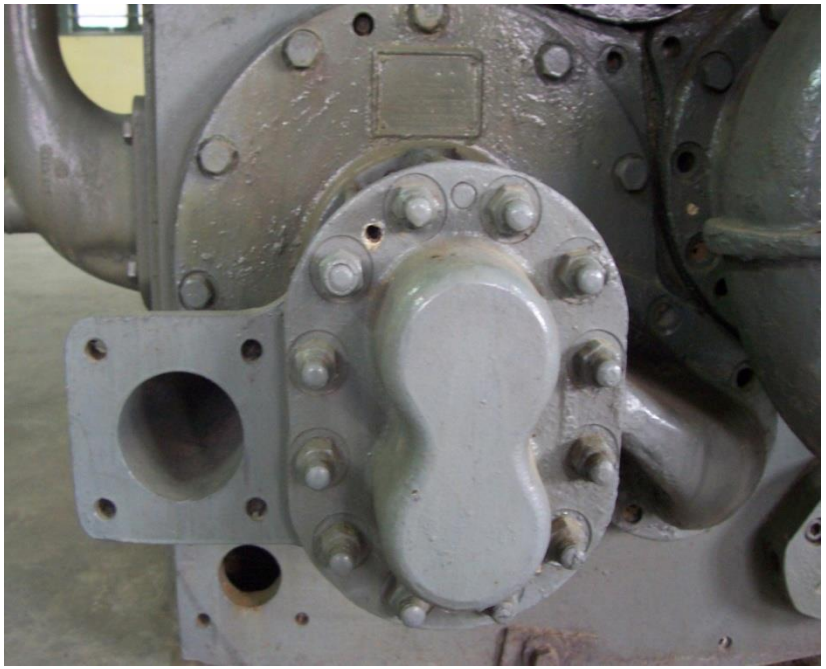
WATER CIRCULATING PUMP

- Centrifugal type pump
- Located on the free end
- Driven by the Crank shaft
- Discharge pressure- 25 PSI. (Min.)



Lube oil pump

- Gear type pump
- Mounted on the free end
- Driven by the diesel engine



Turbo Super Charger

- Air charge of higher density during suction stroke of piston.
- Fitted above After cooler housing at free end .
- Pressure upper limit -1.80- 2.20 kg/cm2.

AFTER COOLER

- Cool the inlet air.
- The cooler consists of-
  - a tube bundle mounted
  - in the air intake passage

FIP & FUEL PUMP SUPPORT

- FIP injects the fuel oil in the cylinder through HP tube & Fuel injector.
- It is mounted on FI Support.

GOVERNOR

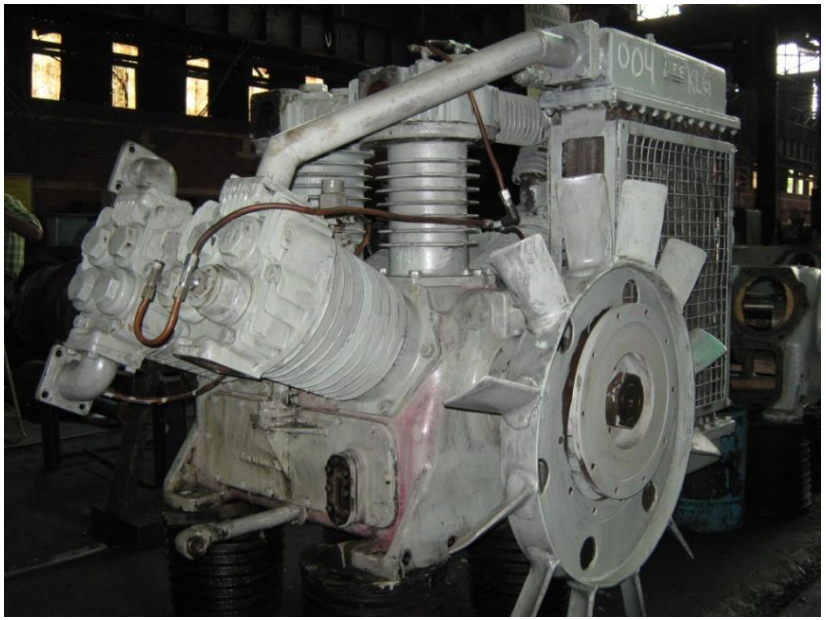
- Controls the speed of the diesel engine by regulating the rate of fuel injection.
  - Electro-Hydraulic Gov. (GE)
  - Mech–Hydraulic Governor (WW Gov.)
  - Microprocessors Controller Based Governor(MCBG)

6.Expressor compartment

- Expressor
  - Exhauster cylinder,
  - Low pressure Cylinder,
  - High pressure cylinder.
  - Inter Cooler
  - Air governor.
- Fuel Booster P/P motor.
- Air intake filter.

Expressor

- It is Compressor-Exhauster unit
- Driven by diesel engine through a flexible coupling.
- This furnishes air for purposes of loco control, air brake system and vacuum in vacuum braked trains.



7.Radiator compartment

- Horizontal Shaft.
- RTMB & Pulley.
- Lube oil CLR.
- Radiators core.
- ECC
- Right angle gear box.
- Universal Shaft.
- Radiator fan.
- Lube oil filter tank.
- Exp.tank (155 ltrs)

RADIATORS & R/FAN

- Vertically mounted- Rear of the locomotive.
- Dissipate heat from water & exhausting the hot air through roof opening.
- Radiator Fan- A single thermostatically controlled engine cooling water fan.
- Driven by universal joint vertical drive shaft ,through the ECC & right angle gear box.

8.Under truck

- 3 axle, Independent Driven Bogie
- CO-CO type,
- Three point loading
  - Pivot Pin -60%
  - Side L/Bearer-40%
- Single piece cast steel
- Adhesion-27%.
- Suspended traction motor arrangement.

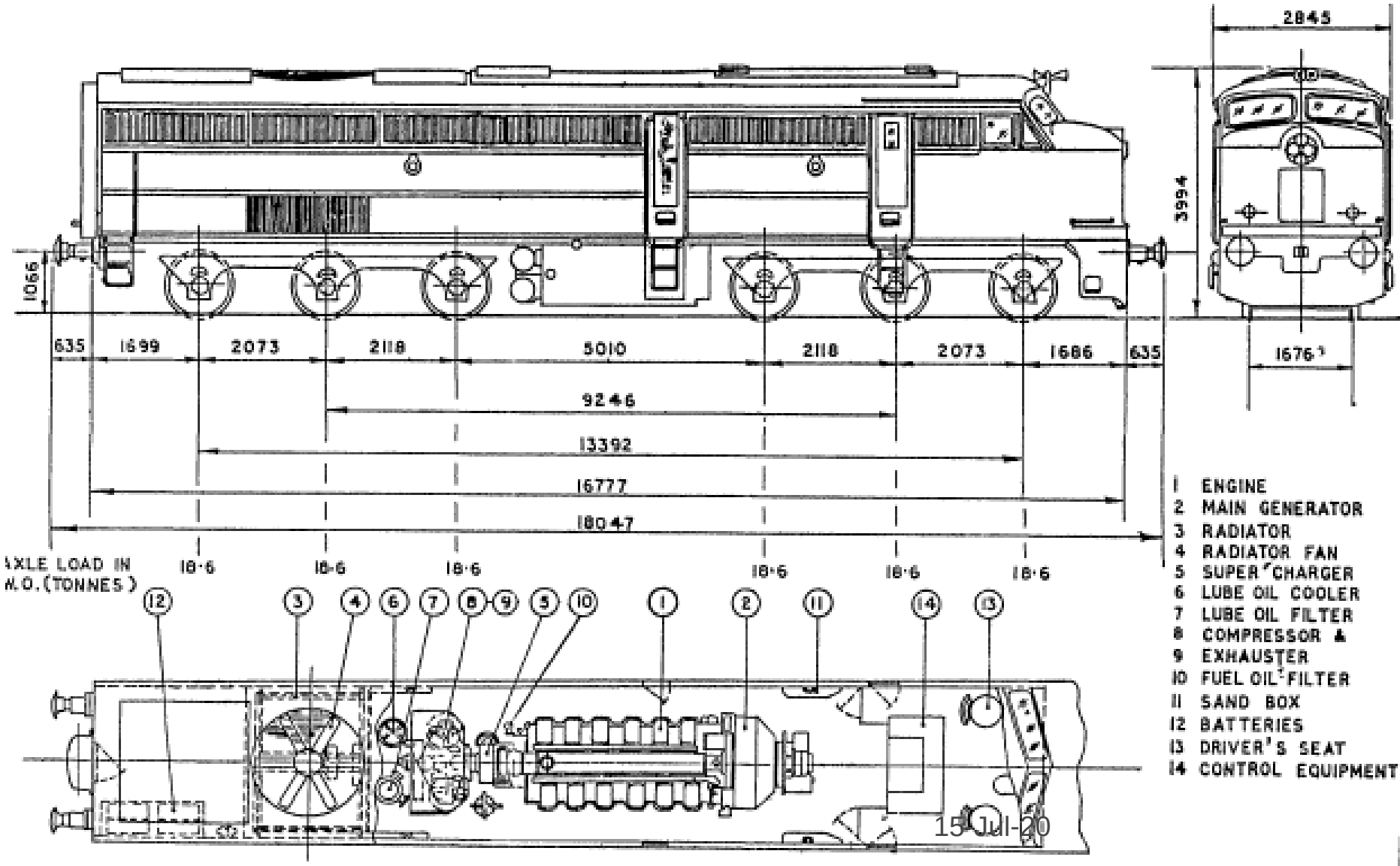
Diesel locomotive Animation

Various kind of Diesel Locomotives

Feature of First Diesel loco (WDM1)

- First mainline diesel electric locomotives used in India.
- Introduced in 1957.
- Imported from ALCO.
- 1977/1800HP at 1000RPM
- 12 cyl , 4 stroke,
- A1A-A1A(some) & Co-Co Bogie
- Max speed -104 KMPH
- Comp.Ratio-13:1
- Today all have been withdrawn.

WDM1 Diagram



Type of Locos(Broad gauge)

- ALCO type locos.
- GM/EMD type locos

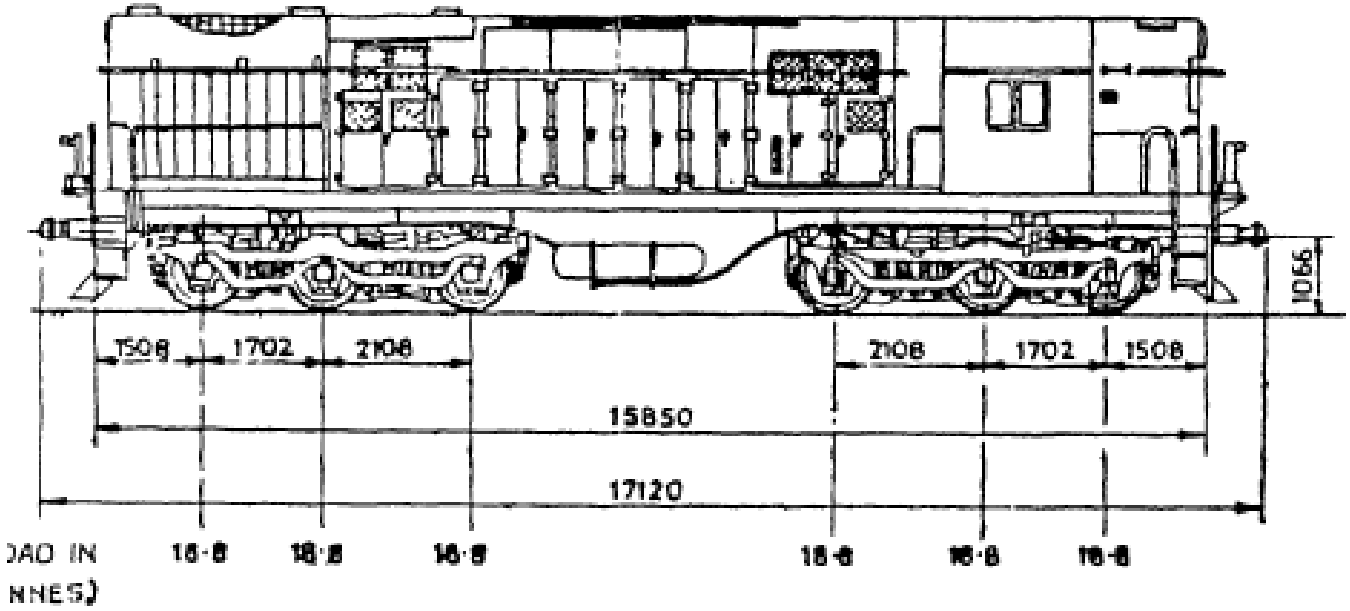
WDM2-History

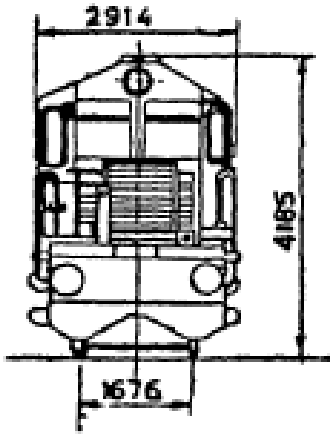
- First homemade mainline diesel-electric locomotives.
- Original prototypes were made by ALCO.
- Introduced in 1962.
- The first unit(40locos) were imported fully built in 1962.
- In 1962, DLW started manufacturing of Alco locos.
- These day more than 2800 WDM2 locos are in IR.
- Most popular diesel loco in IR.

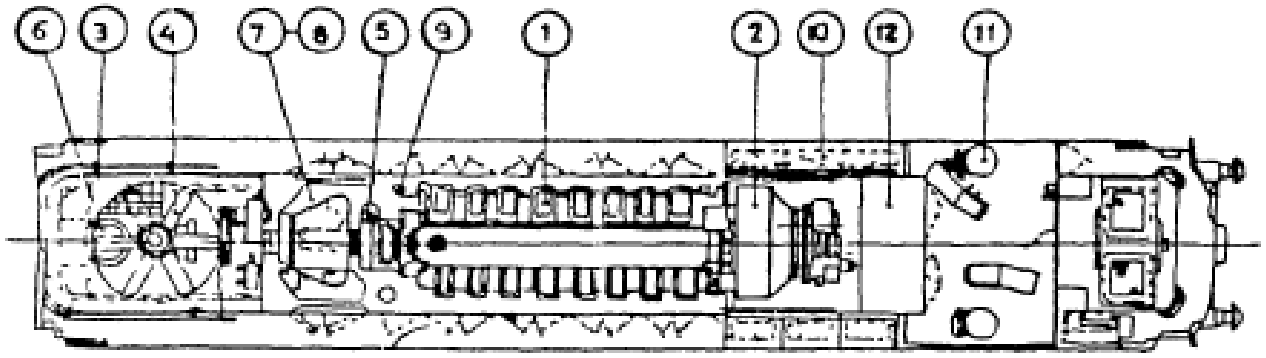
WDM2-Technical feature

- Builder –Alco /DLW
- Put on line –In 1962 in IR
- 2636 /2600HP at SAE condition (ie at 15.6'c & sea level)
- 16 cyls, 4 stroke, 400/1000RPM.
- compression ratio-12.5:1
- Geared for 120KMPH speed
- Gear ratio- 65:18
- DC-DC transmission

WDM2 Diagram







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

WDM4-Technical feature

- Entered in service along with WDM 2 in 1962 in IR
- 2600HP at 835 RPM in standard condition.
- 567 D3 type Engine
- 2 stroke.
- 16 cylinders
- Comp. ratio -14.5:1
- Geared for 120KMPH max speed.
- Gear Ratio -61:16
- CO-CO
- DC-DC transmission

WDM2-Variants

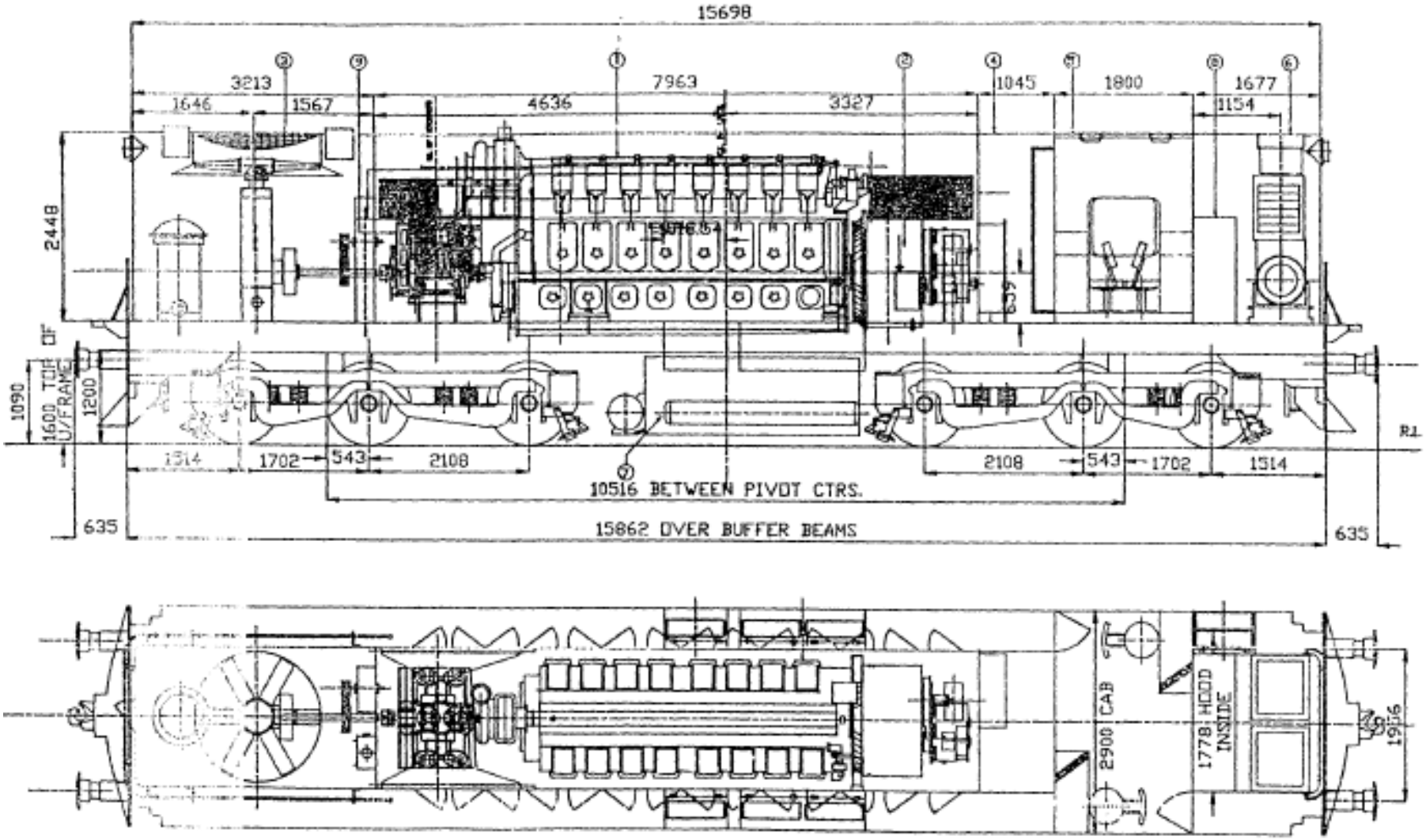
- WDM2A
  - Rebuilt and fitted with Air brake for train (Dual brake capability)
- WDM2B
  - Vacuum brake removed & built with pure Air brake in loco as well as for train .
- WDM2C
  - Technically upgraded &HP increased to 3100HP.
- WDM2S
  - Down graded for shunting.

WDM2A

WDM2c -Technical feature

- Feature
  - Rebuild & 1st turned out from DLW-1994
  - 3100HP at 1050 RPM with High Eff.TSC.
  - AC-DC
  - Max speed - 120KMPH
  - CR-12.5:1
  - Suitable for multi operation
- DMW started conversion of WDM2 in WDM2c(WDM3A) in rebuilding with
  - Tr.Alt & Rectifier in place of Tr.Gen.
  - Centrifuge provided.
  - Detachable fuel Tk.
  - Up graded TM.
  - Dual brake system provided.

WDM2c/WDM3A -Diagram



WDM3A/WDM2c

WDM3D

- Higher power version of WDM3A
- 3300 HP fuel efficient engine.
- Light weight (19.5 T) mixed service locomotive.
- Higher tractive effort.
- Microprocessor control(GE).
- Self load test capability.
- Higher adhesion bogies.
- Max. speed 120 kmph.

WDP1

- Alco,Built by DLW in 1995.
- 2300HP at 400/1000RPM
- 12 cyl
- Comp.ratio-12.5:1
- Left hand driving and managed by single driver
- Only suitable for passenger train.

WDP2

- The new class name for these is **WDP-3A**.
- 3100hp. 1050rpm max / 400rpm idle
- Rated top speed is 160km/h (in both directions).
- Two-stage suspension with Flexicoil Mark IV fabricated bogies (Co-Co).
- Air-braked.
- Upgraded by DLW

WDG2 -Technical feature

- 1st loco Turned out from DLW- in 1995.
- 3100HP at 1050RPM.
- AC-DC,
- Max speed-100KMPH.
- Equipped with high Adhesion bogie
  - All TMs are arranged Uni-directional
  - 2 stage suspension.
  - V&H Hydraulic damper.

WDG3A & WDM3D -Comparison

WDG3A	WDM3D
Type Co.Co	Type Co.Co
Horse Power 3100/2900HP	Horse Power 3300/2950HP
Max. Speed 100 Kmph.	Max. Speed 120 Kmph.
Gear Ratio 18/74	Gear Ratio 18/65
Fuel 6000 Liters	Fuel 5 000 Liters
Traction Motor Pinion 22.7Kg	Traction Motor Pinion 24 Kg

Feature of various model locos

MAIN PARTICULARS	WDM2	WDM2C	WDP1	WDG2	WDP2
ENG. HORSE POWER	2600/2400 HP	3100/2900 HP	2300/2150 HP	3100/2900 HP	3100/2900 HP
WHEEL ARRANGEMET	Co-Co	Co-Co	Bo-Bo	Co-Co	Co-Co
MAX SPEED (KM)	120kmph	120kmph	120kmph	100 kmph	140kmph
TRANSMISSION	DC-DC	AC-DC	AC-DC	AC-DC	AC-DC
LENGTH OVER BUFFER BEAMS	15862 mm	15862mm	14810mm	17850mm	19182mm
WT.IN WORKING ORDER	112.81t	112.81t	80t	123t	117t
MAX.AXLEL LOAD	18.8t	18.8t	20t	21t	19.5t
MAX.STARTING EFFORT	30.4t(27%)	30.4t(27%)	20t(25%)	37.9t(30.8%)	29.25t

Cont…

MAIN PARTICULARS	WDM2	WDM2C	WDP1	WDG2	WDP2
Engine /make & Type	251-B ALCO	251-C, 16 CYL.	251-C, 12 CYL.	251-C,16CYL.	251-C, 16 CYL.
	16 CYL.	UPGRADED	UPGRADED	UPGRADED	UPGRADED
RPM(MAX/IDLE	1000/400	1050/400	1000/400	1050/400	1050/400
TURBO SUPER CHARGER	ALCO 720	ABB/NAP NA 295IR	NAP NA295	NAP NA 295IR/ABB/ GE/HS	NAP NA 295IR
GOVERNOR	GE/WW	GE/WW	WOODWARD	WW/ MCBG	WW/MC BG
RPM	1000	1050	1000	1050	1050
Capacities					
FUEL OIL	5000LT	5000 LT	3000LT	6000 LT	5000 LT
WATER	1210	1210	1210	1210	1210
LUB OIL	910	1150	760	1150	1150

GM/EMD locomotives

- WDG4
- WDP4
- WDP4B
- WDP4D
- WDG5

WDG4-Technical Features

- Model : GT46MAC,EMD,2 stroke ,16 cylinders.
- Total wt of loco on rail: 126.010T
- Comp. Ratio: 16:1
- Displacement per Cylinder: 710 Cubic Inch (11 635 cm3)
- Engine speed : 200/904 RPM,
- Gear Ratio: 90:17,
- Wheel arrangement: Co-Co
- Fuel Capacity: 6000 Litres
- Max. Speed :100 Km/h
- Maximum Stall Tractive Effort: 540KN

WDP4-Technical feature

- Model Designation: GT46PAC
- Total wt of loco on rail:115.54T
- Compression Ratio: 16:1
- Gear Ratio: 77:17
- Wheel arrangement :Bo1-1Bo
- Fuel Capacity: 6000 Litres
- Max.Speed: 160 Km/h
- Maximum Stall Tractive Effort: 270 KN

WDP4 & WDG4- Difference

S.No	WDP4	WDG4
1. Max Speed	160 KMPH	120KMPH
2. Axle load	19.5 T	21 T
3. Max. Tractive effort	27550 Kg.	53000 Kg.
4. Wheel arrangement	A-A-I -- I-A-A	CO – CO
5. *Gear ratio :*	*17/77*	*17/90*
6.Event recorder	*Event recorder down loads various parameters / signals from EM 2000 and stores for later use / analysis.*	Not provided
7.Blended brake	provided to optimize use of Dynamic brake.	Dynamic Brake only.

WDG3A,WDG4,WDP4-Comparison

S.No1457	Description	WDG3A	WDG4	WDP4
1	HP	3100	4000	4000
2	SPEED	100KMPH	100KMPH	160KMPH
3	Length	19.15m	21.24m	21.24m
4	Weight	123.0T	126.1T	115.6T
4	Engine RPM	400/1050	269/904	269/904
5	Gear ratio	18:74	17:90	17:77
6	Transmission	AC-DC	AC-AC	AC-AC
7	Cranking	Excitor & Aux.Gen.	Two DC starting motor	Two DC starting motor
8	Bogie	Fabricated	HTSC cast	HTSC cast
9	L.O capacity	1150/1270 ltrs	1457Lts	1457Lts
10	Max Stall T.E	378.5KN	540KN	270KN

WDP4B-General characteristics

- Microprocessor controlled Brakes
- Wider Cab
- Modified Under frame for fitment of Hotel load accessories
- Elimination of ECC2(Items adjusted in ECC#1)
- Modified Battery Box (Two rows arrangement with sliding platform)
- One additional Inverter of rating 500KVA has been provided for Hotel Load supply
- The Hotel load supply of 750 V, 3 phase AC supply fed to coaches from diesel power car through IV coupler

WDP4B-Technical features

- Engine speed-954RPM
- Gross Horse Power-4500HP
- Wheel Axle Configuration-Co-Co(with 6 MAC TM)
- Maximum operating speed-130KMPH
- Locomotive weight-123 T
- Nominal Axle Load -20.5 T
- Fuel Tank Capacity-5000Lts
- Starting TE-460KN
- Dynamic Brake Effort-230KN

WDP4D-General characteristics

- Two driver cabins with one full width control console in each cabin.
- Each full width control console provides two TFT (Thin Film Transistor) Display –one each for loco pilot and his assistant
- Existing CAB (Short Hood side) is named as CAB#1 and new CAB (Long Hood side) is named as CAB#2
- ECC#4(New mini ECC#1 in rear cab for Loco operation)
- Wider Cab
- Flexibility to provide REMMLOT,DPC in future

WDP4D-Technical feature

- 4500 HP Locomotive for Passenger operation
- Locomotive weight-123±2% T
- Nominal Axle Load -20.5 T
- 5000 liter Fuel Tank Capacity
- Co-Co Axle Configuration
- 460 KN Starting TE
- 230 KN Dynamic Brake Effort
- 130 KMPH maximum operating speed
- 22.5 KMPH minimum continuous speed

WDG5-General Characteristics

- Under frame (Chassis) & Carbody
  - High Strength Lighter Weight Underframe
  - Anti-Climber feature
  - Light weight – carbody access doors – for ease of maintenance
  - Electronic Fuel Gauge near fuel fill
- Cab feature
  - Improved Visibility Cab
  - Heated Windshields For Defogging
  - Air Operated Windshield Wipers
  - Roof Mounted Air-Conditioning & Heating unit
  - Thermo-acoustic insulation in cab wall
- Toilet Compartment
  - Provision for retention toilet / urinal water tank, sink, retention tank

WDG5-Technical Feature

- 20 Cyl - 710 Engine Delivering
- Horse power- 5500 HP
- Electronic Fuel Injection With EMDEC
- Nominal Axle Load-22.3 T
- locomotive weight – 133.8 T
- Fuel tank capacity-8000 L
- 20.98 m (L) x 4.31 m (H) x 3.11 m (W)
- Automatic Engine Start/Stop (AESS) System

Answer the questions .....

1. What do you understand by “Tappet clearance” in Alco engine ? why it is being done?
2. What do you understand by RTMB? Where it is located? How it is being driven?
3. Write the name of various compartment of Alco loco?
4. What is the function of “Grid cooling Blower”. where it is located ?From where it gets power?
5. What is the basic difference between Alco and GM locomotives on basis of engine configuration.
6. Write the name of GM/EMD loco variants.
7. Write the difference between WDG4& WDP4 loco?
8. Which shed is called as “Mother loco shed” for GM/EMD locomotives in IR?.
9. What is the RPM ratio of Crank shaft and Cam shaft in four stroke engine ?
10. What is the function of “Crank case exhaust blower”?where it is located?
11. What is the importance of TSC? How it is driven in Alco loco?
12. What is the function of After cooler ?
13. What do you mean by “Compression pressure” in Alco loco? How it is different from “Peak firing pressure”?
14. What do you understand by ‘Compressor ratio”? What is the C.R of Alco loco?
15. What do you under stand by TRD?

Question continue.....

16.What is SFC of Alco loco? What is its unit?

17.What is supercharging?. How TSC is driven in Alco loco?

18.What is the HP of WDG5?

19. Which model of GM loco having Duel cab?

20. What is the work of FTMB?

Thanking you