



(Govt. of India)
(Ministry of Railways)

HAND BOOK ON WDP4/WDG4 LOCOMOTIVES FOR MAINTENANCE STAFF



(For official use only)
IRCAMTECH/M/GWL/HB/GM loco
October -2013

*Centre
for
Advanced
Maintenance
TECHnology*



Excellence in Maintenance

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**HAND BOOK
ON
WDP4/WDG4 LOCOMOTIVE
FOR
MAINTENANCE STAFF**

FOREWORD

GM locomotive was introduced in Indian Railways services in the year 1999-2000. Due to new version of locomotive, there are various differences from conventional locomotives hence proper knowledge of this technologically upgraded locomotive is necessary to Loco maintenance staff involved in operation and maintenance of these locomotives. The failure of GM Locomotives has a great impact on the reliability of the diesel locomotive. This handbook is prepared for assistance to the staff who are involved in the maintenance and operation of WDP4/WDG4 locomotives.

This hand book not only describes general description of WDP4/WDG4 GM locomotives but care has been taken to explain basic things about WDP4/WDG4 GM locomotives including its description, system details, computer display details and various load parameters with these important features, I am sure that the handbook be highly useful to the concerned staff, to ensure trouble free service of the WDP4/WDG4 GM locomotives.

October, 2013
CAMTECH, GWALIOR

(A R Tupe)
Executive Director

PREFACE

WDG4/WDP4 class of locomotives is high speed, high adhesion, computer controlled and driver friendly Locomotives using state-of-the-art technology.

Proper knowledge of WDP4/WDG4 GM locomotives is necessary to ensure reliability and availability of locomotives. This handbook on WDP4/WDG4 GM locomotives has been prepared by CAMTECH with the objective that those, maintenance staff involved in operation and maintenance of diesel electric locomotives, must be aware of sufficient knowledge of HHP locomotive

Technological Up gradation and learning is a continuous process. Hence feel free to write to us for any addition / modifications or in case you have any suggestion to improve the handbook. Your contribution in this direction shall be highly appreciated.

October, 2013
CAMTECH GWALIOR

(K.P.Yadav)
Director/Mech

CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

IRCAMTECH/M/GWL/HB/GM LOCO/C.S. # XX date -----

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

CORRECTION SLIPS ISSUED

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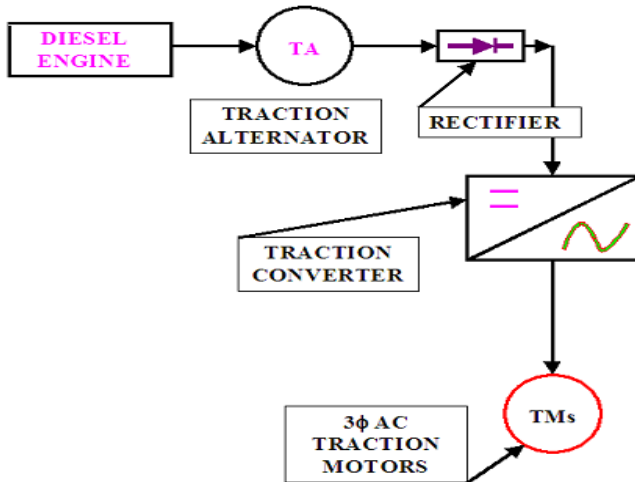
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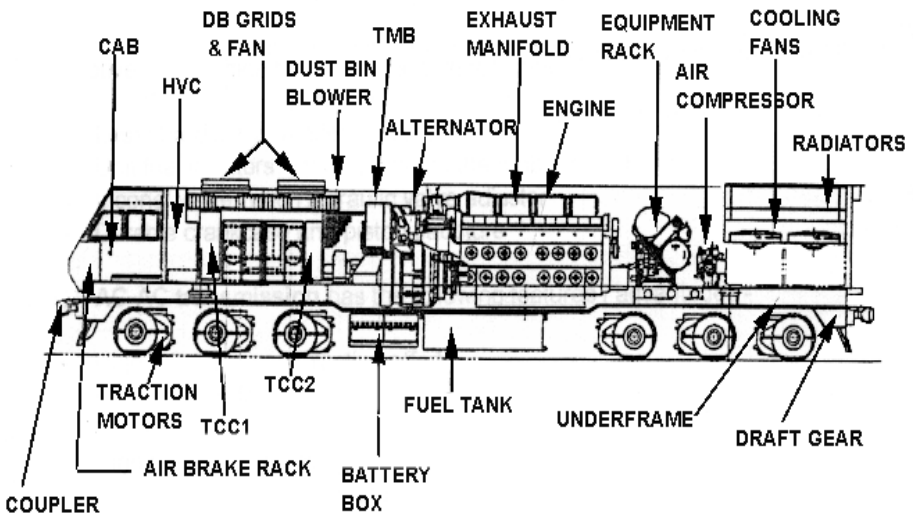
CHAPTER 1

GENERAL INFORMATION

1.1 Basic structure of GM ((EMD) LOCO



1.2 GM LOCO LAYOUT



1.3 LOCOMOTIVE GENERAL DATA – PAC

Locomotive Model Designation..... GT46PAC

Locomotive Type.....A-A-1 1-A-A) 4-2-2-4

Locomotive Power (Nominal)4000 CV (3939 HP)

Power Plant

Engine TypeTurbocharged Two-stroke Diesel

Model.....710G3B

Number of Cylinders..... 16

Full Speed904 RPM

Idle Speed, Normal..... 269 RPM

Idle Speed, Low..... 200 RPM

Model TA17-CA6B Main Generator Assembly

TA17 Traction Alternator Rectified Output

Maximum Potential.....2600 VDC

Max. Continuous Current1250 A

CA6B Companion Alternator Output

Nominal Potential230 VAC

AC Auxiliary Generator

Model..... 5A-8147

Nominal AC Voltage55 VAC

Rectified Potential 74 VDC

Maximum Power Output18 kW

Traction Motors

Model 1TB2622, w/PinionEMD p/n 40086754

Quantity4

Type3 Phase AC Induction

Configuration2 in parallel, per bogie

Traction Inverters (TCC1, TCC2)

DesignationTCC1, TCC2

Model.....1GE420

Quantity2 (one per bogie)

TypeVoltage Source Inverter
with Gate Turn-Off Thyristors

Locomotive Batteries

| | |
|---------------------------------------|---------------------------|
| Type/Model | Ni-Cad/Saft-Nife SRX1500P |
| Quantity | 10 |
| Cells/ Battery | 5 |
| Potential/ Cell) | 1.45 VDC |
| Potential/ across All Batteries | 72.5 VDC |

Air Brake System

| | |
|-------------|---|
| Model | Knorr (NYAB) CCB |
| Type | Electro-Pneumatic (Dynamic Brakes Fully Blended w/ Automatic Brakes) |

Air Compressor

| | |
|------------------------------|-------------------------------------|
| Model | WLNA9BB (Direct Drive) |
| Type | 2-Stage |
| Number of Cylinders | 3 |
| Displacement @ 900 RPM | 7.19 m3/Min. (254 Cu.Ft. / Min.) |
| Cooling Medium | Engine Coolant |
| Lube Oil Capacity | 9.98 litres (2.64 U.S. Gal.) |

Dynamic Brakes

| | |
|------------|---|
| Type | AC Traction Motor Powered, Two parallel 4-grid, 5 Ohm (approx.) circuits |
|------------|---|

Supplies/ Capacities

| | |
|--|---|
| Lube Oil Pan, from bottom to top of dipstick | -371 litres (98 gal.) |
| Engine Cooling Tank | 375 litres (99 gal.) |
| Sand: | 0.226 m3 (8 Ft.3) total; 0.028 m3 (1.0 cu.Ft) /box |
| Fuel Tank | 4000 Litter |

**Major Dimensions (Nominal, w/ 1/2 Variable Supplies)
Height**

| | |
|----------------------------|---------------------|
| Over #2 End Horn | 4.22 m (13' 10.25") |
| Over Engineroom Vent | 4.20 m (13' 9.41") |
| Over Cooling Hood | 4.12 m (13' 6.12") |

Width

| | |
|---------------------------------|--------------------|
| Over Cab | 2.74 m (9' 00") |
| Over Underframe..... | 2.74 m (9' 00") |
| Over Handrails | 2.92 m (9' 7.12") |
| Over Brake Cylinders | 3.07 m (10' 0.87") |
| Cab Sash-to-Sash, Maximum | 3.16 m (10' 4.30) |

Length

| | |
|----------------------------------|---------------------|
| Over Coupler Pulling Faces | 21.24 m (69' 8.38") |
|----------------------------------|---------------------|

Weight

Nominal Axle Load, with/ 4000 liters fuel:

- Approximately 19.5 MT

| | |
|------------------------|-------|
| Weight on Drivers..... | 66.7% |
|------------------------|-------|

Minimum Curve Negotiation

With original equip. "E" type couplers and no buffers:

Single Unit...71.9 Meter (236') Radius - 24.3° Curve

Two Units, Coupled:71.9 Meter (236') Radius -
24.3° Curve

With buffers and draw hooks:

Single Unit:71.9 Meter (236') Radius - 24.3° Curve

Two Units, Coupled:100. Meter (328') Radius -
17.4° Curve

Locomotive Speed Limitations

Note: Limits are based on original equipment, consisting of:

- 77:17 gear ratio
- 1.092 m (43") new diameter wheels, 50% Worn to 1.054m(41.5 inches) diameter

Maximum Speed (protects loco. equipment)160 km/h

Minimum Continuous Speed,

@Max Continuous Tractive Effort44.7 km/h @200 kN

Adhesion/ Tractive Effort

Starting 35%/ 270 kN

Continuous26%/ 200 kN

Dispatchable

Single GT46PAC.....28%/ 214 kN

Multiple GT46PACs.....30%/ 239 kN

Dynamic Braking Effort

Maximum.....160 kN (from 68 km/h to 1 km/h)

1.4 LOCOMOTIVE GENERAL DATA – MAC

Locomotive Model Designation.....GT46MAC

Locomotive Type (C-C) 0660

Locomotive Power (Nominal)4000 CV (3939 HP)

Power Plant

Engine TypeTurbocharged Two-stroke Diesel

Model.....710G3B

Number of Cylinders.....16

Full Speed 904 RPM

Idle Speed, Normal..... 269 RPM

Idle Speed, Low.....200 RPM

Model TA17-CA6B Main Generator Assembly

TA17 Traction Alternator Rectified Output

Maximum Potential.....2600 VDC

Max. Continuous Current1250 A

CA6B Companion Alternator Output

Nominal Potential230 VAC

AC Auxiliary Generator

Model.....5A-8147

Nominal AC Voltage55 VAC

Rectified Potential74 VDC

Maximum Power Output18 kW

Traction Motors

Model.....1TB2622

Number..... 6

Type3 Phase AC Induction

Configuration3 in parallel per bogie

Traction Inverters (TCC1, TCC2)

| | |
|-------------------|--|
| Designation | TCC1, TCC2 |
| Model..... | 1GE420 |
| Quantity | 2 (one per bogie) |
| Type | Voltage Source Inverter with Gate Turn-Off Thyristors |

Locomotive Batteries

| | |
|--------------------------------|-------------------|
| Model | Surrette 16-CH-25 |
| Number | 2 |
| Number of Cells (Each) | 16 |
| Potential (Each Battery) | 32 |
| VDC Rating (8 Hour) | 500 Amp. Hr. |

Air Brake System

| | |
|-------------|-------------------|
| Model | Knorr (NYAB) CCB |
| Type | Electro-Pneumatic |

Air Compressor

| | |
|------------------------------|--|
| Model | WLNA9BB (Direct Drive) |
| Type | 2-Stage |
| Number of Cylinders | 3 |
| Displacement @ 900 RPM | 7.19 m ³ /Min. (254 Cu.Ft. / Min.) |

| | |
|-------------------------|------------------------------|
| Cooling Medium | Engine Coolant |
| Lube Oil Capacity | 9.98 litres (2.64 U.S. Gal.) |

Dynamic Brakes

| | |
|------------|--|
| Type | 8 Grid, AC Traction Motor Powered System |
|------------|--|

Supplies/ Capacities

| | |
|---------------------------|---|
| Lube Oil Pan | 1457 litres (385 gal.) |
| Engine Cooling Tank | 371 litres (99 gal.) |
| Sand | 0.34 m ³ (0.04 m ³ /box) [12 CuFt (1.5 Ft. ³ /box)] |
| Fuel Tank | 6000 litres (1600 U.S. Gal) |

Major Dimensions (Nominal)**Height**

| | |
|-------------------------|--------------------|
| Over Cooling Hood | 4.61 m (13' 7.75") |
| Over Horn | 4.22 m (13' 10") |
| Over Cab | 3.94 m (12' 11") |

Width

| | |
|---------------------------|-------------------|
| Over Handrails | 2.92 m (9' 7.12") |
| OverUnderframe..... | 2.74 m (9' 0") |
| Over Cab | 2.74 m (9' 0") |
| Over Brake Cylinder | 3.07 m (10' 1") |

Length

| | |
|----------------------------------|---------------------|
| Over Coupler Pulling Faces | 21.24 m (69' 8.38") |
|----------------------------------|---------------------|

Weight

| | |
|--------------------------|--------------------------|
| Typically Equipped | 26 010 kg (277,800 lbs.) |
| Weight on Drivers..... | 100% |

Minimum Curve Negotiation

Following data is based on original equipment "F" type couplers.

| | |
|-------------------------|---------------------------------------|
| Single Unit: | 174 Meter (570.8') Radius - 10° Curve |
| Two Units, Coupled..... | 174 Meter (570.8') Radius - 10° Curve |

Locomotive Speed Limitations

Limits are based on original equipment, consisting of:

90:17 gear ratio

1.092 m (43") new diameter wheels,

50% Worn to 1.054 m (41.5 inches) diameter

Maximum Speed (protects loco. equipment)120 km/h

Minimum Continuous Speed

(@Max Continuous Tractive Effort).....22.5 km/h

Tractive Effort

Stall Limit..... 540 kN

Continuous Limit.....400 kN

Reduced TE Limit (Selected on Locomotive Computer Display):

..... 294 kN (66,140 lbf)

Dynamic Braking Effort

Maximum.....270 kN (from 40 km/h to near zero km/h)

1.5 LOCOMOTIVE GENERAL DESCRIPTION:-

The Electro-Motive GT46PAC diesel-electric locomotive is equipped with a turbocharged 16 cylinder diesel engine, which drives the traction alternator. (The traction alternator is an important component of the main generator assembly.) The traction alternator converts diesel engine mechanical power into alternating current electrical power. Internal rectifier banks in the main generator assembly convert traction alternator output alternating current to direct current.

Rectified DC power produced by the traction alternator is distributed through the DC link to DC/AC inverters in the Traction Control (TC) cabinet. Based on inputs from the locomotive computer (EM2000), traction inverters supply 3-phase AC power to four traction motors. The EM2000 responds to input signals from operating controls and feedback signals from the power equipment.

The traction control converter (TCC) is an electrical device that can convert AC to DC and invert DC into AC (traction power). The terms converter and inverter are used interchangeably in this manual.

Each traction motor is geared directly, with a single pinion, to a pair of driving wheels. The maximum speed of the locomotive is set by locomotive gear ratio (ratio of traction motor revolutions to wheel revolutions) and wheel size.

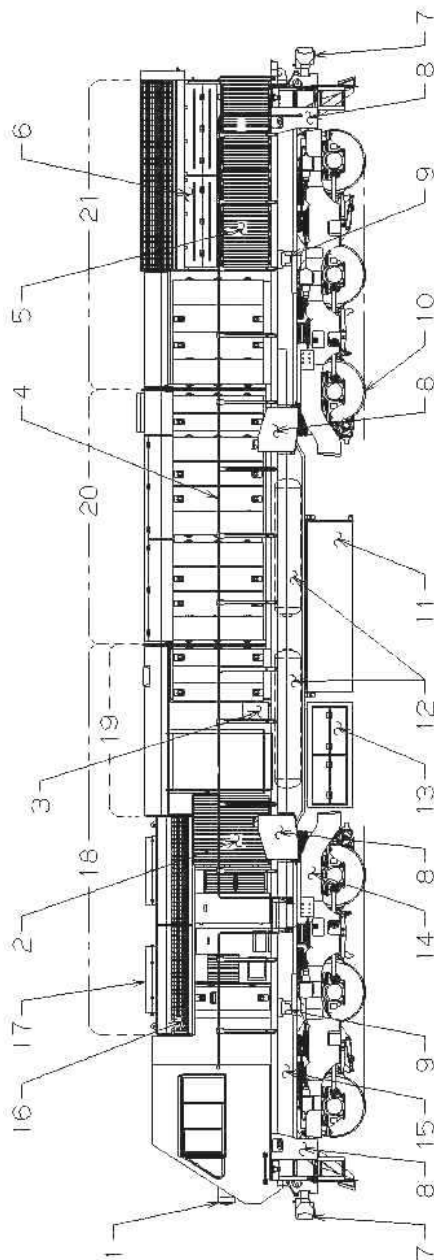
Although each GT46PAC locomotive is an independent power source, a number of locomotives may be combined in a multiple-unit (MU) tandem to increase total

load capacity. The locomotives in tandem may be equipped with either AC or DC traction motors. Operating control functions are trainlined through a 27-conductor MU cable. This enables the lead unit to simultaneously control other locomotives in tandem.

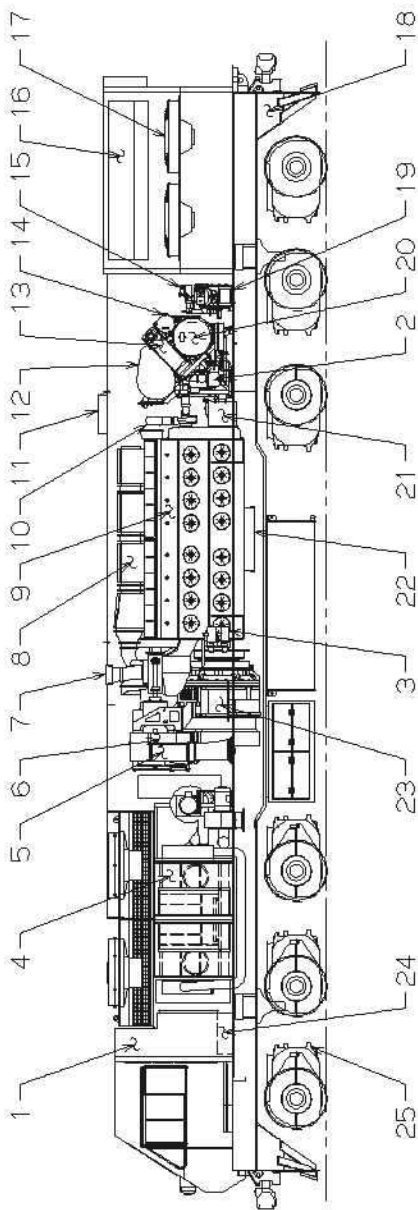
The GT46 PAC & MAC short hood or cab end is considered the front of the locomotive, although the GT46PAC can be operated in either direction. The cab has two drivers consoles: one forward facing and one rearward facing.

Note: When a GT46PAC is the lead unit, with its cab end leading, the left side (No. 1) control console provides the best view ahead for the driver. When the locomotive is operated as the lead unit, with the cab end trailing, the right side (No. 2) control console provides the best view ahead. Trailing GT46PAC may be set up with the cab end leading or trailing.

The front of the No. 1 electrical control cabinet is the back wall of the locomotive cab. The EM2000 locomotive computer display, mounted on the front of the cabinet, indicates locomotive operating conditions, faults, and troubleshooting information from the locomotive computer.

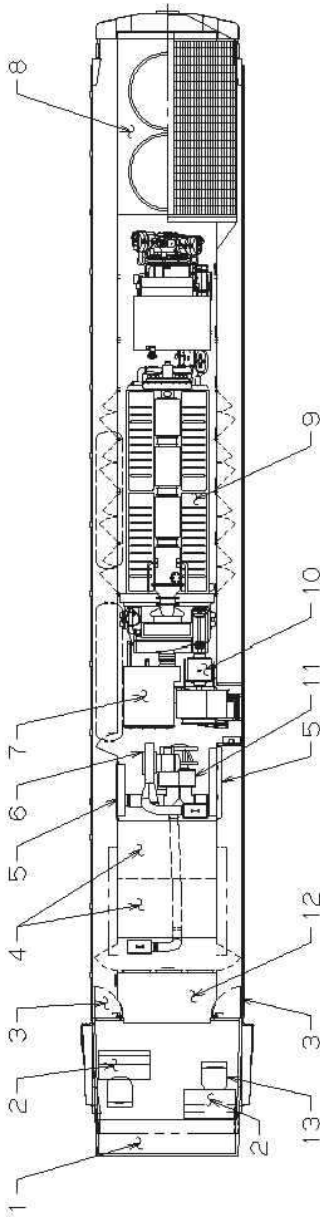


- | | |
|---|---|
| 1) Head light | 10). Wheels (6) |
| 2) Inertial Filter Air Inlet | 11). Fuel Tank |
| 3) Starting Fuse and Battery Knife Switch | 12). Compressed Air System Main Reservoirs |
| 4) Handrails | 13). Battery Box |
| 5) Cooling System Air Inlet | 14). Trucks (3 axle 3 motor HTSC type) Qty. 2 |
| 6) Radiator and Fan Access | 15). Under frame |
| 7) Coupler "E/F" Type | 16). Dynamic Brake Grids |
| 8) Sanding Box (8) | 17). Dynamic Brake Fans (2) |
| 9) Jacking Pads (4) | |



- 1) Electrical Control Cabinet
- 2) Fuel Pump
- 3) Engine Starting Motors
- 4) Traction Control Cabinet
- 5) Traction Motor Cooling Air Blower
- 6) Main Generator/Companion Alternator Blower
- 7) Engine Exhaust Stack
- 8) Engine Exhaust Manifold
- 9) 16-710G3B Diesel Engine
- 10) Governor
- 11) Engine room Vent
- 12) Engine Water Tank
- 13) Lube Oil Cooler

- 14) Primary Fuel Filter
- 15) Air Compressor
- 16) Radiators
- 17) AC Radiator Cooling Fans (2)
- 18) Draft Gear
- 19) Air Compressor Air Filter
- 20) Lube Oil Filter Tank
- 21) Lube Oil Strainer
- 22) Lube Oil Sump
- 23) Main Generator/ Companion Alternator
- 24) Electrical Control Cabinet Air Filter Box
- 25) Traction Motors (6)



- 1) Air Brake Rack
- 2) Engineers Control Console
- 3) Cab Door
- 4) Traction Control Cabinets
- 5) Inertial Air Filters
- 6) TCC Electronics Blower
- 7) Engine Air Filter
- 8) Radiators
- 9) Engine
- 10) AC Auxiliary Generator
- 11) Inertial Filter Dust Bin Blower and Motor
- 12) Electrical Control Cabinet
- 13) Cab Seat

CHAPTER 2

ELECTRICAL SYSTEM

GT46 MAC/PAC locomotives are equipped with 710 G3B type of Diesel Engine. The crankshaft of the Diesel Engine is directly coupled to the main alternator of TA17-CA6B type. The control for production and utilization of power is established through an elaborate electronic circuitry comprising of one main locomotive computer called EM 2000 and two traction computers called ASG computers. The brake system has a separate computer for itself.

The starting of the engine is established through two starting motors. These motors get their power supply from the batteries through starting contactors ST & STA. Once engine is cranked the ST and STA contactors drop out and the power supply to starting motors is cut off.

After the engine is cranked the power supply for the control circuit is through Auxiliary Generator output. The AG is responsible for power supply to the whole of control circuit and the charging of batteries through battery charging assembly (BCA).

The computers (EM 2000, ASG1&2, CCB) get their power supply from the batteries when the loco is in shut down condition and from BCA output if loco is in cranked condition. EM 2000 gets its power supply from batteries/ AG output through PSM cards. The PSM cards get their input from battery/ AG through PRG which ensures that the supply for PSM cards is within acceptable voltage range by suitably regulating the battery/AG output voltage. PSM 300 and PSM 310 give +5V & +/- 12V respectively for EM 2000.

The PSM 320 gives +/- 15V which forms input for PDPs, ASC, Display, FCF and Radar. The companion alternator is housed with TA in one common enclosure and it gets its field excitation from AG output and produces three phase AC. This three phase AC is used for radiator fans, inertial blower, TCC1 & 2 blowers, TCC electronic blower and the field excitation of main alternator. The excitation of main alternator field is effected and controlled through SCR assembly. The firing pulses to SCR assembly are supplied by FCD after amplification of weak gate signals generated by CPU of EM 2000.

The control of field excitation of Main Alternator is effected with the coordination of CPU, FCD & FCF. FCF supplies CA voltage and frequency data on which CPU counts the time necessary before generating a gate pulse. The generated pulse is a weak gate pulse which is amplified by FCD and applied across the gate of SCR unit. In this way, a wide range of power output from Main Alternator is obtained.

The 3 phase output thus generated is rectified through two rectifier banks inside the main alternator housing. The rectified output is available as DC link voltage which is applied across the two TCC units when loco is required to be propelled or across the 8 grid resistors through contactors B1, B2, B3 and B4 in case of Load Test.

The output of the Main Generator is available as DC link voltage which is applied across the two traction control converters. The DC available is processed by the TCCs to invert it into AC supply which is applied across the traction motors. The TCC1 is responsible for power supply to TMs of Truck 1 and TCC2 for Truck 2. The

operation of TCCs is controlled by individual ASG computers for the two TCCs. The response of ASG depends on the demand received from EM 2000. The requirement of different speeds and torque is met by controlling the firing signal to the gate unit of GTOs in TCC units by the ASG. Thus various ranges of Torque and speed can be obtained.

CHAPTER 3

LOCOMOTIVE CAB

The equipments mounted in the cab mainly form the interface between the driver and the locomotive. The main equipments are:-

3.1 Engine Control Panel:

Following switches and controls are mounted on ENGINE CONTROL PANEL:-

- i. Isolation switch
- ii. Classification light switch
- iii. EFCO switch (Emergency Fuel Cut Off switch)
- iv. DB cut out slide switch
- v. Battery charging Ammeter
- vi. Exterior Lights & Maintenance lights, switches.
- vii. Alerter Alvern

3.2 Circuit Breaker Panel:

It contains circuit breakers used for control and protection of Diesel Engine and Electrical system of the locomotive. It also consists of test points for measuring voltage of battery companion alternator and load regulator which is useful for trouble shooting purpose.

3.3 Control console: The loco cab houses two control consoles for the movement of loco in Forward/Reverse direction. The control console is mounted with all operating and indication devices which are needed for the loco operator to interact with the locomotive. Each console has a switch panel on the left lower section which contains switches for cab lights & fans, flasher lights and gauge lights each control console consists of

Dynamic Controller, Air Brake Controller, Various gauges, Horn, Sander & Head light switches and indication panel.

In addition to control console 1, It has control and operating switch panel which consists of slide switches for Engine Run Switch, Generator Field Switch, Control & Fuel Pump Switch and a push button switch for MU Engine stop.

CHAPTER 4 ELECTRICAL CONTROL CABINETS

4.1 ELECTRICAL CONTROL CABINET # 1 This cabinet located at the back side of the driver cab with the display to the front of ECC1. It houses some of the electrical and electronic equipments needed to control the locomotive. These equipments include:-

- i. Locomotive control computer (EM 2000).
- ii. Panel mounted modules (ASC, TLF, FCD, FCF, DVR).
- iii. Braking contactors (B1, B2, B3, B4)
- iv. DC Link transfer switch
- v. SCR assembly
- vi. GTO power supply (GTO PS1 & 2)
- vii. Current and voltage transducers
- viii. Contactors and Relays
- ix. Ground Relay Circuitry
- x. Various circuit resistances
- xi. Diode input panels (DIP 30, 31 & 32)
- xii. Power Distribution Panels (PDP)
- xiii. Circuit breaker panel.

This cabinet is subjected to high voltages and currents; hence it should not be opened without following proper safety precautions:

4.2 ELECTRICAL CONTROL CABINET #2: ECC2 is located in the underframe of the locomotive between Truck 1 and the Fuel tank. It houses:

- i. ST& STA contactors
- ii. Battery charging assembly

- iii. Auxiliary Generator circuit breaker (250A)
- iv. Terminal Board for connecting ECC2 components to external system
- v. DC link reactor core.

4.3 ELECTRICAL CONTROL CABINET #3: It is located near the equipment rack. It is also called AC cabinet. It contains:-

- i. Radiator Fan contactors
- ii. 300 Amps radiator fan fuses or circuit breakers
- iii. Main Reservoir pressure transducer
- iv. Diode input panel DIP 80

All the three electrical control cabinets are pressurized cabinets.

4.4 BATTERY KNIFE SWITCH COMPARTMENT: It contains one 800 Amps starting fuse and Battery knife switch. The battery switch should be kept closed and never opened when the loco is in cranked condition.

CHAPTER 5

EM 2000 COMPUTER

The EM 2000 is responsible for the total functioning of the Locomotive including Traction System and Air Brake System. Some of the important function of EM 2000 are outlined below:-

5.1 EXCITATION: It controls the excitation of the Main Alternator field supply by varying the timing of the gate pulses of the SCR assembly.

5.2 I/O LOGIC: It Monitors the position of control devices in the cab and monitors and control ON/OFF devices on the locomotive, eg: Governor speed Solenoids Contactors, Relays, Magnet valves. It controls the Alerter vigilance system also.

5.3 DISPLAY: It accepts inputs from CPU. Display information on the display screen and initiate diagnostic functions through display panel.

5.4 COM 301: The EM 2000 consists of: **COM 301:** Communication interface between EM 2000,TCC1, TCC2, KNORR Air brake computers & Event Recorder.

5.4.1 MEM 300: Stores fault data and operational data, and all the relevant data for locomotive operation.

5.4.2 ADA 305: Handles scaled analog inputs directly as well as through ASC and converts them to digital signals for the computer. It is also responsible for converting digital signals from CPU to analog signal that is required by receiving devices like TE Meter, SpeedoMeter.

5.4.3 CPU 302: It is the Brain of EM 2000 which controls the total working of the locomotive, through all other computer/panel mounted modules.

5.4.4 DIO: These are three in number (namely 1, 2, and 3 from left to right) and inter changeable also. These are known as Digital Input and Output Modules. It acts as an interface between Locomotive 74V DC control system and computer 5V DC system. Input signals come from Breakers, Switches, Relay/Contactor inter locks giving the status of each. The output is either 74V DC or 0V DC across a relay or contactor coil, so the relay/ contactor is either picked up or dropped out. Each DIO has 24 inputs and 26 output channels.

5.4.5 DISPLAY: The display is used for information regarding any crew message, and also has key pad with 16 keys for use in recovering data, fault analysis, and to give commands to the computer to activate set of programs like self tests, Traction Cutout, Isolation of speed signals, etc., It is mounted on the ECC1 door above the EM 2000.

CHAPTER 6

PANEL MOUNTED MODULES

The panel mounted modules are mounted directly to the rear panel of the high voltage cabinet. These components interface directly with the 74V DC analog systems and high voltage circuits on the locomotive. They are mounted separately away from the EM 2000 chassis for the purpose of electro-magnetic isolation.

6.1 ASC 300: ASC serves to condition analog feedback into DC voltage signals that can be handled by ADA. The signals conditioned by ASC are

1. TL 24 T – Dynamic Brake Reference signal.
2. Main Generator current transformer amperage.
3. LR – Load Regulator signal.
4. Power supply for Barometric pressure transducer.

6.2 FCD 300: Firing Circuit driver – This module contains the gate Amplifier circuitry needed to amplify the weak gate signals that are sent from the CPU. Power for the gate amplifier circuitry is from the three phase Auxiliary Generator. A green LED on the module illuminates to indicate gate amplifier power is present.

6.3 FCF 301: Firing Circuit Feedback – It is responsible for informing the CPU, when ever each phase of the Companion Alternator is crossing the zero line from neg half to positive half so that the CPU can calculate the amount of field current required and accordingly initiate a weak gate pulse at the appropriate angle to each SCR for the excitation of the Main Alternator.

6.4 TLF 301: Train Line Filter – This is connected to the MU signals, to keep the DIO channels from going High erroneously; so that no stray voltage is passed on to the DIO. A total of 12 inputs are filtered by TLF.

6.5 DVR 300: Digital Voltage Regulator – DVR regulates AG. field for maintaining a constant 55V 3O AC output from AG. (74V DC). In case of over voltage, it takes several steps to rectify the situation last of which it trips the Aux. Gen. Field breaker.

CHAPTER 7

MAINTENANCE OF COMPUTER MODULES

1. Check all holding screws for tightness & ensure proper insertion of all computer modules.
2. Keep the computer modules, chassis clean, by removing dust with vacuum cleaner.

7.1 PANEL MOUNTED MODULES:

1. Check all front connector plugs and replace broken plugs, over heated female pins and holding screws.
2. Check wiring of plugs for proper insertion and contact. Use insulator wherever cables are touching on the body of locomotive or equipment.

7.2 POWER SUPPLY MODULES:

1. Insert in nominated slot properly and keep holding screw in tight condition.
2. Check PRG connector (on back) for proper fitment in plug.
3. Check all rear plugs on the computer chassis for proper fitment.
4. Check that flat ribbon cable is not rubbing on body of chassis and insulate wherever necessary.
5. Check all power distribution plugs and provide holding screws wherever missing.

CHAPTER 8

BATTERY

The locomotive is fitted with 500 A lead acid batteries. Each loco contains 8 batteries each having 4 cells. These batteries supply power during cranking for the cranking motors and the low voltage control circuit.

SCHEDULES:

1. Clean the batteries and blow with compressed air.
2. Visually examine the batteries for any terminal cracks, cable overheating marks, any leakage.
3. Remove the vent plugs and clean properly.
4. Record cell voltage (2-2.2V), specific gravity (1.40-1.60), cell temperature (27-38C) and electrolyte level (45 +/-5mm).
5. Ensure tightness of inter connection cables.
6. Ensure that batteries are properly packed in the battery box and there is no rubbing of cables.

Note:

Work on Removed Batteries:-

1. In case any cell is weak, the battery to be removed and new/reconditioned battery to be provided. The removed battery to be reconditioned as per MIS.
2. Whenever batteries are separately charged, ensure that cell temperature does not increase beyond 45 °C
3. Ensure proper electrolyte level during charging.
4. Ensure proper setting of charging current and voltage.
5. Keep the batteries clean & dry.

CHAPTER 9 ROTATING EQUIPMENTS

9.1 TRACTION ALTERNATOR: Diesel Electric Locomotive uses a Main Alternator to convert Mechanical power developed by the Diesel Engine into electrical power. The main alternator is a 3 phase alternator with two independent and inter woven sets of stator windings and a rotating field common to both the windings, in order to provide a higher output voltage.

The Traction Alternator houses two rectifier banks for converting AC into DC these are permanently connected in series



Model – TA 17

Max Voltage – Rectifier output – 3000V DC.

Min Voltage – Rectifier output – 600V DC.

BRUSH CONDEMN – 38mm.

Slip Rings – Min dia – 260mm.

No. of Fuses/bank – 15 (8407729)

No. of +ve diode/bank – 15 (White) (40029132)

No. of –ve diode/bank – 15 (Pink) (40029131)

Fuses – Pin protrudes to indicate blown Fuse.

Max. Permissible Blown fuses = 6.

SCHEDULES:

MONTHLY

1. Check brush sizes.
2. Check condition of Slip rings (surface should be smooth).
3. Check for blown fuses (Blown out fuse indicates 1 or 2 shorted diodes) change diodes with special diode socket.
4. Check and clean Generator pit aspirator.

3 MONTHLY

1. In addition to above, remove all Rectifier bank covers and blow with dry compressed air.
2. Clean Rectifier banks with cleaning Solvent (Orion 77) & again blow.
3. Check all connections, diodes and tighten.
4. Check suppression resistance and capacitors.
5. Clean all covers and refit.

Note: The air pressure for blowing should be kept as minimum as possible.

6 MONTHLY

1. In addition to above Reverse polarity of collector rings connections at the terminal board.
- Further Refer MI – 3317 -2, LSM – 8-3 to 8-13.

9.2 COMPANION ALTERNATOR: The companion Alternator is physically connected but Electrically independent of the Traction Alternator. The Companion Alternator field (rotating field) is excited by a low voltage current output from Aux. Generator through a pair of slip rings adjacent to the slip rings of the main alternator. The 3 phase AC output of the Companion Alternator coming from the stationary armature (stator) is connected to a terminal board on the left bottom of the Companion Alternator.

There are no controls in the Companion Alternator excitation circuit, thus it will be excited and developing



power whenever the diesel engine is running and Auxiliary Generator is producing output. Output voltage frequency will vary with speed of engine, alternator winding temperature and load. The Companion Alternator provides power to the initial filter blower motor, radiator blower motors, TCC blower

motors, TCC Electronic Blower motor and excitation of the Main Generator field through SCRs. (3 Silicon Controlled Rectifiers).

Type – CA 6B

Power – 250KVA at 0.8 PF.

Voltage – 45-220V 3 Ph AC.

Max. Frequency – 120 Cycles/Sec at 900 rpm.

Max. Current – 600 amps.

Brush grade – AY.

No. of Brushes – 4 (+ 2 Nos. –ve 2 Nos.)

Length – 38mm.

SCHEDULES:

MONTHLY

1. Check condition of brushes, condition of pigtails (condemn size – 38mm).
2. Check condition of Slip rings for sparking and clean surface with dry cloth and remove dirt, oil etc.,
3. Check slackness of slip ring bolts.

3 MONTHLY

1. Same as above.

2. Blow out with dry compressed air.
3. Check Terminal connections and clean.
4. Reverse polarity at collector ring connections.

9.3 AC AUXILIARY GENERATOR (BRUSH LESS):



F19363

The AC auxiliary Generator consists of a pilot exciter assembly and a three phase AC Auxiliary Generator Field and armature assembly.

The pilot exciter assembly consists of a Stationary field, a rotating armature and rotating rectifier assembly. The AC Auxiliary Generator has a rotating field and stationary armature. The pilot exciter rotating armature and rotating rectifier assembly and the AC Auxiliary Generator rotating field are installed on a common shaft. During start up, residual magnetism of the pilot exciter stationary field induces voltage on the pilot exciter rotating armature. This AC voltage is rectified by the pilot exciter rectifier assembly and applied to the AC Auxiliary Generator rotating field. This rotating field induces voltage in the AC auxiliary generator stationary armature (stator).

The small AC output voltage of the auxiliary generator is applied to the DVR (Digital Voltage Regulator Module).

The Low AC Signal is used by DVR to determine if the Aux. Generator is turning, if it does, DVR will allow current from the batteries to flow in the exciter field of the Aux. Generator in order to produce the 3 phase 55V AC output.

Model – 5A – 8147

Output – 18 KW at 55V AC

The Aux. Generator supplies voltage to the 2 GTO power supplies, panel mounted module FCD (Firing control driver) and also to the full wave 3 phase rectifier (Battery Charger) assembly to obtain 74V DC for battery charging, companion alternator excitation and low voltage DC control power.

SCHEDULES:

MONTHLY

1. Check condition of Aux. Generator Flexible shaft and tightness of Fastener.
2. Check condition of Diode Plate, soldered connections, and clean with dry cloth.

3 MONTHLY

1. Remove covers and blow with dry compressed air.
2. Check as above and clean diode plate with solvent (Orion 77).

9.4 DYNAMIC BRAKE GRID BLOWER ASSEMBLY:



F23903

Model – DC Series Motor.

No. of Poles – 4

Capacity – 36 HP

Brush Condemn Length – 25.4 mm (1”) Each Dynamic Brake Grid cooling blower assembly consists of a 48” 10 blade fan powered by a series wound DC motor. During Dynamic Braking the locomotive Traction Motors operate as Generators supplying AC power to inverters. The inverters convert AC power into DC voltage and supply back to the DC link. The DC link is connected across the grids through contactors B1, B2, B3 & B4 and the Braking energy is dissipated as heat. A portion of the electrical grid is used to power grid blower motor (36 HP). To dissipate grid heat to atmosphere.

SCHEDULES:

MONTHLY

1. Check for any unusual sound from grid blower motor.
2. Check for sparking on commutator.
3. Check condition of commutator
4. Check condition of brush holders, brush pigtails etc.,
5. Record brush sizes (Min – 25.4m).

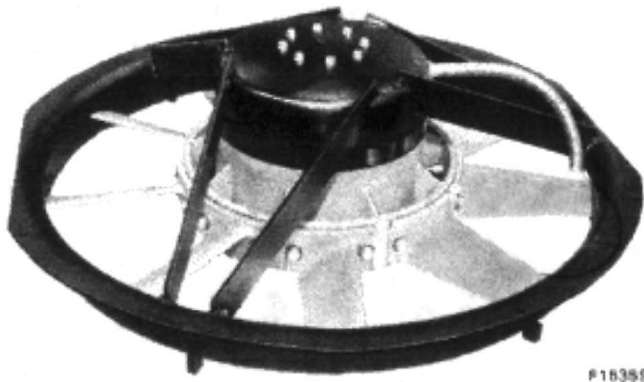
6. Check all connections.
7. Clean all insulators, commutator surface with dry cloth.

3 MONTHLY – Same as above. In addition remove covers and blow with dry compressed air and clean.

1. Check condition of Fan Blades for cracks or breakage.
2. Check condition of frame bolts and tighten.

3 YEARLY –To be unloaded & OHL and fitted. Refer MI 4104 for OHL procedure and torque values.

9.5 RADIATOR COOLING FAN MOTORS:



These motors are of inverted squirrel cage induction type and are an integral part of the cooling fan assembly. The term inverted indicates that they differ from the conventional squirrel cage motor in that the rotor is located outside the stator.

Two 52" Cooling Fans (8 blades) which operate independently are located at the hood under the radiators and blow the cooling air upwards through the radiator cores. They are numbered 1 and 2 with No. 1 close to the cab.

For fuel efficiency each cooling fan is driven by 2 speed

AC Motor which in turn is powered by the Companion Alternator. As the engine coolant temperature rises the fans are energized by the computer control system through radiator fan contactors in slow speed and then in fast speed. Water Temperature Sensors ETP1 and ETP2 give the temperature of the coolant to the computer.

SCHEDULES :

MONTHLY –

Check for any unusual sound, wobble etc.

3 MONTHLY –

Check for proper torquing of fan – Refer MI.

9.6 TCC ELECTRONIC BLOWER:

The cooling of TCC1 & TCC2 Electronic Components is effected by air supplied from TCC Electronic blower. Air is drawn from the central air compartment through 3 phase, TCC Electronic blower motor powered by the Companion Alternator and sent through 2 separate hose pipe and to each TCC filter (Dynacell). This air is used for cooling and pressurizing in some (but not all) parts of the inverter cabinet. The filter keeps dirt from contaminating areas containing DC Link Capacitors, Gate units and Traction Computers.

SCHEDULES:

MONTHLY

1. Check for any unusual sound or heat near bearings on motor junction box.
2. Check for rubbing of impeller on housing.
3. Check condition of base bolts/frame bolts.
4. Check for damage of hoses.

3 MONTHLY

1. Same as above, Clean body with Soap Water.

2. Record each phase current and check whether all are balanced on 1st and 8th notch.

6 MONTHLY -

Same as above.

9.7 FILTER BLOWER MOTOR:

The filter blower motor is located just below the TCC electronic blower motor. The dust in the air which is removed by the cyclonic filter and collected at its bottom is drawn by the dust bin blower through hoses fitted on each cyclonic filter and thrown to the underframe of the locomotive through the passage below, this way the dust in the atmosphere air is removed in the central air compartment.

SCHEDULE ATTENTION –

Same as TCC Electronic Blower.

9.8 FUEL PUMP MOTOR:

The Fuel Pump Motor is a $\frac{3}{4}$ HP 1200 rpm AC Motor which has inbuilt inverter to convert the 74V DC supply into 3 phase 55V AC. The pump supplies oil to the system through primary and secondary spin on filters. To protect the motor pump and to regulate fuel pressure the by pass gauge and by pass relief valves are provided. For easy maintenance the fuel inlet and outlet of the injector is passed through sight glasses.

The Fuel pump is mounted on the equipment rack. The motor is directly coupled to the fuel pump. During engine operation the pump supplies fuel oil for combustion and injector cooling. A by pass valve is connected across the primary filter that protects the motor against overloading due to filter plugging.

SCHEDULES: MONTHLY

1. Rotate shaft by hand & check for free rotation.
2. Check current during starting & in running.

Please Note :

1. If oil appears in bye pass or fuel inlet sight glass, it indicates the filter is choked.
2. If bubbles are observed in the return sight glass, there is a suction leak or leaky injector.

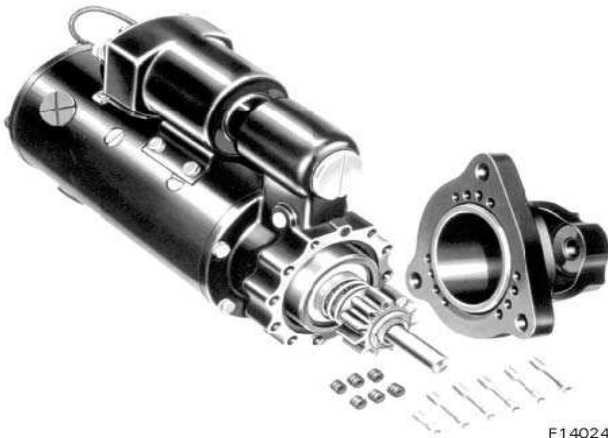
SCHEDULES: MONTHLY

1. Suction strainer cleaning (observe 'O' ring condition).
2. Checking of fuel lines.
3. Checking of fuel leak.

90 DAYS

1. Primary filter changing (Observe 'O' ring condition) and fit properly.
2. Secondary filter changing.

9.9 STARTING MOTORS AND SOLENOIDS:



The loco is equipped with two starting motors each having two solenoids called pick up and holding solenoids. The starting motor solenoids are mounted on

the starting motor housings. It contains concentrically wound PU (Pickup) and Hold coils. When energized by the pickup of STA contactor, the low resistance PU coil drives forward the starter motor pinion. To engage with the engine fly wheel ring wear. The switch inside solenoid closes when pinion is fully traveled resulting contactor pick up which in turn shorts out the PU coil. The high resistance HOLD coil, has sufficient energy to hold the pinion engaged. When the cranking signal is removed, the starting contactors drop out and starting motors pinions dis-engage from the engine ring gear. These motors are 64V DC series motors which are connected in parallel for cranking. Power circuits to the motors are inter locked so that the pinions of both starting motors must be engaged with the engine ring gear before cranking power can be applied for the motor.

9.10 TURBO LUBE PUMP MOTOR:

Model – 4 Pole $\frac{3}{4}$ HP.

RPM – 1200

Voltage – 64-74V DC

The Turbo Lube Pump Motor is a $\frac{3}{4}$ HP, 1200 rpm 64-74V DC Motor assembly, coupled directly to a lubrication oil pump and mounted at engine crank case on the left side of the locomotive. During engine startup, the pump provides lubrication for the Turbo Charger bearings and at shut down the computer (EM 2000) continues pump operation to carry away remaining heat from the Turbo Charger bearings.

SCHEDULES:

MONTHLY

1. Rotate the meter with hand and check for free rotation.
2. Check condition of brushes, and replace if necessary.
3. Check condition of commutator surface and clean with dry compressed air.

4. Check condition of brush holder springs for overheating, damage etc.
5. Brush condemned size – 19mm.

3 MONTHLY

1. Same as above.
2. Remove covers and blow with dry compressed air.
3. Check condition of base bolts tighten.

9.11 AC Traction Motors

AC-AC transmission has the advantage of high adhesion and high tractive effort, maintenance free Siemens



ITB - 2622 - OTA02 Three phase AC traction motors, high reliability and availability and higher energy efficiency. A specialty of this motor is that there is no separate stator frame resulting

in reduction of weight. In braking mode, the three-phase motors act as generators and power is fed back to the DC link via the two inverters.

CHAPTER 10 PROPULSION SYSTEM

10.1 TCC: Traction Control converter controls locomotive operation in power and dynamic brake

The DCL supply which is generated by the Main Alternator is converted to three phase alternating current by these converters for driving the traction motors during motoring/dynamic braking.

It consists of a computer (Sibas), three phase modules (Where DCL Voltage is converted to three phase AC Voltage) and a protection system (IPS) for protecting the Electrical/Electronic components during any undesired eventuality.

The computer consists of 33 Electronic Cards for assisting/controlling in the working of the Traction Converter. The cards are

Z2

Its purpose is to smooth potentially damaging transients on the 74 VDC supply to the TC.

C157

The main responsibilities of the Start-up unit include protection of the traction Computer, as well as providing a supply of smooth 74 VDC to the TC blowers and Power supply boards.

C139

C139 receives battery voltage from C157 and creates a+5 VDC supply.

C121

C121 receives battery voltage from C157 and creates a+15 & -15 VDC supply.

C147

C147 receives battery voltage from C157 and creates

a+24 & -24 VDC supply.

G129

This board buffers the secondary supply voltages of 5, ± 15 , & ± 24 VDC to the TC (74 VDC being the primary supply).

G075

This board can handle up to 8 temperature feedback signals. Each channel provides a constant 2 mA signal to a temperature sensitive resistor. The voltage drop across this thermo-resistor to which the current is applied is measured by the board.

G059, G067

This PCB handles all analog feedback signals (except temperatures), such as DC Link Voltage input and output phase current input as well as digital pulse inputs from traction motor speed pick-ups.

C043

This module receives data from the Input/output Boards G059 & G067. The main purpose of this module is to act as an isolation buffer to protect the rest of the TC from potentially harmful spikes that may occur on feedback lines.

C059 Its main purpose is to convert analog signals into digital equivalents that can be understood by the Central Computer CO27.

C075, C083

The primary function, as the name implies, is to prepare binary feedback for the data bus. Other functions of this board include TCC identification, fault code indication, and residence for commissioning switches. The faceplate of the module has two 7-segment LED displays. These units illuminate whenever the TC operates to indicate any active fault.

G035, G043

These modules take the 15 VDC pulses sent from the Control Set Converter CO11 and convert them to 24 VDC/ 100 mA current signals that can be used by the Gate Units. The module also contains feedback channels used for Gate Unit Monitoring signals.

C003

Data exchange between the EM2000 and each Traction Computer takes place continually over a serial communications link called the RS-485. In order to facilitate this, the EM2000 implements a module called COM300. At the other end of the Link, the Traction Computer employs a very similar design in that the Serial Link C003 preforms this duty.

C027

The CPU module contains the microprocessor that exercises control over the entire TC. Many of the system control modules contain microprocessors for various purposes. This module, though, contains the main processor. It is in a sense the “Conductor of the orchestra”. All functions for TC are “Supervised” by the Central Computer. The board uses an 80186 microprocessor clocked at 8 MHz.

C035

The Memory module contains all of the EPROM chips required for storing the Central Computer’s program as well as all of the chips that makes up the system’s RAM.

C051

This board is dedicated to making flux calculation with the assistance of the vector Calculator, (board G051), which determines phase shifts between voltage and current.

G051

The function for the vector calculator is to develop values which represent phase angles and how they change in a rotating coordinate system. The Vector Calculator uses voltage and current feedback data from the Input/output modules G059 & G067 in its calculations.

C011

The Control Set Converter, sometimes referred to as the sub-processor, holds the data that tells exactly how the GTOs should fire for different torque requests.

C091

The Control Systems monitoring board acts as an inverter regulator. If an overcurrent or overvoltage condition exists somewhere in the TCC, the Control Systems Monitoring board can initiate "Total Blocking" in an attempt to eliminate the condition.

G019 & G027

Each recorder acts as an extension of the fault archive capabilities.

G003 & G011

The amplifiers provide access to a number of signals via front connector test points. A total of 24 analog and 4 binary signal can be passed through each module. The Three phase modules are for inverting the DCL supply into three phase AC power supply to the Traction Motors. Each phase module consists of 2 GTOs (thyristors). A GTO turns 'ON' when its gate is given supply and 'OFF' when the supply is removed one wheeling diode is connected in parallel to each GTO, but Reverse

biased. Snubber elements are also used in the circuit for limiting voltage spikes created by GTO switching.

Gate units are externally fitted on each phase module which serves as an interface between the Traction Computer(TC) and the GTOs. It consists of two gate drivers and a two channel controller with LED indications.

RED LED – indicates firing pulse received from TC.

GREEN LED – indicates No firing pulse received from TC.

YELLOW LED – Indicates Fault condition either firing pulse not received by GTO, or signal lost on Gate Unit wiring or Bus bars from gate unit to phase module.

The snubber circuit within the phase module consists of 6 capacitors (C1, C2, C3, C4, C5 & C6) 3 Resistors (R1, R2, R3) and 2 Diodes (V5, V6). The snubber circuit acts to limit voltage spikes on the AC side of the inverter due to GTO switching. An external ribbon grid type snubber resistor consumes overloads of the snubber circuit within the phase modules.

Power circuit parts in the inverter can be damaged as a result of over voltages, currents, power supply failures or other faults, eg: like power to a gate unit missing may damage a phase module. Hence a protection system is necessary for protecting the equipment in the Traction Converter Cabinet. For this reason, an inverter protection system (IPS) is provided in the system.

The protection system protects the electronic equipment by discharging the power supply (DCL) to the system. For this two type of rapid discharge mechanisms are implemented in the TCC. They are called as Crow bars. One is referred as hard Crow bar and the other is called as Soft Crow bar.

In Electronic term a Crow bar means a short circuit.

Hard crow bar means a Direct short circuit of the DCL supply. Soft crowbar also means a short circuit, but with an added Resistance in the path of the short circuit. Thyristor Control Board (TCB) fires a hard or soft crowbar with a signal from the computer (Sibas). For firing a hard crowbar the computer initiates the supply to a thyristor (SCR) which shorts the DCL power supply. For firing a soft crow bar the discharge is through the additional resistor and thyristor; so that the discharge is not instantaneous like a hard crow bar but gradual.

10.2 ELECTROSTATIC DISCHARGE WARNING:

To help, prevent Electrostatic discharge and damage to electronic equipment it should remain in electrostatic discharge protected bags until installed. Even defective electronic, equipments should be placed in bags when sent for repairs or storing before use.

Place Electronic Equipment in bags while Troubleshooting/ Welding, IR tests etc., When handling electronic (computer modules) always use grounding chord and wrist strap, until work is completed.

Further guidance for use of Electrostatic Discharge Protection items : Refer LSM – 913-4.

CHAPTER 11

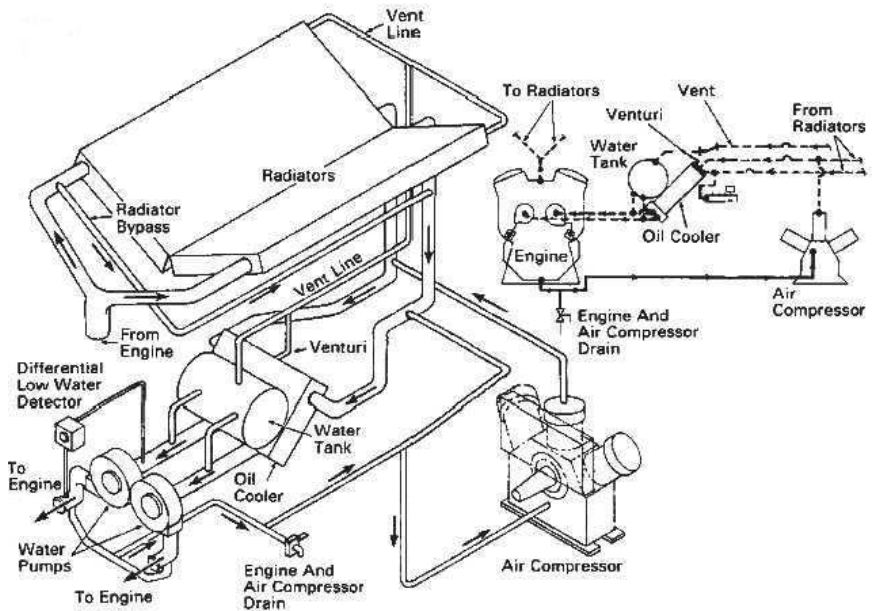
LOAD TEST PARAMETERS

| THROTTLE POSITION | ENGINE RPM | GOVERNOR VALVE STATUS | THROTTLE SWITCHES |
|-------------------|------------|-----------------------|--------------------------------------|
| Low Idle | 200+/-4 | Av, Dv | |
| Normal Idle | 269+/-15 | NO VALVE | |
| TH1 | 269+/-15 | NO VALVE | TH1-8 |
| TH2 | 343+/-15 | Av | TH1-8, TH2, 4,6,8 |
| TH3 | 490+/-4 | Cv | TH1-8, TH3-8 |
| TH4 | 568+/-15 | Av,Cv | TH1-8,TH3-8, TH2, 4,6,8 |
| TH5 | 651+/-4 | Bv, Cv, Dv | Th1-8,TH3-8, TH5- 8.Th5, 6 |
| TH6 | 729+/-4 | Av, Bv, Cv, Dv | TH1-8,TH3-8, TH2,4,6,8,TH5-8, TH5, 6 |
| TH7 | 820+/-15 | Bv, Cv | TH1-8, TH5-8, TH3-8 |
| TH8 | 904+/-4 | Av, Bv, Cv | TH1-8, TH2, 4,6,8 TH3-8, TH5-8 |

| TH POSITION | RPM | TR.GEN. VOLTAGE | TR.GEN. CURRENT | KW fb |
|-------------|----------|-----------------|-----------------|-------|
| TH IDLE | 200+/-4 | 0 | 0 | 0 |
| TH1 | 269+/-15 | 620 | 260 | 133 |
| TH2 | 343+/-15 | 880 | 383 | 294 |
| TH3 | 490+/-4 | 1295 | 577 | 665 |

| | | | | |
|-----|----------|------|------|------|
| TH4 | 568+/-15 | 1540 | 718 | 945 |
| TH5 | 651+/-4 | 1760 | 825 | 1253 |
| TH6 | 729+/-4 | 2130 | 990 | 1820 |
| TH7 | 820+/-15 | 2430 | 1111 | 2400 |
| TH8 | 904+/-4 | 2600 | 1189 | 2757 |

CHAPTER 12 COOLING SYSTEM



LINE DIAGRAM OF THE COOLING WATER SYSTEM

- | | |
|--------------------------|-------------------------------|
| (1.) Engine Block | (2 & 3.) Water pumps |
| (4.) Expansion tank | (5 & 6.) Radiators |
| (7.) Radiator Vent pipes | (8.) Lube oil cooler |
| (9.) Air compressor | (10.) Water drain cock |
| (11 & 12.) After cooler | (13.) Compressor Inter cooler |

Cooling system is a closed loop pressurised system. Water from the expansion tank as well as lube oil cooler is drawn by both bank gear driven water pumps, and is pumped to all the power assemblies through both bank water inlet manifold assemblies, water inlet tubes. Cylinder head outlet elbows and both outlet header and

water header of both banks are connected to both bank after coolers to cool the inlet air to the engine and collected back water return header.

Hot water from the engine outlet is cooled in both radiators and circulated back to engine through lube oil cooler. Hot water in the radiator is cooled by two AC motor driven Radiator Fans (8 blades 52" dia) powered from the Companion Alternator, which is controlled by EM 2000 based on the feed backs from Temperature Sensors (ETP1& ETP2).

Radiator Fans get three phase AC supply from Companion Alternator through 2 sets of 300 amps fuses and 3 sets of Contactors for each fan. FCS (Fan Contactor Slow Speed) for half speed and FCFA and FCF B (Fan Contactor Fast Speed) for full speed. Temperature of the cooling system is maintained between 79 0C and 870C with help of the above computer controlled circuitary.

If, EM 2000 detects the failure of any one of the Temperature probes, it displays a crew message "Engine Temperature Feedback Failure" and stores the message in the Archive memory. If it detects both probes have failed, it ignores both the probes signal, remains in last operation status and engine goes back to idle with a message - "No Load – Engine Temperature Feedback Failure".

If for any reason one set of Fan fuse blows off or one Radiator Fan motor is not working, the coolant temperature will rise beyond max setting of 87 0 C. When the temperature exceeds 970C, the following message will display on EM 2000 Screen - "Hot Engine - Throttle 6 limit" even though the throttle handle is on 7 or 8th notch. This will continue till the engine temperature reaches the safe limit.

A common outlet from both water pumps is taken to Air Compressor. Water taken to air compressor circulate through all 3 cylinders, heads and Intercooler of the compressor. Outlet water from the air compressor is piped back to cooling system through lube oil cooler.

SCHEDULES: MONTHLY

1. Pressure test cooling system to find out any water leaks and attend if leakages noticed.
2. Air blow both radiators in opposite direction of the normal air flow.
3. Check for the availability / proper seating of rubber packing under both radiators and provide packing if required.
4. Water Inlet tubes, cylinder head water outlet elbows & after coolers are to be carefully examined during pressure test.
5. Check all dresser couplings for any water or oil leaks & change gaskets if required.
6. Check the welding of both bank water outlet header 3" clamp bracket etc. Re-weld if required and secure all pipe clamps properly.
7. Check for any leaky/punctured/hardened radiator flexible vent pipes and replace if required.
8. Check for any vibrations in both the radiators during load test and provide proper rubber packing if disturbed (packing may require for both water inlet and outlet headers and also longitudinal).
9. Check the operation of EPD (Low water portion), check for any water or oil leak from EPD and attend to it.
10. Check both water pump tell-tale for any water/oil leak, replace water pumps if leaking.
11. Close radiator inspection covers properly ensure that the radiator compartment sealed air tight.

90 DAYS

1. Same as above.
2. Check operation of EPD (Engine Protection Device) for low water and low crank case vacuum protection shut down.

YEARLY

1. Change complete cooling water with fresh DM water and coolant.
2. Clean Water expansion tank gauge glass, renewing the gasket & refit.
3. Renew both radiator vent hoses.

2 YEARLY

1. Renew expansion tank pressure cap.
2. Overhaul EPD duly renewing the Kit. Test the overhauled EPD on test stand before fitment on the locomotive.

3 YEARLY

1. Scheduled items as mention in Yearly.
2. Renew all dresser coupling gaskets, hoses & strainer housing 'O' ring kits.
3. Overhaul both water pumps.
4. Renew radiator header to core gaskets.

PROCEDURE TO CONDUCT COOLING SYSTEM PRESSURE TEST

1. Provide pressure testing cap before shutting down the loco, removing the working pressure cap.
2. Shut down the engine and open air box covers.
3. Connect controlled MR pressure (12 /20 psi) pipe using quick connectors to Expansion tank.

4. Set the pressure to 12 psi and check for any water leaks from water cooling system i.e., from power assemblies, head to liner joint, water inlet tubes, water outlet elbows, after coolers, water pumps and any pipe joints, dresser couplings etc.,
5. If water reduction is reported and no leakage is confirmed with 12 psi pressure, increase to 20 psi or upto 30 psi & check again.
6. Further, if no leaks found, engine to be isolated from the cooling system and pressure test the engine block alone upto 90 psi to check engine block for any water leaks.

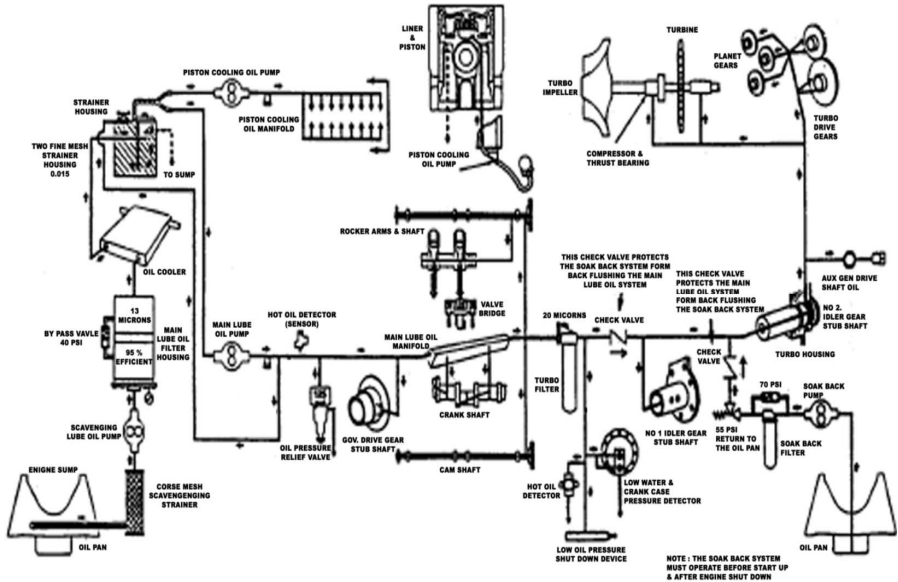
PRESSURE TESTING OF RADIATOR

1. Provide dummies on Inlet and outlet of radiator headers.
2. Fill the radiator with water by removing a threaded dummy on radiator header.
3. Pressurize the water to 50 psi in the radiator and check for any leakages in radiator tubes, header joints.
4. If any leakage noticed in the radiator tube, remove the headers on both sides and check individual tubes near the area where leakage was noticed.
5. Provide dummy to one end of the tube and pressurise the tube to 50 psi with water supply from the opposite side using a special fixture.
6. Once leakages are identified, dummy the defective tube on both ends by providing plugs (Phenolic plugs).
7. A maximum of 2% of total number of tubes can be plugged in a radiator.

TYPE OF RADIATORS

Twin core and Single core Radiators. Both are Mechanically bonded radiators. Tubes & fins are made up of Brass & Copper respectively.

CHAPTER 13 LUBRICATING OIL SYSTEM



LINE DIAGRAM LUBRICATING OIL SYSTEM

Lubricating oil system consists of Engine sump, scavenging pump, Main lube oil pump, Lube oil strainer housing, Filter assembly, Lube oil cooler assembly, Turbo oil filter.

Oil from the engine sump is drawn by gear driven scavenging pump through a coarse mesh lube oil strainer element and is filtered in lube oil filter tank in which 5 filter elements are housed. Oil from the filter tank flows to main lube oil pump through a lube oil cooler and fine mesh lube oil strainer elements.

A lube oil bye pass valve is provided across lube oilfilter tank which is set at 40 psi. This valve is responsible for continuous oil supply to engine moving parts when filters are choked. A filter condition gauge is provided across the filter tank and is in parallel with bye pass valve to continuously indicate the condition of lube oil filters inside the filter tank .

Pressurized lube oil supplied by scavenging pump is further pressurized by a main lube oil pump. Main lube oil pump is basically having two pumps in one housing. One for piston cooling and the other for the complete engine moving parts including turbo charger. Piston cooling pump supplies pressurized oil to all the pistons through headers and piston cooling pipes on both banks. Oil supplied from piston cooling pipe cools the piston crown from the bottom and lubricate cylinder liners and piston rings while dropping down to the sump.

Pressurized oil from Main lube oil pump passes through a pressure relief valve set at 125 psi, lubricate - all 10 main bearings, 8 connecting rod bearings, both end engine gear trains, stub shafts, all cam bushes through drilled oil passages in cam shafts, valve lever mechanism, bridgeassembly, Lash adjusters & exhaust valves etc.,

Oil pipeline from the cam gear end lube oil main header is taken to engine Governor to shut down the engine in case of low lube oil pressure.

One 55V AC Electrical Motor (3/4 HP) driven pump (Turbo soak back pump) circulates engine lube oil to turbo before cranking and after shutting down the engine

to protect the turbo running without oil and to cool turbo after the engine is shut down.

Working time of this Turbo soak back pump is decided by EM 2000. Turbo lube pump works for 15 minutes after engine shut down, if loco was working below 4th notch before shutting down of the engine and runs for 35 minutes after engine shut down, if loco was working above notch before shutting down of the engine.

Oil for the Turbo is taken from cam gear end lube oil main header through a paper type spin on filter.

NOTE:

1. If the filter tank bye pass gauge needle shows Yellow (warning) and Red Zone, lube oil filters need change. A test plug is provided on the filter tank cover to measure the oil pressure inside filter tank by providing a gauge to assess filters condition. Oil pressure should not be more than 7 psi in Idle & 25 psi in 8th notch.
2. If the engine is shut down for more than 48 hours, pre-lubrication of the complete lube oil system is required to be done with an external pump (Engine crank shaft has to be barred or rotated manually during pre lubrication).
3. Do not put off Turbo and Computer Control Circuit breakers immediately after shutting down the engine. A minimum time of 15 Minutes has to be given for cooling down the Turbo.

CAPACITY OF OIL PAN:

950Litrs. in case of WDP4 (imported) & 1457 ltrs in case of WDG4 locos, also for DLW manufactured WDP4 locos.

RENEWAL OF FILTERS:

Operate the engine till it is warm, then shut down and open filter tank oil drain gate valve provided in lube oil strainer housing (Oil drains faster from the warm engine than a cold engine). Once oil is drained, open filter housing cover to renew filters and clean interior of filter housing, drain pan and surrounding area. Replace filters with new elements (5 Nos). Ensure that the elements are fully seated over the oil outlet tubes inside the filter housing. Check 'O' rings in the circular grooves of filters. Renew filter tank cover 'O' ring. Close the cover and torque the cover nuts to 81 Nm (60ft lbs) diagonally and close filter drain gate valve.

SCHEDULES:**MONTHLY**

1. Check lube oil filters condition from the bye pass valve gauge.
2. Attend any leakages in the system.
3. Check oil level by using a dip stick. Do not remove hand hole covers to check oil level. Oil level has to be maintained between low and full marks of the gauge when the engine is idling and oil is hot. Oil filling has to be done from the strainer housing.

90 DAYS

1. Clean lube oil strainer elements and refit back duly renewing 'O' rings.
2. Renew lube oil filter elements (5 Nos.) Turbo oil filter (1 No.), soak back filter element (1 No.)

2 YEARLY

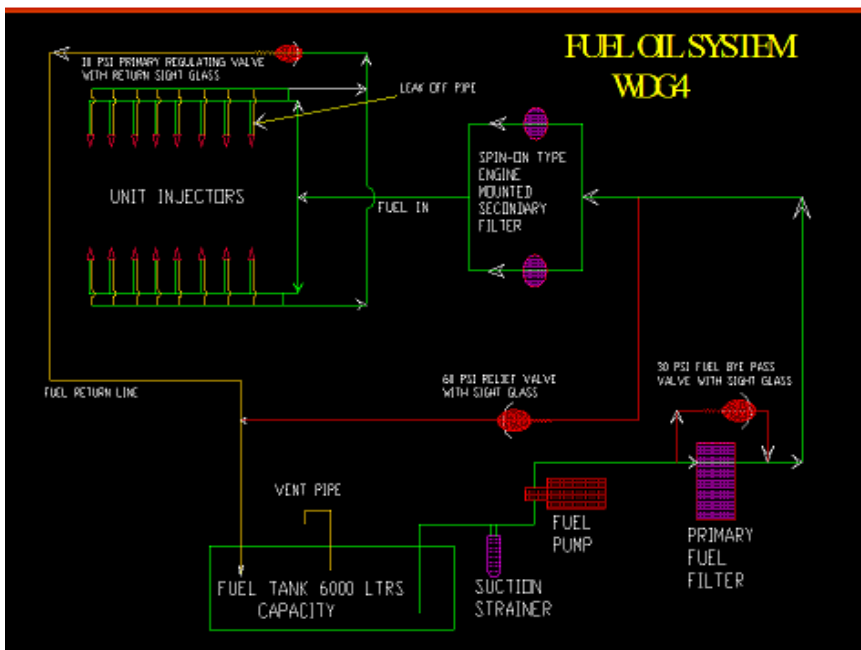
1. Qualify hot oil detector on the test stand.

3 YEARLY

1. Renew all dresser coupling gaskets & flexible hose pipes.

CHAPTER 14

FUEL OIL SYSTEM



Fuel oil system is designed to give constant volume/ pressured fuel to the injectors irrespective of load. As per the thortle position and load requirement, Engine Governor controls the injector rack position.

The system consists of fuel tank, suction strainer, fuel pump, fuel filters, pressure control relief and bye pass valves. Fuel headers (one on each left and right bank) are fitted inside the top deck head frame assembly and connected to fuel injectors through individual fuel lines.

Fuel supplied to fuel injectors from the fuel pump is injected into cylinders as per the requirement and the

excess fuel is used to cool and lubricate fuel injector parts taking away the heat to fuel tank through return fuel line.

GENERAL ARRANGEMENT :

Fuel from the fuel tank (of capacity 6000 ltrs.) is drawn by the fuel booster pump through suction strainer, where the suspended particles are filtered. Fuel from suction strainer flows to fuel booster pump which is a crescent type positive displacement gear pump. Pressurised fuel from the booster pump is piped to fuel primary filter which is a paper type filter in which fuel is filtered.

A by-pass valve and gauge is provided across fuel primary filter to prevent overloading fuel booster pump in case of choked fuel filter.

The by-pass valve is set at 30 psi and the gauge is having Green, Yellow & Red zones. Gauge needle in the Green zone indicates the healthy condition of the fuel primary filter. Yellow and Red zones indicate choked filter needs renewal. Fuel from primary filter flows to engine mounted spin-on secondary paper type filters (Two numbers).

A secondary filter bye pass valve is provided for the fuel spin-on filters is set at 70 psi. which is placed inside a sight glass bowl provided over the spin -on housing. Oil inside this bowl indicate that the fuel spin-on filters are choked need to be replaced. This sight glass should be always empty.

Fuel flown to secondary filters enter both bank fuel

headers after secondary /fine filtration. Fuel from both bank fuel headers enter individual fuel injectors through the fuel lines.

According to the notch and load demand, engine governor meters the fuel supply to the engine cylinders by operating fuel racks of the injectors through linkages connected to fuel control shaft.

The excess fuel flows back to fuel return headers and to fuel tank through a return sight glass provided on the fuel spin on filters with a 15 psi pressure regulating valve. This sight glass is near to the engine block which should be always full of fuel without air bubbles.

Bubbles in the fuel return sight glass when the engine is in dead condition & fuel pump is running indicates air draw in suction side of the fuel booster pump. Bubbles after cranking the engine indicates the leaky fuel injector.

Bubbles in higher notch with full load indicates insufficient fuel supply.

SCHEDULES:

MONTHLY

1. Cleaning of fuel suction strainer.
2. Draining of condensate from fuel tank & checking for any leaks.
3. Visual check of fuel leaks inside top deck, examination of all linkages for their intactness.

90 DAYS/180 DAYS/270 DAYS:

1. Renewing fuel primary & secondary spin on filters.
2. Checking the torque value of fuel line bolts.
3. Examination of fuel booster pump gears for any Scoring/damage.

YEARLY/2 YEARLY:

1. Renewing sight glass gaskets.
2. Checking fuel relief valve & bye pass valves on test stand.
3. Checking & renewing defective sight glass clevis clamps.
4. Cleaning fuel tank glow rod gauges and renewing 'O' rings.
5. Overhauling fuel booster pump, testing on test stand & refitting
6. Removing all fuel injectors from loco, testing, calibrating and refitting.

3 YEARLY:

1. Overhauling all fuel injectors and refitting.
2. Renewing worn out rack linkage bearings & pins.

CHAPTER 15

COMPRESSED AIR SYSTEM

Air Compressor used on WDG4/WDP4 locomotive is a three cylinder, two stage (low pressure and high pressure) water cooled air compressor. The compressor is mechanically driven by the engine with the help of flexible couplings and extension shaft from the front or accessory end of the diesel engine.

Atmospheric air is taken to the locomotive Clean Air Compartment through cyclonic filters. Filtered air from the cyclonic filter is compressed in the TM blower and taken to cool all the 6 TM's through the duct passage in the superstructure. Inlet air for the air compressor is also taken from the TM duct through two flexible hose pipes and individual air inlet filters of low pressure cylinders.

Air received at the compressor air inlet filters is filtered through these filters (fibre glass filters - one for each LP cylinder). Primary stage of air compression is done in LP cylinders and enters HP cylinders through a water cooled inter cooler. Air after secondary stage compression in the HP cylinder enters cooling coils laid inside radiator compartment. The atmospheric air drawn by radiator cooling fans passes through these cooling coils and the compressed air inside cooling coil gets cooled before entering Main reservoirs.

Compressed and cooled air enters MR1 (Main Reservoir 1) of capacity 492 litres. MR 1 air is taken to feed MREQ pipe and also a pipeline is taken to MRET (Main Reservoir Pressure Transducer) in the CCB system. CCB system CRU (Computer Relay Unit) get continuous

feedback from MRET regarding MR1 pressure so as to take corrective action by CCB in case of less main reservoir pressure/parting between locomotives.

MR1 outlet air further passes through a MR safety valve set at 10.5 kg/sq.cm pressure and enters air dryer. The air dryer separates moisture content in the compressed air (Purges out moisture through twin towers). Dry air from the air dryer is taken to Air Manifold (Located inside Air compressor compartment). From the air manifold the MR1 air is taken to operate – Sander magnet Valves, Horn Magnet Valves, MR1 & MR2 tank ABD Valve operating Magnet Valve (MV-EBT) and MVCC (Magnet Valve Compressor Control) which releases air pressure to operate compressor unloader valves on LP & HP cylinders. An air pipeline tapping is taken from MR1 tank outlet to MRPT (Main Reservoir Pressure Transducer). EM2000 get the feedback from MRPT regarding the compressed air pressure in the MR1 circuit. EM2000 decides and operates MVCC to load/unload air compressor accordingly.

When the MR1 pressure reaches 9.84kg./sq.cm. (140 psi), the MVCC is energized by EM2000 and the MVCC releases pilot air pressure to unloader valves to unload the air compressor.

When MR pressure drops to 8.44 kg./sq.cm.(120 psi), MVCC is de-energized from EM2000 and the pilot air pressure supplied to unloader valves is withdrawn and released to atmosphere through MVCC valve. Thus, the loading & unloading of air compressor is controlled.

A pipeline is taken from MR1 outlet pipeline to MREQ

pipe (main reservoir equalizing pipeline) and also, a tapping is taken from MREQ pipe to MRET (main reservoir equalizing transducer) in the CCB system.

This will help to safeguard the trailing locomotive in a MU consist during parting between locomotives. Sudden pressure drop in the MREQ pipeline is sensed by MRET and CCB applies loco brakes from the trailing loco itself.

Another pipeline is taken after air dryer to D24-B (feed valve for feed pipe) valve in which MR1 pressure is regulated to 6 Kg./sq.cm. and the feed pipe is charged from this valve.

Main pipeline from MR1 tank after passing through air dryer is taken to MR2 tank. Air from MR2 tank is taken to CCB system through MR2 final filter. There are two automatic blow down valves (ABD valves), one on each MR tanks. These valves are meant for draining the moisture from MR1 & MR2 tanks periodically. EM2000 computer is controlling the loading and unloading of air compressor based on the pressure feedback of main reservoir from MRPT. At the same time, EM2000 activates EBT (Electronic Blow-down Timer) valve by giving 74 V DC supply. EBT releases pilot air pressure to both the MR1 & MR2 ABD valves and ABD valves purges out the moisture collected inside MR1 & MR2 tanks. Both ABD mounted bottom of the MR tanks.

SCHEDULES:

MONTHLY

1. Check pamic filters for any damage, choking & for proper sealing.
2. Check compressor oil level and any leakage. Top-up oil as required.
3. Check compressor breather for proper breathing.

90 DAYS

1. In addition to the above, unloader greasing to be done.
2. Air compressor oil pressure (should be more than 15 psi at engine normal working temperature in idle) to be recorded.

180 DAYS

1. Same as above.
2. Compressor oil to be changed.
3. Compressor spin on filter to be renewed.

YEARLY

1. Air intake filters are to be renewed.
2. Overhaul all valves and refit.

3 YEARLY

1. All the above jobs.

6 YEARLY

1. Complete overhauling of Air compressor.

CHAPTER 16

COMPUTER CONTROLLED BRAKE SYSTEM

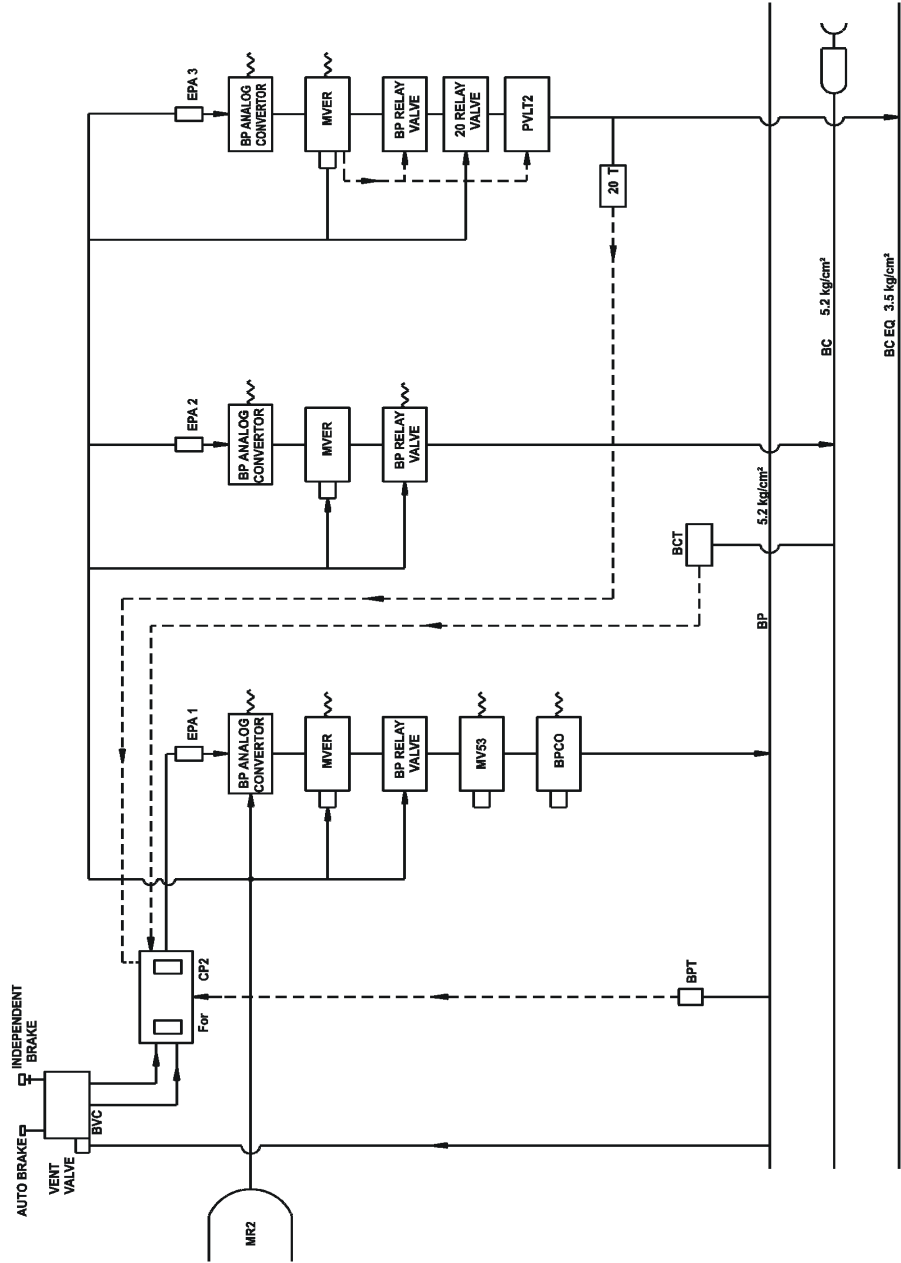
The loco is equipped with KNORR/NYAB CCB system.

This system is an electro-pneumatic micro processor based system. The CCB is mounted on a brake rack on the short hood (front) of the locomotive.

The brake rack consists of a 1. VCU (Voltage Conditioning Unit) 2. CRU (Computer Relay Unit) 3. PCU (Pneumatic Control Unit) 4. KE Valve for back up brake system. 5. Air Brake set up switch 6. Brake Valve Controllers (BVC) for drivers operation.

The brake valve controller consists of automatic (A9) and independent brake system (SA9) controllers. Each handle is attached to variable potentiometer that provide signal to the CP (Central processor) within the CCB. The handles are operated from front to rear side of the operator, so that the brakes are released when the handle is close to the operator. During the period of working, all the handles, i.e. Throttle, Auto Brake and Direct brake are moving upward motion. For braking action downward motion is for running the locomotive without braking.

Automatic brake (A9) controls the application and release of both the locomotive and train brakes having 5 positions Release, Run, Minimum Reduction, Full service and Emergency. Independent (SA9) controls the application and release of loco brakes having 2 positions Release application or full



BRAKE EQUIPMENT RACK

Computer Relay Unit:

The computer relay unit contains computer & related modules used for control of the brake system. (one mother board and 12 other system boards). Digital display monitor for fault diagnostics.

Pneumatic Control Unit:

The pneumatic control unit includes the equipment required to operate the pneumatic system. Mounted with electro pneumatic and pneumatic valves of both side of the manifold.

Voltage Conditioning Unit:

- i. The voltage conditioning unit is the main power supply for the CCB system.
- ii. The VCU reduces the incoming battery supply of 72 Volts DC to a filtered 24 volts DC to CRU of brake system.

Back up valve:

The KE valve provides pneumatic back up function to allow basic air brake function in the event of failure of micro - processor control or KE valve will not maintain pressure against leakages valve mounted with 13 liters reservoir

Note : In MU loco separation, if both the loco CCB system in working, brake only used to work.

BRAKE VALVE CONTROLLER:

- i. There are two brake valve controllers in the cab, one on each control stand.
- ii. The brake valve controller includes one Automatic & one independent brake control handle and one Lead/Train switch.
- iii. Two type brakes are used in controller:
 - a) Auto Brake (A9)
 - b) Independent Brake (SA9)

AUTO BRAKE (A9)

- i. The Automatic Brake fiber optic output signal commands the computer to the desired control of the brake pipe (BP) train line.
- ii. The Main function of Automatic brake valve is to control the formation as well as loco brakes, i.e., conjunction operation.
- iii. The Auto brake handle has five positions:-

| POSITIONS OF A9 HANDLE | BP PRESSURE | CORRESPONDING BP PRESSURE |
|------------------------|------------------------|---|
| 1. Release | 5.7 kg/cm | 0 |
| 2. Run | | 5.2 kg/cm ² |
| 3. Minimum | 4.7 kg/cm ² | 1.1 kg/cm ² |
| 4. Full service | 3.4 kg/cm ² | 4.35 kg/cm ² |
| 5. Emergency | 0 | 4.35 kg/cm ² & BCEQ=3.5 kg/cm ² |

RELEASE:

- i. In this position, a frequency is transmitted to the computer to charge the BP at a faster rate to release the train brakes.
- ii. When Automatic brake handle is kept in release position BP increases from 5.2 to 5.7 kg/cm². This is a spring loaded position. Leaving the handle from Release position will come back to RUN position. BP from 5.7 kg/cm² will come back slowly in normal pressure of 5.2 kg/cm² after 182 sec. should not use during train working.

RUNNING:

- i. In this position, a frequency is transmitted to the computer to charge the BP fully, i.e., 5.2 kg/cm².

ii. In this position loco and formation brakes release completely.

MINIMUM:

i. In this position brake pipe pressure reduces slightly to control the train.

ii. In this position BP drops to 4.7 kg/cm² & BC pressure attains 1.1 kg/cm².

FULL SERVICE :

i. In this position brake pipe drops to 3.4 kg/cm² to control train & loco brakes in conjunction.

ii. This position is also used to recover penalty brake application i.e., 10 seconds.

EMERGENCY :

i. In this position, BP dropping to “zero” rapidly to control train loco brake.

ii. The pneumatic position of the brake valve is connected directly to brake pipe (i.e., through emergency vent valve).

iii. This position is also used to recover a penalty brake application (i.e., 60 seconds).

iv. In emergency position electronic emergency brake also activated through CCB system.

INDEPENDENT BRAKE :

i. The independent brake (SA9) release and apply is related to the brake application to loco only.

ii. The independent brake handle has 2 position & a range of application zone between these two positions.

a. BC Pressure in Release – 0 kg/cm²

b. BC pressure in Full – 5.2 kg/cm²

iii. In emergency position is bail off, loco brake will not release, as soon on release the trail off hand brakes will get applied again.

iv. BAILOFF : when an Automatic brake is applied lifting the bail off ring provided on direct brake handle releases brake cylinder pressure of the loco to zero applied in

conjunction with BP. During emergency braking BAIL OFF will not work for releasing the loco brake.

PNEUMATIC CONTROL UNIT:

i. The pneumatic control unit is an Electro Pneumatic device that develops and destroys air from the Main reservoir to the locomotive:-

a. Brake cylinders.

b. Brake pipe.

c. Brake cylinder equalizing pipe.

ii. The PCU has

a. Electro – Pneumatic control circuit.

b. High capacity Relay valves.

c. Analog converter valves

iii. These are devices mounted on a laminated manifold that provide all inter valve connections minimizing the interface piping required.

iv. There are 3 pressure control circuit in the PCU.

a. Brake pipe control circuit for use on formation.

b. Brake cylinder equalizing pipe control circuit for locos in MU operation.

c. Brake cylinder control circuit for loco brake.

BRAKE PIPE SYSTEM:

i. Analog converter (AW4-ER).

ii. Equalizing Reservoir, transducer.

iii. MVER (ER MAGNET Valve).

iv. BP relay (KR-5E0).

v. MV 53 (53 Magnet Valve).

vi. BPCO (Brake Pipe cutoff valve).

vii. Brake pipe Transducer (BPT).

viii. Brake pipe fittings.

ix. PVEM & MVEM (Emergency Pilot Air Valve & Emergency Magnet Valve to make the train line BP to zero either by driver option or by train parting without the knowledge of driver.

Note: ER is a pilot air to maintain train line BP through

BP relay.

(Sl.No. 5, 6 & 7 for changing the system according to Lead trail modeselection).

BRAKE CYLINDER CONTROL UNIT:

- i. Analog Converter (Aw4-16)
- ii. 16 Pipe Transducer (16T)
- iii. 16 Magnet Valve (MV – 16T)
- iv. BC Relay (J-1)
- v. BC Transducer (BCT)

Note : To operate the loco brake system from lead loco to trailing loco.

BRAKE CYLINDER EQUALIZING PIPE CONTROL UNIT:

(To operate the loco brake system from lead loco to trailing loco)

- i. BCE Valve (Brake cylinder equalizing valve/20 portion valve).
- ii. MVLT (Magnet Valve Lead/Trail).
- iii. PVLT (Pneumatic Valve for Lead/Trail).
- iv. PVLT2.
- v. 20 Relay valves.
- iv. 20 Transducer.

BRAKE CYLINDER EQUALIZING VALVE :

The purpose of the brake cylinder equalizing valve is to provide an air pressure to the brake cylinder equalizing pipe from the lead locomotive to control brake cylinder pressure on the trailing locomotive during both Automatic & Independent brake applications & release.

INDEPENDENT BRAKE VALVE

Independent Brake provides independent control of the locomotive brakes irrespective of train braking effort.

a. RELEASE: Brake Cylinder pressure 0 kg/cm²

B. APPLICATION ZONE: the status is in between release and Full Application, i.e., 0 kg/cm² to 5.2 kg/cm²

c. FULL APPLICATION: Brake Cylinder pressure is 5.2 kg/cm²

d. BAILOFF: when an Automatic brake is applied, lifting the bail off ring provided on brake handle releases brake cylinder pressure of the loco to zero (i.e., Release for 60 seconds. But, loco brake re-applies immediately if the A9 handle is in emergency position.

SELECTOR SWITCH (LEAD TRAIL SET UP SWITCH) :

This is the switch connecting CCB system with EM 2000.

a. TRAIL position is used when the loco is in trailing position as well as in the non working control stand of the loco.

b. LEAD position is used in the working control stand in the leading loco.

c. HELPER position is used when the loco used as Banker (Helper) attached anywhere in the train formation other than LEAD. In this mode, the auto brake handle should be in FS only as like “of trial mode”. In this mode, loco brake application and release can be obtained either by “Banker mode” driver’s direct brake or according to train line BP conjunction. The bail off ring also will be in working condition.

D.TEST mode is used when leakage of BP pressure to ensure either in loco or train line BP. In this mode, direct brake will not function including bail off. Also the BC is applied to maximum, (i.e., 5.2 irrespective of the direct brake handle as a safety to avoid the driver to start the train without train line BP continuity).

CHAPTER 17

FORCED AIR SYSTEM

The compartment used for drawing the ambient air through inertial air filters (cyclonic filters) is called the Central Air compartment. The air that is drawn is used for

- i. Combustion air for diesel engine.
- ii. Cooling air for Main Generator and Companion Alternator.
- iii. Cooling air for Traction Motors.
- iv. Cooling air for Traction inverter equipment.
- v. Pressurization of electrical cabinets.
- vi. Air for Air compressor.

The compartment is located between TCC2 and Generator compartment. Two inertial air filter panels on either side of the locomotive which are made up of a series of tubes designed to produce cyclonic action. The demands of devices that air from the central compartment creates a suction within the compartment which draws outside air rapidly through the inertial tubes so that dirt and dust particles present in the air which are heavier than air is thrown to the outer wall of the tube as the turbulence is created by cyclonic filters and dropped down. Further, these captured particles are sent out through the dust bin blower motor to the bottom of the locomotive and then clear air is used for the six above uses in the locomotive.

Supplementary use is also made of Traction Motor cooling air for following:-

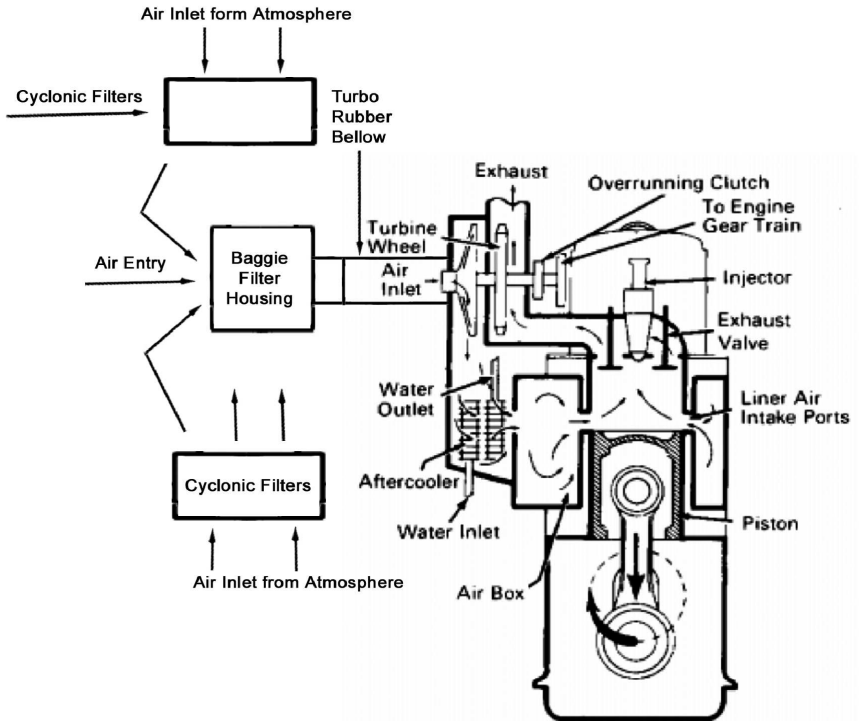
- i. To provide pressure to counteract the depression in the central air compartment.
- ii To provide filtered air under pressure to the electrical cabinets.

Inspection of Central Air System:

If any leaks exists in the Central air compartment, then unfiltered air will enter, this is caused by any of the following defects :-

- i. Compartment door not tightly closed due securing bolts missing/gaskets/seals are not properly applied.
- ii. Engine room partition and attached cover plates are not properly secured and closed.
- iii. Generator pit aspirator not properly connected:-
 - a. Check aspirator drain holes for any obstruction.
 - b. Check that Traction Motor cooling air is getting exhausted from the aspirator tube causing ventury action at the aspirator drain holes.
- iv. Check whether dust bin blower motor is working and rotating in the correct direction to exhaust the dust particles.
- v. Keep initial filter tubes clean.

CHAPTER 18 AIR INTAKE SYSTEM



Engine Air intake system takes care of the amount of oxygen required for complete combustion of fuel injected in the cylinders in various operating conditions.

Air intake system consists the following:-

- a. Exhaust manifold
- b. Turbo
- c. Turbo clutch
- D. Baggie filters
- e. After coolers

In order to supply the required quantity of air for complete combustion of injected fuel, this loco is provided with a turbo charger. The turbo charger is primarily used to increase engine horse power and provide better fuel economy through the utilization of exhaust gases.

The turbo charger used here is a single stage turbine with a connecting mechanical gear train also through a overriding clutch.

The connecting gear train is necessary for engine starting, light load operation and rapid acceleration. Under these conditions, there is insufficient exhaust heat energy to drive the turbine fast enough to supply the necessary air for combustion, and the engine actually driving the turbocharger through the gear train assisted by exhaust gas energy.

When the engine approaches full load, the heat energy in the exhaust gases reaches temperatures upto 1000 OF (5380C) is sufficient to drive the turbocharger without any help from the engine.

At this point, an overrunning clutch in the drive train disengages the mechanical drive and the turbocharger is mechanically disconnected from the engine gear train.

The engine inlet air is initially filtered through cyclonic filters and finally filtered in baggie filters and enter turbo impeller casing. The intake air is compressed by the turbo impeller & the outlet air from turbo enters both bank after coolers, where the heat generated in the compressed air is cooled by after coolers. Compressed air after cooling in after coolers enter both bank air boxes of the engine. Always pressurized air is filled in the air boxes by turbo. This pressurized air rushes into cylinders through 18 air inlet ports provided on each cylinder according to the engine timing.

**SCHEDULES :
MONTHLY**

1. Cleaning & blowing cyclonic filters in reverse direction of normal air flow.
2. Record pressure drop across cyclonic filters & baggie filters.

90 DAYS :

1. Renew baggie filters.
2. Visually examine the condition of turbo impeller.

4 YEARLY :

Renew turbo clutch.

6 YEARLY :

Overhaul turbo & refit.

PRESSURE TO BE CHECKED

Inertial Filters (Central Air Compartment)

Minimum 76mm (3") H₂O

Maximum 178mm (7") H₂O

Engine + Inertial filter

Minimum 127mm (5") H₂O

Maximum 356mm (14") H₂O

Electrical Control Cabinet Filters

Minimum Static Pressure 13mm (0.5") H₂O

AC Cabinet

Minimum Static pressure 2.6mm (0.1") H₂O

CHAPTER 19 UNDERTRUCK

HTSC BOGIE:

The GT 46 MAC Locomotive is equipped with an HTSC (High Tensile Steel Cast) truck. The truck assembly supports the weight of the locomotive and provides the means for transmission of power to the rails.

The HTSC truck is designed as a powered bolster less unit. Although the truck frame itself is rigid, the design allows the end axles to move or yaw within the frame. This movement used to allow the wheels to position itself tangent to the rails on curves for reduced wheel and rail wear. Traction loads are transmitted from the truck to the locomotive under frame through car body pivot pin assembly.

The truck is equipped with three AC Powered Traction Motors (3O), in MAC locos & two AC powered TM's in PAC locos which are fitted on each axle and fitted on the truck through nose link assemblies (dog bones) that increases the easyness for dis-assembly and assembling of traction motor/wheel sets for maintenance.

The Traction Motor converts the Electrical Energy into Locomotive Tractive Effort. The motors are fitted with pinions (17 teeth for MAC and PAC) which meshes with the Bull gear on the axle (90 for MAC & 77 for PAC) which in turn apply rotational force to the wheel. This in turn passed on to the truck frame through traction rods attached to the journal bearing adapter and the frame.

From the truck frame, the driving force is transmitted to the locomotive car body through car body pivot pin.

The weight of the locomotive car body is transferred directly to the truck through four rubber compression spring assemblies located on four corners of the truck where the side beams and cross beams intersects & thus providing the yaw stiffness for tracking stability. These relatively stiff secondary spring suspension limits weight transfer between axles during adhesion, as all traction motor nose positions are on the same side of each axle with in the truck. The soft primary suspension made up of twelve single coil journal spring (two at each journal), is designed to provide better ride quality and equalization of wheel set loads for taking care of track irregularities, if any.

Two Nos. of heavy duty lateral shock absorbers are fitted in between bogie and super structure to take care of longitudinal and lateral shocks between bogie and super structure at higher road speeds. Two Nos. of lateral stops are provided on bogie to limit the super structure lateral movement when the loco is running in a curve. These two lateral stops which limits the shearing force on rubber load pads while negotiating the curved track.

6 Nos. of vertical shock absorbers are fitted (2 Nos. at each ends) at 80 with the vertical to take care of lateral and vertical shocks between bogie and axle at higher road speeds.

6 Nos. of lateral thrust pads (wear pads) are fitted between bogie and axle adapter to limit the lateral movement of axle within the bogie.

Vertical stop clearance between bogie and super structure under frame is 16 +/- 3.2mm. If the clearance is beyond the given limit, rubber load pad heights to be checked for analysing its stiffness.

12 Nos. of rod primary interlocks are provided on each axle adapter

(1 No. at each side) to prevent the separation of axle from bogie in case of derailment.

Air Brake cylinders and brake rigging equipment mounted on the truck are used to apply retarding forces to the wheels to slow down and stop the locomotive. A single shoes system is used which is a composite type brake shoe at each wheel.

WHEEL SIZE VARIATION LIMITS:

1. Between two wheels on same axle 0.5mm to 1.6mm.
2. Between axles on the same bogie 3.2 mm to 6.4 mm.
3. Between bogies 14.2mm to 31.8 mm.

WHEEL SIZE CONDEMING LIMITS:

1. Minimum Wheel Diameter - 1016mm
2. Minimum Rim Thickness - 25.4mm

BRAKE ADJUSTMENT (BRAKE CYLINDER PISTON TRAVEL WHEN BRAKES FULLY APPLIED)

2.0" (50.8 mm) to 6.5" (165.1 mm)

Brake block to wheel clearance

SINGLE BLOCK POSITION

0.62" (15.9 mm) Max (Disc 1 & 6)

TWO BLOCK POSITION

0.75" to 1.25 (19.1 mm to 31.8 mm)

(Disc 2-3, 4-5)

LOAD DISTRIBUTION

SUPER STRUCTURE

SECONDARY RUBBER SPRING

BOGIE

COIL SPRINGS

AXLE ADAPTER

JOURNAL BEARING

AXLE

WHEEL

RAIL

TRACTIVE EFFORT

- PINION

- BULL GEAR

-AXLE

-AXLE JOURNAL

BEARING

-AXLE ADAPTER

- TRACTION ROD

- BOGIE

- CAR BODY ARMS

- CENTRE PIVOT

ASSEMBLY SUPER
STRUCTURE**IMPORTANT ASPECTS TO BE CHECKED IN UNDERTRUCK IRRESPECTIVE OF SCHEDULE**

1. Check the temperature of the all axle journal bearings immediately on loco arrival. Difference between two journal bearings should not be more than 5 degree centigrade

2. Side Buffers to be checked usually for any cracks. Rotate the buffer with hand for any rotation of plunger. If it rotates, it indicates that inside helical springs are broken.

3. Screw couplings to be checked for worn out screw threads, any crack/damage

4. All vertical shock absorbers to be checked for any signs of leakages. Shock absorber holding brackets to be checked for any cracks missing of fasteners.

5. All brake cylinder pipeline connections are to be checked for air leakages and brake cylinder piston travel lengths to be kept within limit for better and equal braking force on each wheel. Brake cylinder piston travel lengths

can be adjusted by adjusting slack adjuster in slack adjuster barrel.

6. All sand nozzles to be correctly set for better sand flow during wheel slip. Check sand hose pipe for any leakages of sand & intactness.

7. CBC and knuckles to be checked for any cracks and wear of knuckle. CBC heights to be adjusted between 1030-1105mm.

8. All bolts and nuts of under truck to be checked for any slackness.

9. All gear case breather caps to be checked for any slackness.

10. Check gear case for any leakages.

11. Check centre pivot sealing. Check centre pivot carbody arms for any cracks and elongation of huck bolt holes.

12. Check hand brake operation and lubricate it.

13. Check all brake blocks condition and change i.e., if worn out or broken into two pieces.

14. Check wheel disc for any cracks, overheating marks, pitting and skidding marks etc.

15. Check all axle adopter for any slackness.

16. Check all coil springs for any cracks or broken.

17. All Traction rod bushes to be checked for rubber bush working out.

18. All brake rigging hangers to be checked for any loose bolts & nuts.

19. Both side cattle guard & rail guard heights to be checked & adjust.

20. Check all axle suspension tube for any grease oozing out.

21. Lubricate buffers, CBC, Screw couplings, and brake cylinder pistons.

22. Check loadpads, rubber damages or working out of pin.

23. Check all lateral shock absorbers for any leakages and its securing bolts for any looseness.

CHAPTER 20

INSTRUCTIONS FOR ATTACHING & DETACHING THE EMD LOCOS WITH FORMATION

FOR MAKING MU: (Both the locos under cranked condition, but independent)

1. Couple both the working locos & ensure both CBC's are locked properly.
2. Set both the control stands as below:-

LEADING LOCO:

WORKING CONTROL STAND

A9 - Release/Run
SA9 - Full application
L/T Switch - Test

NON WORKING CONTROL STAND

A9 - Full Service
SA9 - Release
S/T Switch - Trail

TRAILING LOCO: BOTH CONTROL STANDS

A9 - Full service, SA9 – Release, L/T Switch - Trail

Note: Ensure both control stand Fireman emergency handles are in closed (down) position.

3. Connect hose pipes between two locos; (BP, FP, MR Equalising, BC Equalising). Open cut out cocks on both the locos to equalise pressures Ensure no leakages in coupled pipes of MRE, BCE, BP & FP.
4. Now keep L/T Switch to "lead" position on working control stand of the leading loco & charge BP. Ensure BP charging on both the locos from leading loco. Ensure continuity of BP & FP from both free ends MU locos.
5. Apply hand brake.
6. Release loco brakes (SA9) from leading loco & see that the loco brake releases on leading & trailing loco.

7. Drop BP from leading loco and see that the loco brakes apply on leading and also on trailing loco. Recreate BP and see that the loco brake releases on leading and trailing loco.

8. Connect MU jumper cable between both the locos.

| 9. Keep | Leading loco | Trailing loco |
|----------------------------|--------------|---------------|
| Isolation switch | RUN | RUN |
| Eng. RUN switch | ON | OFF |
| Gen.Field switch | ON | OFF |
| Control & Fuel pump switch | ON | OFF |

(Note: Before moving locos ensure hand brakes are released)

BREAKING OF MU

1. Un-couple the locos from formation duly securing formation.

2. Apply hand brakes on both the locos.

3. Set the leading loco control stand as below:-

| WORKING CONTROL STAND | NON WORKING CONTROL STAND |
|--------------------------|------------------------------|
| A 9- Release/Run | A9 - Full Service |
| SA9 - Full application | SA9 - Release |
| L/T Switch - Test | L/T Switch - Trail |

4. Isolate both the locos by closing all the angle cocks, where both the loco are coupled each other.

Ensure no air inside the Hose pipes.

5. Un-couple all hoses between two locos. Also ensure no leakages after uncoupling.

6. On Leading Loco, set the working control stand L/ Trail switch to lead.

7. On Trailing Loco set the control stands as below:-

WORKING C/S

A 9- Release/Run
SA9 - Full application
L/T Switch - Lead

NON WORKING C/S

A9 - Full Service
SA9 - Release
L/T Switch - Trail

8. Release hand brakes & uncouple CBC and now both locos are ready for single head operation.

ATTACHING A LOCO AS IDLING WITH ANY TYPE OF OTHER WORKING LOCO

1. Couple the working loco to the Idling WDG4/WDP4 loco. Ensure both CBC's are locked properly.

2. Set the leading loco control stand as below: - (For EMD locos only)

WORKING C/S

A 9- Release/Run
SA9 - Full application
L/T Switch – Test

NON WORKING C/S

A9 - Full Service
SA9 - Release
L/T Switch - Trail

IDLING LOCO

Both Control Stands

a. A9 - Full service, SA9 - Release, L/T Switch - Trail

b. Isolation Switch - in isolation position.

c. GF & ER switches on L/H control stand - OFF.

3. Connect hose pipes between two locos; (BP, FP, MR Equalising, BC Equalising). Open cut out cocks on both the locos to equalise pressures Ensure no leakages in coupled pipes of MRE, BCE, BP & FP.

4. Now keep L/T Switch to “lead” position on working control stand of the leading loco & charge BP. Ensure

BP charging on both the locos from leading loco. Ensure continuity of BP & FP from both free ends MU locos.

5. Apply hand brake.

6. Release loco brakes (SA9) from leading loco & see that the loco brake releases on leading & trailing loco.

7. Drop BP from leading loco and see that the loco brakes apply on leading and also on trailing loco. Recreate BP and see that the loco brake releases on leading and trailing loco.

Note : Ensure engine not shut down automatically on run.

ATTACHING AN EMD LOCO FOR BANKING PURPOSES

1. Attach EMD loco at the back of the formation end.

Ensure both CBC's are locked properly (Banker loco & formation).

2. Set control stands as below:-

WORKING C/S

A 9- Full Service

SA9 - Full application

L/T Switch - HLPR

NON WORKING C/S

A9 - Full Service

SA9 - Release

L/T Switch - Trail

3. Connect BP hose pipe of loco with formation BP hose pipe.

4. Open both angle cut out cocks of loco and formation and ensure BP charging on Banker loco as per leading loco.

5. Release loco brakes of banker loco, drop BP from leading loco and ensure BP dropping in banker loco and application of loco brakes proportionately.

Note: Alerter once will arrived in banker loco

EM2000 on panting recovery once a on handle keep in Full service for 10 sec right 10 sec panting will renew A-9 handle should kept in full service when banker working.

ATTACHING A DEAD LOCO WITH ANOTHER WORKING LOCO (Any type)

Option 1 (with only BP connection)

1. Couple the working loco to dead WDG4/WDP4 loco. Ensure both CBC's are locked properly.
2. Ensure all the breakers in dead loco are in "OFF" position and open battery knife switch.
3. Open MR Equalising & BC Equalising cut out cocks from any one end of dead loco and allow MR & BC to drain.

Note: Keep both MR Equalising & BC Equalising cut out cocks in open condition only.

3a. Open "Dead Engine cut out cock" of dead loco (Provided in nose compartment of cab in CCB unit below VCU)

This COC handle is always in horizontal position for normal (which is in closed position). Keep this handle in vertical position for dead engine movement.

4. Connect BP hose between two locos & open angle cut out cock's. Ensure BP is charged in dead loco and MR2 (on control stand gauges) charging in dead loco.
5. Drop BP from leading loco and ensure BC application in dead loco. Re-charge BP from leading loco & ensure BC on trailing loco releases.

Note: a. During BC application on dead loco, a slight air leakage from opened BC Equalising palm end of dead loco is permitted.

b. Loco brakes of dead loco will get operated only by BP reduction.

Option 2 (with all MU hose connections)

1. Couple working loco with dead WDG4/WDP4 loco. Ensure both CBC's are locked properly.
2. Ensure all the breakers in dead loco are in "OFF" position and open battery knife switch.
3. Follow the points of making MU.

ATTACHING EMD LOCO ON FORMATION

1. Couple loco on formation and ensure both CBC's of loco and formation are locked properly. Do not open the cut out cock immediately after coupling the hose pipes with the formation.

2. Set control stands as below:-

WORKING C/S

NON WORKING C/S

A 9- Release/Run

A9 - Full Service

SA9 - Full application

SA9 - Release

L/T Switch – Test

L/T Switch - Trail

3. Now connect BP & FP pipes of loco and formation and open both BP & FP angle cut cocks of both formation and loco.

4. Charge FP first fully.

5. Keep L/T switch from test position to lead from working control stand and ensure BP start creating.

Note: Air flow indicator shoots up and drop back to zero once BP is created fully.

6. Check BP continuity test with the help of GUARD from brake van.

7. Keep

Isolation switch

RUN

Eng. RUN switch

ON

Gen. Field switch

ON

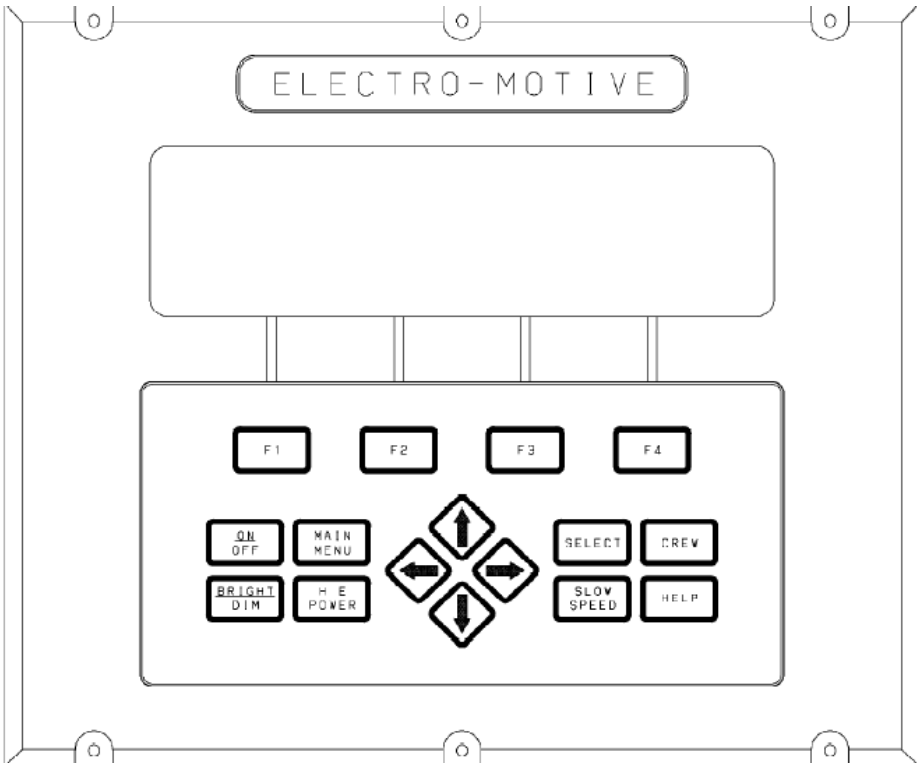
Control & Fuel pump switch

ON

CHAPTER 21

DESCRIPTION OF LOCOMOTIVE COMPUTER DISPLAY PANEL

The locomotive computer display panel, consists of a 6-line, 40-column vacuum fluorescent display with a 16-key back-lit keypad.



**Figure 1.0 – Computer Display Panel
Panel with key pad:**

This display panel is an interactive device that is an interface between the locomotive computer (EM2000) and the locomotive operating crew. The crew can

read the display and input information to EM-2000 through the keypad. EM-2000 messages further instruct the crew.

i. Display Panel Keypad

The locomotive computer display panel is equipped with a keypad. The keys are:

- **F1, F2, F3, F4 Keys** are function keys. The functions may vary on each screen. Pressing a function key typically requests the loco computer to perform a function- reset a fault, cut out an inverter, display stored data, etc.

The function keys are directly below the display screen. The bottom line on the screen names the function that each function key can perform. If no function appears above a function key, it has no function on that screen.

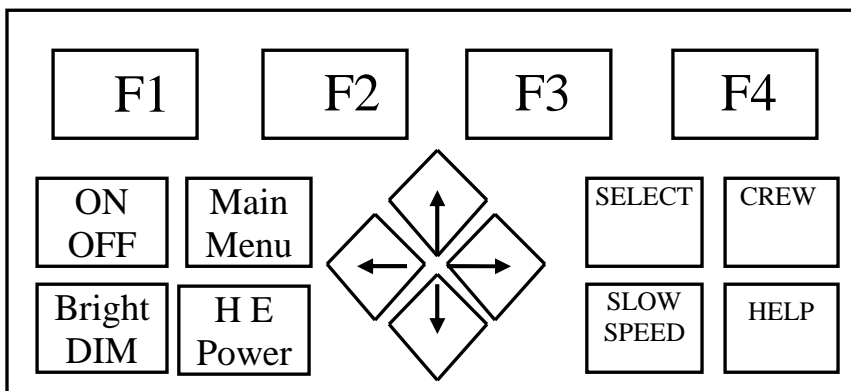


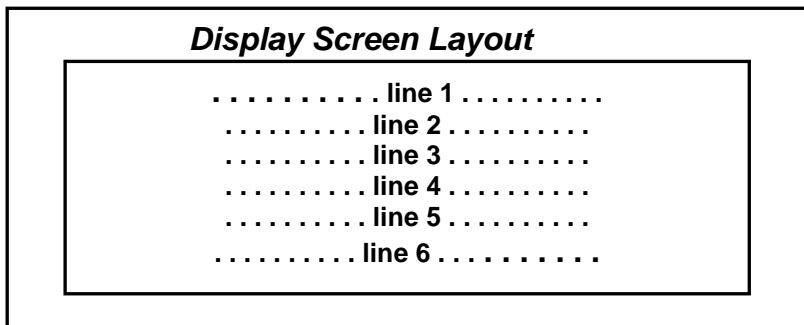
Figure 1.1 – Display Panel key pad

- **ON / OFF Key** controls display panel operating power.
- **MAIN MENU Key** returns screen to main menu.
- **BRIGHT/DIM Key** controls screen intensity.
- **HE POWER Key** Not used.
- **Arrow Keys** ↑, →, ↓, ←) move the screen cursor.

- **SELECT Key** selects the item at the cursor location.
- **CREW Key** returns screen to crew messages display.
- **SLOW SPEED Key** Not used.
- **HELP Key** Not used.

ii. Display Panel Screen:

The display screen has 06 horizontal lines which are designated for reference as shown below.



There are three major locomotive computer display screen classifications:

- **Crew Message Screens** replace annunciator module and local engine indicator lights used on previous model locos.

Note: Crew Messages describe normal operating conditions and various locomotive problems.

Examples of conditions and problems described by crew messages:

- Engine speeds-up because water temperature is too low.
- Locomotive is not properly set up for the requested mode of operation.
- Traction power is being limited for some reason.

- Some locomotive equipment or system has failed, and a protective function is active.
- **Menu Screens** offer choices such as various service functions routinely performed by the operating crew: fault reset, system cut out, etc.
- **Blank Screens** reduce annoying screen illumination when screen is not in use.

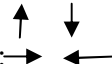
iii. Navigating the Menus:


The locomotive computer display has a cursor-driven menu system.

The cursor consists of two inward-pointing arrowheads:

→ ←

Menu items appear between the two cursor arrowheads, in the “.” space shown above.

Move the cursor with the keypad arrow keys: 

Press the  key to move the cursor from the bottom of one column to the top of the column to the right.

To select a menu item, move the on-screen cursor to the item, then press the SELECT function key. Selecting one menu item causes a sub-menu to appear on the display. To activate certain menu items, it is necessary to press a function key, such as CUT OUT.

iv. COMPUTER DISPLAY OPERATION

The locomotive computer display performs both loco operation and loco service functions. Loco

operation functions include some service-related procedures, such as traction motor cutout and fault reset.

1. **Operation** - Loco crew members use only Crew Message screens to monitor unusual operating or fault conditions and cut out motors or reset faults.
2. **Service-** Maintenance personnel use two types of screens:
 - Crew Message screens to examine fault conditions.
 - Main Menu screens to load test the locomotive, self-tests for certain locomotive systems, meter screens, and other trouble shooting data.

Note: The GT46PAC locomotive is equipped for traction inverter cutout. Cutting out traction inverter #1 cuts off power for both bogie #1 traction motors. Cutting out traction inverter #2 cuts off power for both bogie #2 traction motors. If a traction inverter or its blower fails, the fault causes bogie power lockout and a crew message. To continue operation, cut out the traction inverter for that bogie.

v. Display Power Up:

When the locomotive computer and its display panel initially power up after a shutdown, the computer displays the following on the screen:

1. Fault messages that occurred since the fault annunciator was last reset are stored in locomotive computer archive memory.

The “MAINTENANCE INFORMATION STORED” message appears at the top of the screen for ten seconds after power-up if there are any messages in the annunciator.

2. If there are not any stored (archived) fault messages, but there are active crew messages, then the computer will display the active crew messages on the Crew Message screen.

Note: Only one message is displayed on the screen at a time.

Each message includes a specific priority number.

EM2000 displays messages in order by priority number.

The priority numbers have been assigned based on urgency.

3. If there are no active crew messages, then the locomotive computer displays the Main Menu screen,

vi. Crew Messages:-The Crew Message screen, displays fault conditions that require immediate attention - important crew messages interrupt the other display functions.

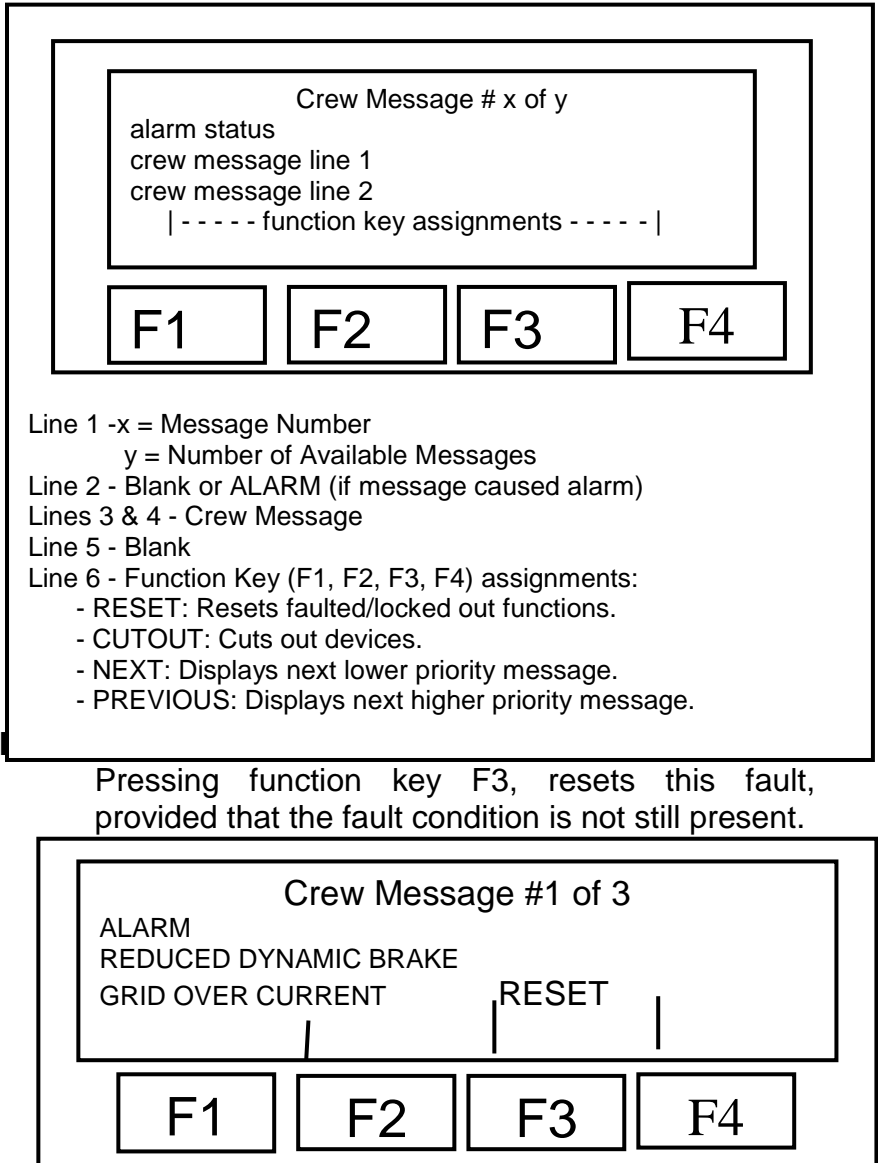


Fig. 1.2 Typical Crew Message

vii. Main Menu

To bring up the Main Menu screen, press the MAIN MENU key once, or press the EXIT key on other screens as many times as necessary.

The Main Menu screen is the starting point for access to the EM2000 for locomotive service and service-type driver functions. Starting at the Main Menu screen, service personnel have multiple screen options available for evaluating performance, testing subsystems, and troubleshooting equipment and circuitry.

The cursor in is set at Data Meter. If the SELECT function key is pressed, the displayed screen changes to the meter menu screen,

Main Menu Screen

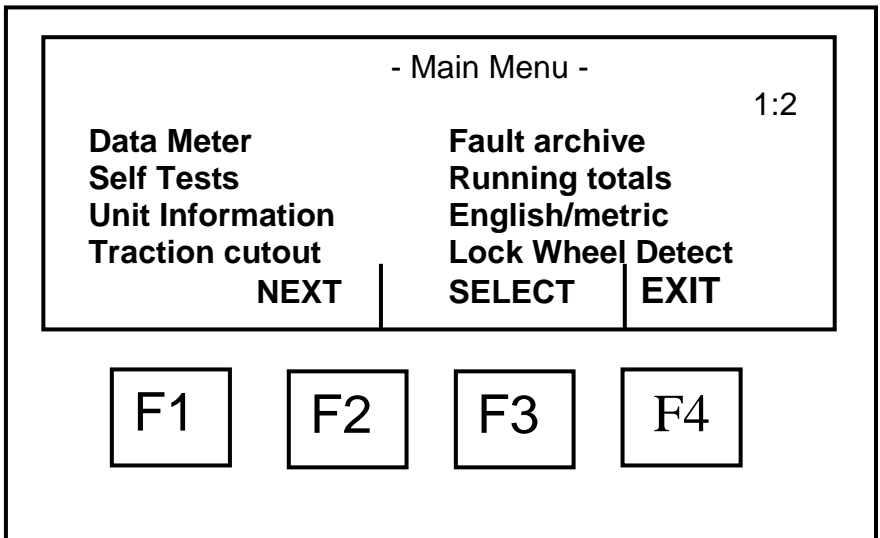


Fig. 1.3

If the NEXT function key is pressed while the Page 1 Main Menu screen displays,

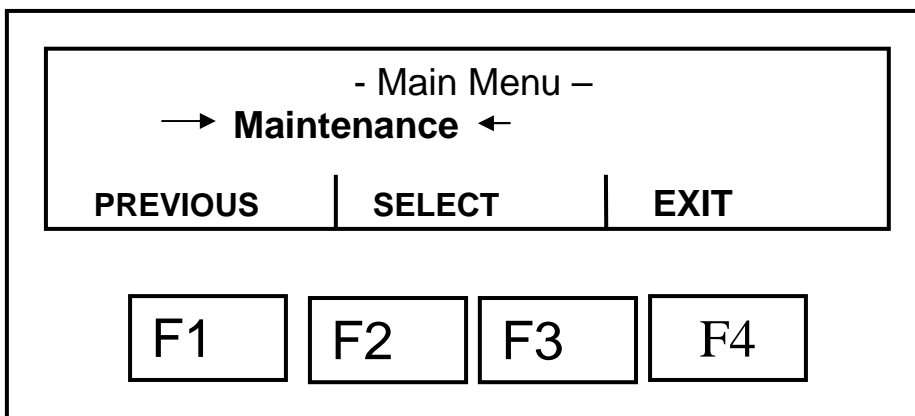


Fig. 1.4 Main Menu Screen

viii. Traction Inverter Cutout

The traction inverter cutout function replaces the engine control panel traction motor cutout switch on previous EMD locomotive models. This function enables the locomotive crew to view the status of both traction inverters on the EM2000 display, and enables them to cut out or cut in either traction inverter with the display.

This locomotive has separate cooling air blowers for each traction inverter. If one of the blowers fail, then it is advantageous to cut out the traction inverter associated with that

blower, enabling the locomotive to be powered by the other traction inverter. The entire bogie (truck) can be electrically disabled or enabled through the display.

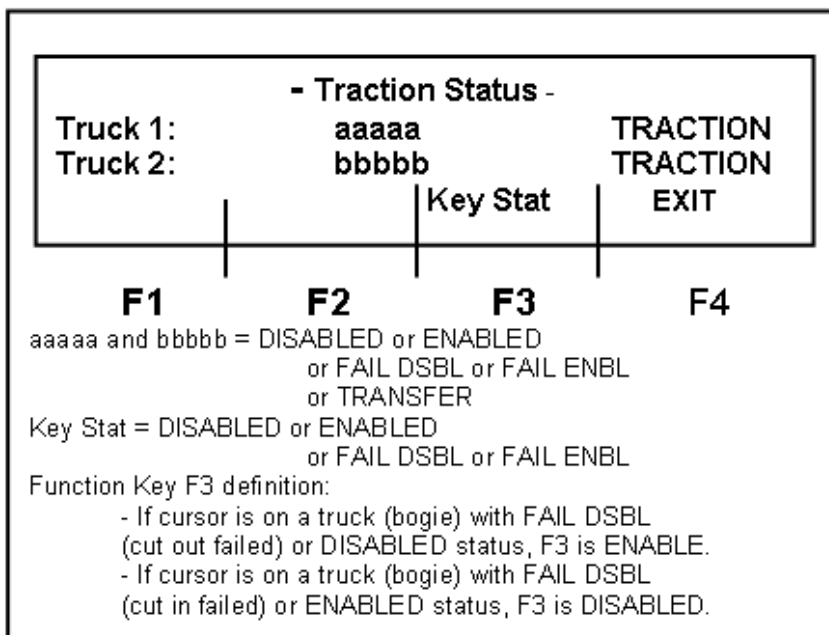


Figure 1.5 Truck (Bogie) Electrical Status

Traction inverter disable/enable functions can be performed from the Traction Status display screen, Figure given above.

Note: The locomotive must be unloaded while attempting to disable/enable a traction inverter.

Access the Traction Status screen in either of two ways -

- Select TRACTION CUT OUT on the Main Menu.
- Operate the CUTOUT function key on a Crew Message screen indicating a faulted device.

Note: In order to continue operation after a fault causes power lockout (crew message appears), it is necessary to disable a truck (bogie).

ix. Cutting-out or Cutting-In a Traction Inverter or Bogie (Truck)

Changes in traction status usually must be made because of a fault condition that is indicated by a crew message on the locomotive computer display. The following are traction status changes:

- Disabling a bogie (truck): all motors on a bogie and the associated blower motor are cut out.
- Enabling a bogie (truck): all motors on a bogie and the associated blower motor are cut back in.

For each fault condition, a crew message is displayed that identifies the fault and assigns it to a bogie.

A failure of the a traction inverter blower produces a crew message -

TRACTION INVERTER BLOWER #1 IS NOT TURNING, for example. If the CUT OUT key on Crew Message screen is pressed, the screen changes to the Traction Status screen, Figure given above, to enable the bogie to be cut out.

Proceed as follows to cut out an inverter or bogie:

1. The CUT OUT designation is above the function key on the Crew Message screen having the fault message.
2. Isolate the locomotive. (Set isolation switch in START/STOP/ISOLATE.)
3. Press the CUT OUT function key to bring up the Traction Status screen.

Note: The Traction Status screen is also accessible directly from the Main Menu screen by selecting the Traction Cut Out option.

3. On the Traction Status screen the Key Stat function key (F3) is designated ENABLE or DISABLE for a faulted bogie blower. Moving the cursor to the faulty bogie causes the function key designation to indicate the status of that device.
5. The status of the bogie (truck) displays.
4. If the cursor is at Truck 1, and bogie 1 is ENABLED, only the DISABLE and EXIT functions are available because this bogie is already enabled.
7. Press DISABLE key to cut out the #1 bogie.
 - During cutout process, truck (bogie) status changes to TRANSFER.(No function keys are designated during cutout process.)
 - If cutout process is successful, Truck 1 (bogie 1) status changes to DISABLED on the display.

Note: If just interrogating computer for bogie status, be sure both bogies are cut in before operating locomotive.

x. Maintenance Menu

Pressing NEXT key on Main Menu page 1 brings up Main Menu page 2.

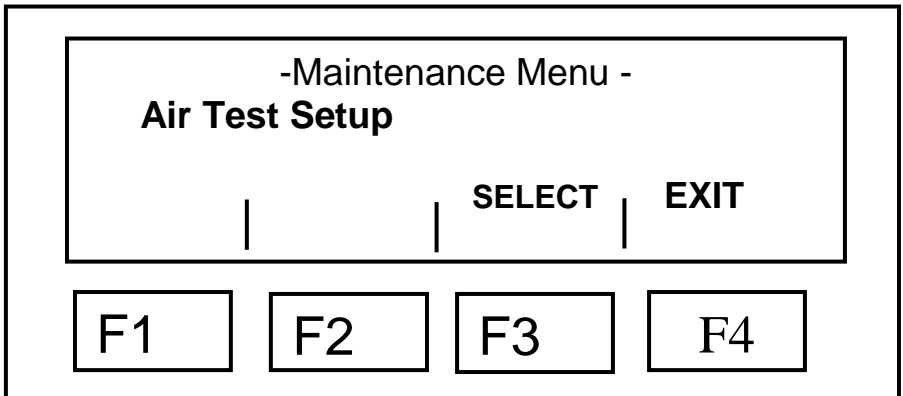


Fig. 1.6 Maintenance Menu Screen

xi. Meter Menu :

Selecting DATA METER on the Main Menu brings up the Meter Menu screen, Setting the cursor at any of the meter menu items, then pressing the SELECT key brings up a screen that displays information about the selected subject.

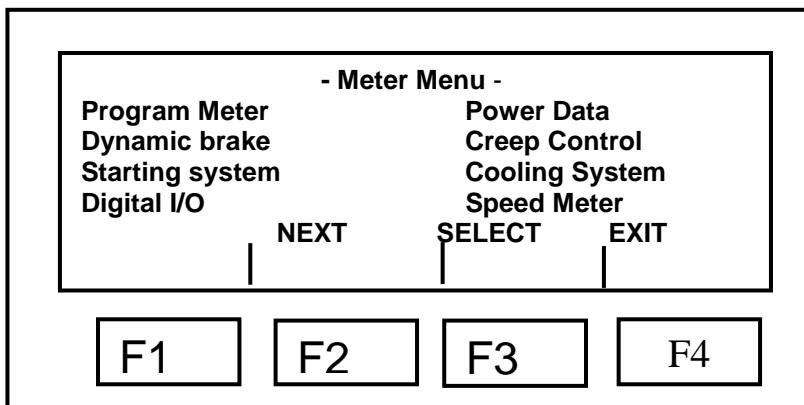


Fig. 1.7 Meter Menu Screen Format

xii. Blanking the Screen

Screen blanking eliminates all screen text from the EM2000 display when it is not needed. Screen blanking actuates when either of the following conditions is true:

- OFF key on keypad is operated.
- There has been no keypad usage for the past 30 minutes provided that:
 - There are no active crew messages, and
 - No locomotive system self-test or device cut-out process is running.

To return to the previous screen after the screen has been blanked, press the ON key (on display panel keypad) no later than 10 minutes after the screen was blanked.

During locomotive operation, the display screen is blank most of the time because there are no loco fault conditions & the locomotive crew has not used the keypad for 30 minutes.

CHAPTER 22

LIST OF THE IMPORTANT CREW MESSAGES WITH CODE

Following are some common potential crew messages.

| CODE | CREW MESSAGES |
|------|---|
| 241 | DYNAMIC BRAKE GRID OVERCURRENT |
| 309 | ENGINE AIR FILTERS DIRTY |
| 14 | ENGINE AIR FILTERS DIRTY-THROTTLE 6 LIMIT |
| 0 | ENGINE DEAD - UNIT NOT ISOLATED |
| 73 | ENGINE DIED WHILE ISOLATED |
| 206 | ENGINE IS NOT RUNNING |
| 322 | ENGINE PROTECTION SHUTDOWN |
| 76 | ENGINE SPEED INCREASE – Turbo COOL DOWN CYCLE |
| 77 | ENGINE SPEED INCREASE - LOW AIR PRESSURE |
| 311 | ENGINE SPEED INCREASE - LOW WATER TEMPERATURE |
| 240 | ENGINE SPEED INCREASE - TRACTION MOTOR COOLING |
| 512 | FILTER BLOWER MOTOR CIRCUIT BREAKER IS OPEN |
| 96 | FORCED IDLE - ENGINE RUN SWITCH DOWN |
| 281 | FUEL PUMP IS NOT RUNNING |
| 124 | GENERATOR FIELD OVEREXCITATION |
| 61 | GROUND RELAY - DYNAMIC BRAKE |
| 319 | GROUND RELAY - POWER |
| 302 | HOT ENGINE - THROTTLE 6 LIMIT |
| 15 | #n LOCKED WHEEL |
| 494 | #n LOCKED WHEEL DETECTION DISABLED |
| | NO ACTIVE CREW MESSAGES |
| 172 | NO DYNAMIC BRAKE - DYNAMIC BRAKE CUTOUT |
| 600 | NO DYNAMIC BRAKE - GROUND RELAY LOCKOUT |
| 174 | NO LOAD - ENGINE TEMP FEEDBACK FAILURE |
| 176 | NO LOAD - GENERATOR FIELD SWITCH DOWN OR SDR RELAY IS PICKED UP |
| 178 | NO LOAD - GROUND RELAY CUTOUT |
| 192 | NO LOAD - IMPROPER B CONTACTOR STATUS |

| | |
|-------------|--|
| 179 | NO LOAD - IMPROPER GFC STATUS |
| 200 | NO LOAD - IMPROPER GFD STATUS |
| CODE | CREW MESSAGES |
| 453 | NO LOAD - NO COMPANION ALTERNATOR OUTPUT |
| 456 | NO LOAD - PCS OPEN |
| 221 | NO LOAD - SIMULTANEOUS FORWARD/ REVERSE REQUEST |
| 131 | NO LOAD - SIMULTANEOUS POWER/SLOW SPEED REQUEST |
| 125 | NO LOAD - UNIT IS ISOLATED |
| 8 | NO LOAD TEST, DYNAMIC BRAKE - EXCESSIVE GRID BLOWER #n CURRENT |
| 4 | NO LOAD TEST, DYNAMIC BRAKE - GRID BLOWER #n GRID FAILURE |
| 2 | NO LOAD TEST, DYNAMIC BRAKE - GRID CURRENT IMBALANCE |
| 10 | NO LOAD TEST, DYNAMIC BRAKE - GRID OPEN CIRCUIT |
| 11 | NO LOAD TEST, DYNAMIC BRAKE - GRID OVERCURRENT |
| 7 | NO LOAD TEST, DYNAMIC BRAKE - NO GRID BLOWER #n CURRENT |
| 59 | NO POWER - GROUND RELAY LOCKOUT |
| 127 | REDUCED DYNAMIC BRAKE - ENGINE SPEED UP FAILURE |
| 22 | REDUCED POWER, DYNAMIC BRAKE - TRACTION MOTOR BLOWER #n FAULT |
| 130 | SIMULTANEOUS POWER/DYNAMIC BRAKE REQUEST |
| 133 | STARTER MOTOR OVERLOAD |
| 149 | TRAINLINE ALARM BELL |
| 222 | TURBOCHARGER CIRCUIT BREAKER OPEN |
| 521 | TURBOCHARGER LUBE PUMP NOT RUNNING |

CHAPTER 23

INDICATOR LIGHT MESSAGES

The control consoles each incorporate a six-indicator light assembly. Each indicator is imprinted with a word or phrase that conveys a message for the locomotive driver.

BB C/O Light On:

Conditions: Engine control panel BLENDED BRAKE switch is set in CUT OUT (slider Down). Setting AUTO brake handle in SERVICE ZONE causes air braking alone to apply - without any dynamic braking.

Action Required: To regain use of blended braking, set BLENDED BRAKE switch slider in CUT IN (Up).

SAND Light On:

Conditions: This light indicates locomotive sanding is active on this locomotive and on train lined locomotives for any of various reasons (SAND switch operated, automatic sanding initiated for wheel creep enhancement, etc.)

Action Required: None.

WHEEL SLIP Light, Continuous or Flashing Regularly

Locked Powered Wheel Condition:

Note: follow prescribed instructions concerning Locked Wheel faults.

Locomotive computer immediately lights WHEEL SLIP indicator and drops load when Siemens system detects locked wheel. After 10 seconds delay, (20 sec. if air brakes are applied), locomotive computer sets fault, sounds alarm bell, continues WHEEL SLIP light, and displays following message: #n LOCKED

WHEEL - STOP TRAIN AND THEN CHECK IF THE WHEELS TURN FREELY. Fault indications above continue until driver uses loco computer display panel to reset fault.

WARNING

Locked wheels on moving locomotives are very dangerous. If locked wheel is indicated, do the following:

Action Required: Stop the train and set the throttle handle in IDLE. Then follow the procedure provided for Locked Wheel Condition.

WHEEL SLIP Light, Flashing Irregularly or Occasionally

For any locomotive connected to any loco by train jumpers, the conditions given below can activate the control console WHEEL SLIP light.

Startup/Slow Conditions: Speed under 2.4 km/h (1.5 MPH); normal startup wheel slip correction operation.

Action Required: No action required. Do not reduce throttle unless slipping threatens to break the train.

Normal Running Conditions: Speed over 2.4 km/h (1.5 MPH); backup of Super Series wheel creep control operation. Possible failure of Super Series. May also indicate normal wheel slip detection/control on train lined non-Super Series units.

Action Required: No action required. Do not reduce throttle unless slipping threatens to break the train.

Over speed Conditions: Wheel over speed detected by computer. The indicator light flashes- 3 seconds "On"/ 3 seconds "Off" - to indicate

wheel (and traction motor) over speed, and locomotive computer displays WHEEL OVER SPEED message.

Cause may be excessive track speed or simultaneous slipping of all locomotive wheels. In either case, the system automatically corrects by regulating traction alternator output (power drops out until speed drops, then picks up again). Locomotive computer message and indicator light flashing automatically cancel after recovery.

Action Required: Reduce throttle setting.

FLSHR LAMP Light:

Conditions: This light flashes On/Off when either outside flasher lamp (at cab end or at long hood end) is flashing, provided that outside flasher lamp is not burned out and LIGHTS breaker is closed. Flashes at same rate as outside flasher lamp.

Action Required: Open flasher light switch when flasher light operation is no longer required.

PCS OPEN Light On:

Conditions: Penalty or emergency brake application and loss of power. Computer displays NO LOAD - PCS OPEN message, motoring/Diesel engine will come into throttle idle however dynamic braking can be availed.

Action Required: Set throttle in IDLE. Set automatic brake in EM (Emergency), wait 60 seconds, then set in REL (Release). For the recovery of penalty is always gets displayed on EM 2000 screen. For example: EM 2000 displays "keep auto brake handle

in full service for 10 seconds to recover normal air brake”.

BRAKE WARN Light On:

Conditions: Excessive dynamic brake current on this loco or on a train lined locomotive.

Action Required: Reduce dynamic brake handle setting immediately. If light stays On, set DYN BRAKE cutout switch on engine control panel in CUT OUT (slider Down). Computer then displays NO DYNAMIC BRAKE-DYNAMIC BRAKE IS CUT OUT message.

CHAPTER - 24

Miscellaneous

Checking of the Loco by Loco pilots:

1. Before starting the train, ensure good quality sand is available in all sand boxes.
2. Check water level in loco dead condition and after cranking condition.
3. Keep 10 seconds gap for power to DB and DB to power mode.
4. If loco is not cranking 2/3 times, wait to cool down the starting motors for 2-3 Minutes.
5. If required for raising the Engine, put -
 - A. Engine Run Switch to run.
 - B. Isolation switch to run.
 - C. Reverser in natural
6. Don't reverse the loco operation while in moving.
7. For enroute, if loco shut down, first secure the loco before cranking.

WDP4 / WDG4 Locomotive Cranking Procedure

1. Put on the hand brake.
2. Check oil and coolant water levels.
3. Make sure that LLOB on Governor, Low water and low crank case pressure reset buttons are pressed in.

4. Make sure that Engine Over Speed Trip Reset Lever (OSTA) is in Reset position (Handle should be tilted towards left side of locomotive in Reset position).
5. Make sure that the Isolate / Run switch is in 'Isolate' position.
6. On the Long hood control stand – Ensure
 - Engine Run switch is down (OFF).
 - Control & FP breaker is up (ON).
 - Generator field switch is down (OFF).
 - MU shut down RUN button is pressed-in.
7. On working control stand –
 - Ensure Reverser handle in Neutral.
 - Throttle handle in idle.
 - Keep Auto brake handle in RUN position.
 - Keep Independent brake handle in Full application position.
 - Keep Lead / Trail switch in Lead position.
8. On Non-working control stand –
 - Ensure Reverser handle is removed.
 - Throttle handle in Idle.
 - Auto brake handle in FS (Full service) position.
 - Independent brake handle in released position.
 - Lead / trail switch is in Trail position.
9. Ensure all circuit breakers on circuit breaker panel are in OFF position.
10. Ensure that start Fuse is in position and and close the battery knife switch. (ON)
11. On the circuit breaker panel
 - Put on BLACK labelled circuit breakers.
 - Put on White labelled circuit breakers as applicable.
 - Put on Yellow labelled circuit breakers (Turbo & Computer).
13. On Computer select starting system

- Main Menu,
- Data Meter
- Starting system

14. TLPR shows on (Turbo Cooling Cycle Starts) Now engine is ready for cranking.

15. Go to the FUEL PRIME / ENGINE START switch and turn the switch to FUEL PRIME side (left side). If the shutdown procedure was followed properly earlier, the fuel pump motor will start (the motor sound can be heard). If the fuel pump motor does not start, wait for 15-20 minutes and try again.

16. Keep holding the Engine PRIME / ENGINE START to prime side and see that the fuel secondary sight glass is full of fuel and shows no bubbles. Out of the two sight glasses, the one closest to engine block should be full without any air bubble and one away from the engine block should be empty.

17. Turn the Engine PRIME / ENGINE START switch to ENGINE START side and press the lay shaft gently to crank the engine. Release the lay shaft and the switch when you feel the lay shaft being pulled from your hand (only for WDG4 Locomotive). In case of WDP4 locomotives, start switch can be released when engine RPM goes above 160 – 180, which can be readily seen on the starting system screen on EM 2000. EPU RPM.

18. Caution: Excessive pressing of the lay shaft will overspeed the engine and OST will trip causing the engine to shut down.

WDP4/WDG4 LOCOMOTIVE SHUT DOWN PROCEDURE

1. Put on the hand brake.
2. Turn Isolate / Run switch to isolate position.
3. On the long hood control stand, keep.
 - Engine Run Switch down (OFF).
 - Control & FP breaker up (ON).
 - Generator field switch down (OFF).
4. On the working control stand -
 - Keep Throttle handle in idle.
 - Keep reverser handle in neutral and remove the handle.
 - Auto brake handle in released position.
 - Apply Independent brake to full application position.
 - Ensure Lead / Trail switch is in Lead.
5. On the non-working control stand – Ensure -
 - Auto brake is in full service position.
 - Independent brake is released.
 - Lead / Trail switch is in Trail Position.
6. Select Starting system on computer to watch the status of TLPR. (Shows off)
7. Press EFCO (Red) button on the Control panel till the engine stops (TLPR shows ON)
8. Make sure that the Turbo lube pump motor is running.
9. Switch off all circuit breakers on the circuit breaker panel except turbo lube pump circuit breaker and computer circuit breaker.
10. Open battery knife switch.
11. Remove the reverser and hand over to reliever or CCC.

12. Wait till TLPR goes OFF. (Turbo cooling cycle completes)

14. Put-off Turbo lube pump circuit breaker and computer circuit breaker.

Procedure for recycling of circuit breaker:

1. Stop the locomotive.
2. Secure the loco by
 - (i) Apply SA9/hand brake.
 - (ii) Keep throttle handle.
 - (iii) Keep reverser neutral.
 - (iv) Isolation switch on isolate.
 - (v) ER off.
 - (vi) GF off.
3. Switch off computer circuit breaker
4. Switch off concerned circuit breaker (TCC1, TCC2, MAB, auxiliary generator, breakers etc.).
5. Wait for 20 to 30 seconds.
6. Switch on concerned circuit breaker.
7. Switch on computer circuit breaker.
8. Recover air brake penalty by keeping A9 on FS for 10 seconds.

CHANGING WORKING CONTROL STAND TO NON/WORKING CONTROL STAND

| WORKING CONTROL STAND PRESEN TPOSITION | CHANGING TO NON/WKG CONTROL STAND |
|--|---|
| A9 (auto brake) lever in RUN BP Pressure 5 Kg/cm 2 | Move A9(AUTO brake) To Full Service BP Pressure Drops to 4.0 Kg/cm2 |
| SA9(DIR BRAKE) Lever in Full BC Pressure 5 Kg/cm2 | Move SA9(DIR BRAKE) To Release BC Pressure drops to 4.0 Kg/cm2 |
| L/T switch in LEAD ER Pressure 5Kg/cm2 | Move L/T switch To Trail (TRL)ER Pressure drops to 0 Kg/cm2 |

CHANGING NON WORKING CONTROL STAND TO WORKING CONTROL STAND

| NON WORKING CONTROL STAND PRESENT POSITION | CHANGING TO WORKING CONTROL STAND |
|--|---|
| L/T switch in TRL (trail) | Move L/T switch to LEADER Pressure builds to 4.0 Kg/cm ² |
| SA9 in RELEASE (DIR brake) | Move SA9(DIR BRAKE) To FULL BC builds to 5.0 kg/cm ² |
| A9 in FS (Auto brake) | Move A9 To RUN BP builds upto 5.0 kg/cm ² |

IMPORTANT DO's AND DONT's FOR LOCO PILOTS & SHED MAINTENANCE STAFF

DO's

- 1 DO-Let the locomotive warm up properly to the desired temperature of 125°F(55°C) before attempting to move the locomotive. (The locomotive raises engine speed to 3rd notch RPM automatically till the temperature is obtained).
- 2 DO-Ensure cranking of the locomotive at least once in 24 hours to make sure that there is no hydraulic lock up if the engine has not been cranked for more than 24 hours by barring the crankshaft manually.

- 3 DO-Ensure pre-lubrication of the engine (to be done by maintenance staff) if the engine has not been cranked for more than 48 hours.
- 4 DO- Follow correct cranking and shut down procedures to enhance engine and turbo life.
- 5 DO- Ensure all brakes are released properly before moving the locomotive.

Dont's

- 1 DON'T – Raise the engine beyond 4th notch without load.
- 2 DON'T– Spill tea / coffee or other eatables on control stand or cab. (The sensitive air brake equipment in control stand and air brake compartment may malfunction)
- 3 DON'T– Permit incorrect lube oil, governor oil or coolant water to be added in the locomotive.
4. DON'T- Permit bad quality sand or wet sand to be added in the sand boxes.
5. DON'T– Stable the locomotive without applying the hand brake.
6. DON'T– Move your train unless you physically check that the brakes are active.

DIFFERENCES BETWEEN WDG₄ AND WDP₄ GM LOCOMOTIVES

| S. No. | Description | WDG ₄ | WDP ₄ |
|--------|-------------------------------|---------------------------------------|--|
| 1. | Model | GT46MAC | GT46PAC |
| 2. | Service | Goods | Passenger |
| 3. | Speed | 100KMPH | 160KMPH |
| 4. | Speedometer | 0-120KMPH | 0-180KMPH |
| 5. | Weight | 129Tonne | 115.8Tonnes |
| 6. | No. of Axis | 6 | 6 |
| 7. | No. of Traction Motor | 6(Each Bogie 3 Drivers) | 4(Each Bogie 2 Drivers) |
| 8. | Under TCC1 | 1,2,& 3 Axle TM | 1, & 2 Axle TM |
| 9. | Under TCC2 | 4,5 & 6 Axle TM | 5 & 6 Axle TM |
| 10. | TM Pinion and Bull Gear Ratio | 17:90 | 17:77 |
| 11. | Batteries | LEAD ACID | NICKEL CADMIUM |
| 12. | No. of Batteries | 2 | 10 |
| 13. | No. of Cells | 32 | 50 |
| 14. | Cell Voltage | 2.1 | 1.5 |
| 15. | Total Voltage | 68 | 75 |
| 16. | Engine Starting Switch | Located below Water Expansion Tank | Located in the cab itself. |
| 17. | For quick engine firing | Governor Lay Shaft Manually operation | Governor booster pump starts automatically |

| | | | |
|-----|---------------------------------|---|--|
| 18. | Radar System | Located between front bogie & Fuel tank | Located between fuel tank & rear bogie |
| 19. | Cab Light Switch | Near Cab Light | In control stand side switch panel |
| 20. | Lube oil Filter Drum | Only Bye-pass Valve | Bye-pass valve with gauge (Like fuel oil Primary filter) |
| 21. | Blended Brake | Not provided | Provided |
| 22. | Location of Blended Brake | Not provided | On engine control panel |
| 23. | Low water Level Switch | Not provided | Provided in the engine Cooling Water system |
| 24. | Temperature Gauge | Not provided | Located on the inlet line to the Water pump |
| 25. | Colour Code (Temperature gauge) | Not provided | Blue (cold), Green (Normal) & Red (Hot) |

OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity and performance of all Railway assets and man power which inter-alia would cover reliability, availability, utilization and efficiency.

If you have any suggestions and any specific comments, please write to us.

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