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**Question Bank for JE Elec. (LDCE)**

**I. Diesel locomotive theory:**

1. What are the electrical rotating machines available in ALCO locomotive? Explain briefly any five machines.
2. What are the electrical rotating machines available in WDG4 locomotive? Explain briefly any five machines.
3. Write the common problems encountered in electrical D.C. machines?
4. Procedure for mounting the pinions of TM and AG and checks to be done on the pinion before Mounting.
5. Measures to be taken at the time of overhauling to prevent bearing seizures in Traction motors.
6. Measures to be taken at the time of overhauling to prevent TM failures other than bearing seizures.
7. Testing procedures of rotating machines given below after overhaul.
8. Procedure followed for testing the battery capacity at the time of overhauling.
9. Attention given to batteries during light and medium schedules.
10. Sensors in MEP ALCO locomotive.
11. Write the advantages of AC small motors over DC small motors and specifications?
12. Explain about the safety devices available in ALCO locomotive?
13. Explain about 'Dynamic Braking' in ALCO locomotive.
14. Explain about salient features of WDG4 locomotive.
15. What are the functions of Governor? Explain advantages of MCBG.
16. Write short notes on:
  - a. ~~Air Dryer~~
  - b. Auto Flasher Light
  - c. 40 days Trip schedule
  - d. Twin beam head light
  - e. Benefits of microprocessor control systems
  - f. TM isolation procedure in MEP locomotive
  - g. Wheel slip logic in MEP locomotive
17. Explain the trouble shooting procedures for the following problems in MEP ALCO locomotive?
  - a. Continuous wheel slip.
  - b. Power ground
  - c. Poor hauling power
  - d. Hot Engine
  - e. LM not responding
  - f. Throttle not responding
  - g. Engine not starting in WW governor
18. Explain the trouble shooting procedures for the following problems in WDG4 locomotive?
  - a. Continuous wheel slip.
  - b. Power ground
  - c. Poor hauling power
  - d. Hot Engine
  - e. LM not responding
  - f. Throttle not responding
19. Draw and explain the block diagram of MCBG.
20. Draw and explain the MEP system Excitation block diagram.
21. How IRC will be conducted in MEP locomotive during schedule attention?

22. How IRC will be conducted in WDG4 locomotive during schedule attention?
23. What is Self Load Test and how it will be conducted in MEP locomotive.
24. Explain about VCD in MEP locomotive.
25. Explain the following in MEP locomotive.
  - a. Pre and Post lubrication
  - b. TE limit switch
  - c. Power setter switch
  - d. Intelligent low idle Feature
  - e. SSIP data
26. Explain the following in WDG4 locomotive.
  - a. Blended Brake
  - b. RAPB
  - c. AESS
  - d. IPR
  - e. LCC & TCC
  - f. Self tests
  - g. EM 2000 computer
  - h. Panel mounted modules in EMD locomotive
  - i. Event Recorder
  - j. RADAR
  - k. PRG & PSMs in EMD locomotive
  - l. Electrical control cabinets in HHP locomotive.
  - m. Recycling procedure
27. What is Load Test? How Load Test will be conducted in ALCO locomotive? What are the readings to be note down during load test and write the normal values? How engine HP will be calculated?
28. How Shed target outage will be calculated? A shed homing 214 locos, in which 2 are accident locos, 58 are link locos & 24 are inferior locos. Calculate shed target outage.
29. Explain about REMMLOT.
30. Explain about APU.
31. Explain about TCAS system.
32. Explain about DPCS system.
33. MU setup Procedure for Single cab loco and Dual cab locomotive.
34. MU setup Procedure for two Dual cab locomotives.
35. **Circuit diagrams with explanations:**
  - a. Draw and explain the engine starting circuit of MEP WDG3A locomotive.
  - b. Draw and explain the power circuit of MEP WDG3A locomotive.
  - c. Draw and explain the engine starting circuit of WDG4 locomotive.
36. **Overhauling Procedures:**
  - a. Explain the Overhauling procedure of Traction Motor (TM) of ALCO locomotive.
  - b. Explain the Overhauling procedure of Traction Alternator (TA) in ALCO locomotive.
  - c. Explain the Overhauling procedure of AC fuel pump motor (FPM) in ALCO locomotive.
37. **Schedule attention:**
  - a. What is schedule? What are the latest RDSO standard schedules adapted to ALCO and WDG4 locomotive and indicate their periodicity?
  - b. Explain 90 days schedule attention to WDG4 locomotive.
  - c. Explain 180 days schedule attention to WDG4 locomotive.
  - d. Explain Monthly schedule attention to MEP ALCO locomotive.



- e. Explain Quarterly (QLY) schedule attention to MEP ALCO locomotive.
- f. Explain Half- yearly (M12) schedule attention to ALCO Diesel locomotive.

38. **Latest technological up gradations and Modifications:**


- a. Write latest RDSO electrical modifications in ALCO locomotive.
- b. Write latest RDSO electrical modifications in WDG4 locomotive.
- c. Write electrical modifications done at KZJ shed.
- d. Write latest technological up gradations in ALCO locomotive.
- e. Write latest technological up gradations in WDG4 locomotive.

39. Explain the following:

- a. REMMLOT
- b. APU
- c. TCAS
- d. DPCS
- e. CReDI

40. **General:**

- a. Explain about IMS.
- b. Explain about '5S'.
- c. Explain about EnMS.
- d. Define AAC & Write the difference between stock and Non stock Item.
- e. Write the procedure for stocking an item?  
Write a short notes on i) Stock Items ii) Ordinary Stores iii) Emergency Stores  
Write a short notes on i) Non Stock Items ii) Special Stores iii) Surplus Stores
- e. As per official language Act, India is divided into how many Regions? What are the states under those regions?
- f. List out any three incentives for doing official work in Hindi and also passing Hindi Examinations?
- g. What is the objective of Raj-basha policy? What are the steps taken to promote raj-basha in Indian Railways?
- h. What is 'Working Knowledge of Hindi'?
- i. What is 'Proficiency in Hindi'?
- j. What are the documents covered under section 3(3) of official language act 1963?
- k. Salient features of official language rules 1976

  
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## BIT BANK

1. 1 HP = ----- watt. (746)
2. LCD means ----- (Liquid crystal display)
3. HP of WDM3A locomotive = ----- (3100)
4. Inverter converts ----- to ----- (DC to AC)
5. Hot Engine power reduction to TH6 setting in WDG4 locomotive = ----- (96° C)
6. No. of power contactors in WDP1 locomotive = ----- (6)
7. On run if MB1 breaker tripped ----- will happen. (No battery charging)
8. Hot Engine setting in MEP ALCO locomotive = ----- (92° C)
9. PCS2 drop setting = ----- kg / cm<sup>2</sup>. (2.8)
10. PCS3 connected in ----- circuit. (DMR)
11. Gear ratio of WDG3A = ----- (18:74)
12. Idle RPM of WDG4 = ----- (269)
13. Transition speed of WDG3A locomotive = ----- (42 kmph)
14. During Dynamic braking ----- power contactors will make TM field circuit. (S1, P1 & P32)
15. TM 3 is connected with ----- power contactor during parallel operation. (P22)
16. Maximum grid current during dynamic braking in ALCO locomotive ----- (800 amps)
17. OSTA tripping RPM of WDM3A locomotive = ----- (1200±20)
18. Control air pressure maintained by ----- (N1 reducing valve)
19. No. of transitions in WDG3A = ----- (1)
20. Maximum speed of WDG3A = ----- (105kmph)
21. No. of gears in Traction generator gear box = ----- (5)
22. IGBT means ----- (Insulated Gate Bipolar Transistor)
23. GTO means ----- (Gate Turn Off Thyristor)
24. No. of voltage sensors in Medha microprocessor locomotive = ----- (5)
25. GR1 is replaced by -----, in Medhamicro processor locomotive. (TANGI)
26. GR2 is replaced by -----, in Medhamicro processor locomotive. (BANGI)
27. Insulation resistance is measured by ----- (Megger)
28. TM winding resistance value measured by ----- (Micro Ohm meter)
29. P1 switch pickup setting = ----- kg / cm<sup>2</sup>. (4.8)
30. P2 switch drop setting = ----- kg / cm<sup>2</sup>. (4.4)
31. No. of current sensors in medha Microprocessor locomotive = ----- (14)
32. TANGI means ----- (Traction Alternator Neutral to Ground Leakagecurrent sensor)
33. Pre-lubrication time in MEP locomotive during engine cranking ----- (1 min.)
34. Post-lubrication time in MEP locomotive during engine cranking ----- (5 min.)
35. No. of cards in MEP ver. 2.0 microprocessor panel ----- (19)
36. No. of DIO cards in EMD WDG4 locomotive ----- (3)
37. GFOLR is replaced by -----, in MEP locomotive. (EXAI)
38. During VCD penalty brake application, after ----- seconds VCD will get resetted. (34)
39. If Driver failed to do any loco operation, after ----- seconds penalty brakes will come. (76)
40. In MEP ver. 2A locomotive TM isolation can be done through ----- (Display)
41. In MCBG fitted loco FRP sensor is provided in ----- (Actuator unit)
42. In WW gov. fitted loco, to get Low idle rpm, ----- solenoids should energize. (A & D)
43. Carbon Brush used in Traction Alternator in ALCO locomotive is ----- (HM6 Morgan)
44. Carbon Brush used in Traction Motor is ----- (EG 14D)
45. Carbon Brush used in Exciter is ----- (EG 251)
46. Carbon Brush used in Eddy Current Clutch is ----- (EGO)



46. Carbon Brush used in Eddy Current Clutch is ----- (EGO)
47. Traction Alternator carbon brush condemn size is ----- ( )
48. Traction Motor carbon brush condemn size is ----- ( )
49. Eddy current clutch carbon brush condemn size is ----- ( )
50. TA 10102 CW maximum output is ----- KW. ( )
51. RPM of AC CCEM is ----- ( )
52. RPM of AC FPM is ----- ( )
53. Brush holder clearance of Traction motor is ----- ( )
54. Brush holder clearance of Eddy current clutch ----- ( )
55. Resistance value of ECC coil is ----- ohm. (5.6 – 6.5 ohms)
56. RDSO means ----- ( )
57. IRCON means ----- ( )
58. AIDS means ----- (Acquired Immuno Deficiency Syndrome)
59. RITES means ----- (Rail India Technical & Economic Services)
60. REMMLOT means ----- (Remote Monitoring and Management of Locomotives and trains)
61. Gear ratio of WDM2 is ----- (18:65)
62. During dynamic braking which valve isolates the loco brake? (BKIV)
63. If ECC drawing over current, which breaker will trip? (FPB)
64. The safety device provided in the brake system? (PCS)
65. On run if MCB1 trips what trouble will be experienced. (Throttle will not respond)
66. To protect power circuit from earth fault which sensor is provided in MEP locomotive? (TANGI)
67. No load voltage of MEP ALCO loco (1100)
68. Reference voltage in WDM3A loco is ----- volts (24.4)
69. 8<sup>th</sup> notch RPM of WDM3A locomotive is (1050)
70. No. of traction motors in WDP1 locomotive are (4)
71. TMs used in WDG4 locomotive are ----- (3 phase induction motor)
72. The reason for using DC series motor as Traction motor is (High starting torque)
73. How many solenoids are there in WW governor? (5)
74. No. of WSRs in Medhamicro processor loco is (0)
75. PCS pick up setting is ----- Kg /cm<sup>2</sup>. (4.0)
76. Normal LCR position in WW gov. loco is (5:30)
77. No. of sensors available in MCBG actuator unit is (4)
78. Twin beam head light focus distance is (305 meter)
79. In ALCO loco engine cranking done by (both AG & Exciter)
80. Wattage of twin beam head light is (100/90)
81. In MEP ver. 2.0 locomotive no. of Analog Distribution Boxes (4)
82. No. of digital input cards in MEP ver. 2.0 loco is (5)
83. No. of digital output cards in MEP ver. 2.0 loco is (5)
84. No. of Self Load box contactors in MEP locomotive. (3)
85. No. of power diodes in Direct power Rectifier in D.E. locomotive. (36)
86. If Lube oil pressure sensor fails, in MCBG fitted loco engine will come to (shutdown)
87. Low Idle RPM in MCBG fitted loco is (350)
88. Alternator bearing number is (NU 330)
89. Traction Motor Pinion end bearing number is (NU 330)
90. GHP of WDG4/WDP4 HHP locomotive is 4500 HP.
91. Max speed of WDP4 locomotive is 160 KMPH.
92. TM pinion to bull gear ratio in WDP4 locomotive is 17:77.
93. TM pinion to bull gear ratio in WDG4 locomotive is 17:90.



95. Maximum tractive effort of WDG4 locomotive is 53 tons
96. Locomotive model of WDG4 loco is GT46MAC.
97. Locomotive model of WDP4 loco is GT46PAC.
98. Type of traction motors fitted in HHP loco (3-Phase AC Induction motors)
99. In HHP loco TCC convert DC power into 3 phase AC power.
100. Number of traction inverters in HHP loco of Medha traction system six
101. Number of traction inverters in HHP loco of EMD traction system two
102. Number of traction inverters in HHP loco of Siemens traction system) two
103. In HHP loco LCC, Traction computer, DCL are located in ECC1.
104. Number of Phase Modules in HHP loco (Medha Microprocessor) 18.
105. Number of Phase Modules in HHP loco (EMD Microprocessor) 06.
106. Number of Phase Modules in HHP loco (Siemens Microprocessor) 06
107. Input voltage & current of TCC is 620-2600 V DC, max 1200A DC.
108. Output voltage & current of TCC is 0-2000 V AC, max 1100A AC.
109. Weight of TCC is 2400 Kg.
110. Current rating of Computer control, AC control, Cab fan, Air dryer, CCB circuit breakers in HHP loco is 15 Amp.
111. Current rating of Fuel pump, Turbo, Gov. Booster pump, Local Control, TCC blower, Filter blower circuit breaker in HHP loco is 30 Amp.
112. Current rating of Head Light circuit breaker in HHP loco is 35Amp.
113. Current rating of Control circuit breaker in HHP loco is 40 Amp.
114. Current rating of Generator Field circuit breaker in HHP loco is 90 Amp.
115. Current rating of TCC1, TCC2, Aux. Gen feedback, Aux. gen. field circuit breakers in HHP loco is 10 Amp.
116. Current rating of TCC1, TCC2 blower circuit breaker in HHP loco is 50 Amp.
117. Current rating of DCL and Event recorder circuit breaker in HHP loco is 3 Amp.
118. Number of DC link switch gears in MEDHA HHP loco 6.
119. MEDHA locomotive TCC cabinet consists of 6 Traction computers, 6 DCL switch gears, 6 IGBT based inverters, DC link capacitors and crow bar circuit.
120. In HHP loco during dynamic brake, TCC converts 3 phase AC in to DC.
121. In HHP loco ECC2 is located in Under Truck.
122. In HHP loco ST, STA contactors, AGAI, AGAV sensors are located in ECC2.
123. In HHP loco Battery charger and Aux. Gen Circuit breaker are located in ECC2.
124. In HHP loco ECC1 is located in driver cabin.
125. In HHP loco ECC3 is located near compressor room.
126. Radar is provided to measure the speed of locomotive in WDG4 loco.
127. Number of power contactors available in WDG4 loco Zero.
128. In WDG4 loco power contactors are replaced with DC link contactors
129. In WDG4 loco if loco pilot fails to acknowledge the alerter it gives audio warning for 8 sec.
130. In WDG4 loco, load meter will not respond if GFB trips.
131. In WDG4 loco, no CA voltage will take place if AGFB trips.
132. In WDG4 loco, when false locked axle indication, defective speed sensor should be isolated.
133. In WDG4 loco, location of Battery Knife Switch is located on Foot plate.
134. In HHP loco oil lubricated TM gear case is provided.
135. In HHP locos if AGFB trips, Battery will discharge & Load meter will not respond.
136. Model of main generator assembly in WDG4 loco is TA17-CA6B.



132. Model of main generator assembly in WDG4 loco is TA17-CA6B.
133. Model of AC Aux. generator in WDG4 loco 5A-8147.
134. Model of Traction Motor in WDG4 loco TB26221.
135. Speed of Traction Motor in WDG4 loco 3220 RPM.
136. Power rating of Traction Motor in WDG4 loco 500 KW.
137. In WDG4 loco TM is forced air ventilated cooled.
138. Nominal AC Aux. Generator voltage in WDG4 loco is 55V AC.
139. Rectified voltage of AC Aux. Generator in WDG4 loco is 74V DC.
140. Maximum power output of AC Aux. Generator in WDG4 loco is 18KW.
141. Total number of batteries (Lead Acid type) in WDG4 loco 8
142. Total number of cells (Lead Acid battery) in WDG4 loco 32
143. Total number of batteries (Ni-Cadmium type) in WDP4 loco 10
144. Total number of cells (Ni-Cadmium) in WDP4 loco 50
145. Voltage of battery cell in WDP4 loco ( Ni-Cadmium) 1.5V
146. Voltage of battery cell in WDG4 loco ( Lead-Acid) 2.1V
147. Total voltage of batteries in WDG4 loco is 68V
148. Total voltage of batteries in WDP4 loco is 75V
149. In WDG4 loco Engine Starting Switch is located in ECP (Engine control panel)
150. In WDG4 loco Radar is located between front bogie and fuel tank.
151. In WDP4 loco Radar is located between rear bogie and fuel tank.
152. Starting Tractive Effort of WDG4 loco is 540 KN
153. Starting Tractive Effort of WDP4 loco is 270 KN
154. Maximum continuous Tractive Effort of WDG4 loco is 400 KN
155. Maximum continuous Tractive Effort of WDP4 loco is 200 KN
156. Maximum Dynamic tractive effort of WDG4 loco is 270KN
157. Maximum Dynamic tractive effort of WDP4 loco is 160KN
158. Total number of keys on EM2000 display panel are 16
159. Number of grid blower motors in WDP4 & WDG4 locos 2
160. When Computer control breaker is recycled the disabled speed sensor get enabled automatically & has to be disabled.
161. Brake warn lamp indicates excessive current in DB
162. Each Traction Motor is provided with one speed sensor & one temperature sensor
163. The Companion Alternator runs at the same speed as Engine RPM.
164. In HHP loco Radiator fans are controlled by EM2000.
165. Load demand of TM is met by TCC.
166. In WDG4/WDP4 slipped pinion will be indicated clearly by high motor RPM in computer feed back.
167. Head light rating in HHP loco is 200W, 30V.
168. HHP loco Flasher light working voltage is 12V
169. IGBT stands for Insulated Gate Bipolar Transistor
170. In BL Key, BL stands for Button Lever.
171. LCC stands for Locomotive Control Computer.
172. EFCO stands for Emergency Fuel Cut Off.



174. MVCC stands for Magnet Valve compressor Control.
175. ST stands for Starting contactor.
176. STA stands for Starting Auxiliary Contactor.
177. The safety device that provides safety to TCC1 & TCC2 is Crow Bar.
178. APU stands for Auxiliary Power Unit.
179. DPCS stands for Distributed Power Control System.
180. CCB stands for Computer Controlled Brake.
181. TCAS stands for train collision avoiding system.
182. In WDG4D loco ECC4 is located in Cab2.
183. If there is no acknowledge from loco pilot, VCD takes penalty after 76 sec.
184. ECC stands for Electrical Control Cabinet.
185. TCC stands for Traction Control Converter.
186. In HHP loco Radiator fans get supply from Companion Alternator.
187. No. of carbon brushes in EMD TA 06.
188. Condemn size of TA carbon brush in BHEL WDG4 locomotive 38 mm.
189. No. of radiator fan contactors available in WDG4 locomotive 06.
190. No. of slip rings in BHEL TA of WDG4 locomotive 04.
191. AG output is controlled by DVR (Digital voltage regulator) of WDG4 locomotive.
192. Maximum speed of WDG4D locomotive is..... (105 kmph)
193. Transmission in WDG4D locomotive is ..... (AC – AC)
194. Battery Ammeter of WDG4D locomotive have been provided in..... cab. (CAB 1).
195. Alerter Reset is possible in Dual Cab (WDG4D/WDP4D) locomotive from ..... (Active Cab only).
196. Maximum Tractive effort of WDG4D loco is ..... (54 Tones)
197. Maximum Dynamic braking force at rail level of WDG4D loco is ..... (27 Tones)
198. TM pinion and bull gear ratio in WDG4D loco is. .... (17:90)
199. WDG4D/WDP4D (Dual) locomotive each control console having ..... Displays. (03 TFT Displays)
200. Total nos. ECCs in WDG4D/ WDP4D (Dual) locomotive ..... (04)
201. Total nos. ECC in WDG4/WDP4 locomotive ..... (03)
202. Name of manufacturers of Traction Alternator in WDP4D/WDG4D is..... (M/s EMD, M/s BHEL, M/s Yongji)
203. What is max continuous current of Traction Alternator in WDP4D & WDG4D Locomotives? (1250A DC)
204. What is max voltage of Traction Alternator in WDP4D & WDG4D Locomotives. (2600V DC)
205. What is max speed of Traction Alternator in WDP4D & WDG4D Locomotives. (954 rpm)
206. Make & Type of Main Traction Alternator in WDG4D/WDP4D Loco is..... (EMD TA-17 & BHEL TA-9001)
207. Make & Type of Companion Alternator in WDG4D/WDP4D loco is ..... (EMD CA-6B & BHEL AA9201)
208. Make & Type of Traction Motor in WDG4D/WDP4D Loco is ..... (Siemens 1TB2525-OTA02 & EMD A2916-8)
209. What is max power of Traction Motor (Siemens & EMD) in WDP4D & WDG4D locomotives is..... (630KW)
210. What is continuous current of Traction Motor (Siemens) in WDP4D & WDG4D locomotives is..... (202Amps)
211. What is nominal rating of Traction Motor (Siemens) in WDP4D & WDG4D locomotives is..... (485KW)
212. What is continuous current of Traction Motor (EMD) in WDP4D & WDG4D locomotives is..... (265Amps)
213. What is nominal rating of Traction Motor (EMD) in WDP4D & WDG4D locomotives is ..... (485KW)
214. Maximum speed of Traction Motor (EMD) in WDP4D & WDG4D locomotives is..... (3200RPM)
215. Battery voltage in the Dual cab locomotive is (Ni-Cadmium type)..... (72.5 volts)
216. Fuel oil tank capacity of WDG4D loco is. ( 6000Lts.)
217. Fuel oil tank capacity of WDP4D loco is. (5000 Lts.)
218. Maximum Tractive effort of WDP4B/WDP4D loco is. (41 Tones)



214. Maximum speed of Traction Motor (EMD) in WDP4D & WDG4D locomotives is..... (3200RPM)
215. Battery voltage in the Dual cab locomotive is (Ni-Cadmium type)..... (72.5 volts)
216. Fuel oil tank capacity of WDG4D loco is. ( 6000Lts.)
217. Fuel oil tank capacity of WDP4D loco is. (5000 lts.)
218. Maximum Tractive effort of WDP4B/WDP4D loco is. (41 Tones)
219. Blended brake is mixture of ..... (Dynamic +Loco)
220. In Dual Cab Locomotive Fuel Prime & Engine Start switch is provided in both the Cabs. (In Parallel)
221. What is the low IDLE speed RPM of the HHP locomotive engine. (200 RPM)
222. What is the minimum continues speed of the WDG4 locomotive. ( 22.5Kmph)
223. In WDP4/WDG4 loco during false locked axle indication. (Isolate the defective speed sensor)
224. In WDP4/WDG4 Loco when lube oil temperature exceeds 124 degree centigrade.(Hot oil detector operates & LOB operates)
225. In WDP4/WDG4 (Medha) loco if GR (power) trips continuously three times within 10 minutes. (Defective TM is to be isolated)
226. Brake warning Indication . (Excessive Breaking current in DB)
227. Each Traction Motor provided with ..... (One speed sensor & one temp sensor)
228. Head light rating in WDP4/WDG4 loco is . ..... (250W, 32V)
229. SW1 switch is provided for switch off (RESET) flasher light.
230. If SA9 is in application position BP pressure will be 3.5 kg/cm<sup>2</sup>.
231. BKBL motor gets current from TM armature in Alco locomotive.
232. Electrolyte used in Batteries is Diluted H<sub>2</sub>SO<sub>4</sub>.
233. SF 11 is to be issued for imposition of minor penalty.
234. SF 5 is to be issued for imposition of major penalty.
235. No pension is paid for service less than 10 years.
236. Within 10 days the employee should submit his explanation in the case of minor penalty.
237. Supervisory staff comes under Excluded category.
238. 07 kinds of passes are there in IR.
239. With holding of passes or PTOs or both is a minor penalty.
240. With holding of promotion for a specific period is a minor penalty.
241. TA for grade pay 4200 is Rs.1600+DA in A1 cities.
242. TA for grade pay 4200 is Rs.800+DA in other than A1 cities.
243. For participation in sports events Special casual leave will be granted.
244. Decode ENIAC \_\_\_\_\_. (Electronic Numeric Integrator and Calculator)
245. 1 KB is equivalent to \_\_\_\_\_ bytes. (1024)
246. Full form of HTM L \_\_\_\_\_. (Hyper text markup language)
247. Decode JPEG \_\_\_\_\_. (joint photographic experts group)
248. The width of the broad gauge is \_\_\_\_\_. (1676 mm)
249. SCR consists \_\_\_\_\_ divisions. (6)
250. RITES stands for \_\_\_\_\_. (Tail India technical economic services limited)
251. IR divided in to \_\_\_\_\_ zones. (17)
252. IRIMEE is situated at \_\_\_\_\_. (Jamalpur)
253. Son up to the age of \_\_\_\_\_ is included in a pass. (21)
254. Paternity leave period is \_\_\_\_\_. (15 days)
255. LHAP is sanctioned on the grounds of \_\_\_\_\_. (Medical certificate)



## STUDY MATERIAL ELECTRICAL

### Rotating Electrical machines in HHP locomotive:

### 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.

## 2. COMPANION ALTERANTOR:

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 develop 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. Current – 600 amps.

### 3. AC AUXILIARY GENERATOR (BRUSH LESS):

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 powersupplies, panel mounted module FCD (Firing control driver) and also to the full wave 3 phase rectifier (BatteryCharger) assembly to obtain 74V DC for battery charging, companion alternator excitation and low voltage DC control power.

#### 4. DYNAMIC BRAKE GRID BLOWER ASSEMBLY:

Model – DC Series Motor, No. of Poles – 4, Capacity – 36 HP, Brush Condemn Length – 25.4 mm (1") Each DynamicBrake Grid cooling blower assembly consists of a 48" 10blade fan powered by a series wound DC motor. DuringDynamic Braking the locomotive Traction Motors operateas Generators supplying AC power to inverters. Theinverters convert AC power into DC voltage and supplyback to the DC link. The DC link is connected across thegrids through contactors B1, B2, B3 & B4 and theBraking energy is dissipated



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

#### 4. DYNAMIC BRAKE GRID BLOWER ASSEMBLY:

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 (36HP). To dissipate grid heat to atmosphere.

#### 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.

#### 6. FUEL PUMP MOTOR:

The Fuel Pump Motor is a ¾ 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.

#### 7. 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 gear. The switch inside solenoid closes when pinion is fully traveled resulting contactor pickup 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 motor 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 interlocked 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.



#### 8. TURBO LUBE PUMP MOTOR:

Model – 4 Pole ¼ HP, RPM – 1200, Voltage – 64-74V DC

The Turbo Lube Pump Motor is a ¼ 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.

#### Procedure for mounting the pinions of TM and AG and checks to be done on the pinion before Mounting:

##### TM pinion mounting:

- i. WDG3A Pinion and WDM3A pinions are easily identifiable by size. WDG3A pinion is smaller than WDM3A pinion.
- ii. Apply thin film of Prussian blue uniformly inside the pinion bore.
- iii. Press the cold pinion force fully on the shaft (as hard as possible by hand). Do not twist the pinion.
- iv. Mark the relative angular position of the pinion on the shaft with chalk.
- v. Remove the pinion from the shaft by using stud wedges between the pinion hub and seal collar.
- vi. Visually inspect the bluing fit on the armature shaft.
- vii. Dress the blue spots on the shaft with fine silicon paper and clean with dry cloth.
- viii. Record the blue match of the shaft on a graph paper using cellulose tape, calculate the percentage of blue which should not be less than 90% (approximately the area of the white spots excluding oil groove gap and space between the strips should be less than 2500mm<sup>2</sup>) and file the same.
- ix. Clean the shaft and the bore of the pinion with Orion 77/Kerosine.
- x. Place the cold pinion on the shaft by hand in the same relative position.
- xi. Measure the position of the pinion relative to the end phase of the shaft with pinion advance gauge in cold & record.
- xii. Remove the pinion and heat it by an induction heater for 190-220° C.
- xiii. Ensure the temperature with digital pyrometer. Record the temp.
- xiv. Just before the pinion is hot enough to mount, clean the shaft with dry cloth.
- xv. Wear asbestos gloves over the hands, take the pinion from oven at correct temperature as stated in 12.13. align the hot pinion on the shaft with the reference marks, and then snap the pinion forcibly onto the shaft with a quick push.
- xvi. Examine the position of the pinion when hot on the shaft with the same pinion advance gauge without altering the cold setting reading.
- xvii. Measure the pinion advance and record.
- xviii. If the advance from cold to hot position is not within the limit of 2.25 to 2.45 mm remove the pinion & try once more to get the proper advance.
- xix. When the proper advance is obtained, allow the pinion to cool on the shaft and provide dummy and record the advance.



**AG pinion mounting:**

- i. Clean and check the gear for any physical damages. If any damages are noticed renew the gear.
- ii. Heat the gear to the temperature of 150° C to 180° C and mount on to the shaft.  
Tighten the nut with lock washer.

**Measures to be taken at the time of overhauling to prevent bearing seizures in Traction motors:**

- a. Ensure bearing clearance PE side 0.03 to 0.15mm and CE side 0.03 to 0.1 mm.
- b. Check endplay, which should be between 0.1 and 0.36mm.
- c. If end play is not coming in the above range attend CE end bearing cap to get the end play
- d. Even with the above attention endplay not coming, take motor for stripping and renewal of bearings.
- e. Connect the motor to trail run kit.
- f. Run the motor at deferent speeds as indicated below.

Motor RPM	Approximate time	Bearing temperatures		Action
		Observe	Record	
1100±50	1 Hour	Yes	- Yes -	>40° C re-overhaul
1700±50	Maximum 40 minutes.	Yes	- Yes -	>25 + AT° C re-overhaul

- g. Clean the shaft of P/E at seal collar seating area & the pinion area using dry cloth and smooth silicon paper during slow run.
- h. Stop the trial run and the check the condition of shaft.
- i. Check the matched seal collar and heat it to 90 to 100°C above ambient temp.
- j. Take it by using hand gloves & a set of suitable mounting bolts.
- k. Fit it on the shaft & in outer cap, gently.
- l. Allow to cool after seating & encaging properly.
- m. If it is not matched, the seal collar to be extracted & to be tried with another one.

**Measures to be taken at the time of overhauling to prevent TM failures other than bearing Seizures:**

- a. Ensure TM brush arm spring tension 4.5 to 5.4 kg/cm<sup>2</sup>.
- b. Ensure Brush arm IR value is more than 100M ohm.
- c. Ensure armature IR value is more than 100 M ohm.
- d. Ensure Clearance between brush arm to commentator is 1.6 to 2.5mm.
- e. Ensure endplay is 0.1 to 0.36mm.
- f. Ensure blue match of pinion is more than 90 percent.
- g. Ensure pinion advance is 2.25 to 2.45mm.
- h. Ensure overall TM IR value is more than 20 M ohm.



**Testing procedures of rotating machines given below after overhaul:**

**i. TM testing:**

- xx. Check endplay, which should be between 0.1 and 0.36mm.
- xxi. If end play is not coming in the above range attend CE end bearing cap to get the end play
- xxii. Even with the above attention endplay not coming, take motor for stripping and renewal of bearings.
- xxiii. Connect the motor to trail run kit.
- xxiv. Run the motor at deferent speeds as indicated below.

Motor RPM	Approximate time	Bearing temperatures		Action
		Observe	Record	
1100±50	1 Hour	Yes	- Yes -	>40 <sup>0</sup> C re-overhaul
1700±50	Maximum 40 minutes.	Yes	- Yes -	>25 + AT <sup>0</sup> C re-overhaul

**ii. AG / Exciter Testing:**

- a. Give DC supply of 25 to 40 volts to the generator through test stand and observe current, which should be between 40-60 Amps.
- b. Allow the generator to run for approximately half an hour to one hour and observe for smooth running. If any defects is noticed attend the same.
- c. While testing put some gear case oil on roller bearing at drive end.

**iii. AC FPM testing:**

- a. Connect 72V DC to inverter
- b. Inventor output should be 40V AC ± 5% input range.
- c. Check the no load current 2 amps.
- d. Check the RPM it should be 1730.
- e. Observe both end bearing temperatures.
- f. TEST RESULT OF AC FUEL PUMP MOTOR AT FULL LOAD (ISHP)

Input Voltage	Input current Amp	Output voltage	Out Frequency	RPM
65	17.4	38.5	60.0	1730
72	15.7	39.2	60.0	1735

**iv. AC CCEM Testing:**

- a. Connect 72V DC to inverter
- b. Inverter output should be 40V AC.
- c. Check the RPM it should be 2880.
- d. Check the input current by covering inlet of the blower it should be around 2.5 Amps.

TEST RESULT OF AC Crank case exhaust motor AT FULL LOAD (ISHP)



Input Voltage	Input current Amp	Output voltage	Out Frequency	RPM
65	5.4	38.5	50.0	2980
72	5.0	39.2	50.0	2980

**v. Tacho Generator Testing:**

- Connect the Tacho Generator to the test stand.
- Drive the Tacho Generator by the motor to the speed of  $2384 \pm 20$
- Set the load current to  $475 \pm 5$  mA by regulator provided on testing panel.
- Measure the voltage, which should be 100 to 130 volts.
- If any deviation is found attend the Tacho Generator and retest.
- Provide nylon gear on the shaft with key, tight the check nut and provide the split pin and keep ready for service.
- After loading on loco, check backlash. It should be 15 to 30 thou.

**Procedure followed for testing the battery capacity at the time of overhauling:**

- After fully charging, connect the batteries to discharging plant.
- Switch on the discharging plant and set the discharging current as per the table 01.
- Record the readings such as cell voltage, specific gravity of electrolyte and cell temperature of each cell for every one-hour.
- Stop the discharge when the cell voltage drops to 1.75 Volts in any one cell.
- Calculate the percentage capacity as shown below and Record.

$$\text{Percentage capacity} = \frac{\text{Discharge current X discharge hours}}{\text{Rated ampere hour}} \times 100$$

- If the capacity is less than 50 % condemn the batteries.
- Recharge the batteries with rated recharge current as per battery make.

**Attention given to batteries during light and medium schedules:**

**A) Attention during Light schedules:**

- Record temperature of cell, it should be  $27^{\circ}$  to  $55^{\circ}\text{C}$ .
- Record specific gravity of all cells, it should be 1200 to 1250, if low add electrolyte and if high add distilled water.
- Record cell voltage, it should be 1.9 to 2.3 volts.
- Check Electrolyte level it should be, 38 to 52 mm.
- Blow with dry compressed air and clean collection of dirt, corrosion products and oil at the top of the batteries.
- Check the battery connecting cables for any overheating. Renew if necessary Keep all the connections in the battery circuit tightly bolted, clean and well-greased (petroleum jelly).



- g. Ensure that the vent plugs are cleaned.
- h. Equalize charge with one cell varies with the other cell with respect to specific gravity water consumption.

**B) QUARTERLY/HALF YEARLY SCHEDULE ATTENTION:**

- a. Visually examine the batteries for any terminal cracks, container breakage, lid cracks, cable over heating marks.
- b. Blown out with compressed air.
- c. Remove the ceramic vent plugs and rinse in distilled water and provide.
- d. Record the battery make, Serial Number, lug date, cell voltage, specific gravity, cell temperature in the order starting from the main positive as first cell.
- e. Top up distilled water if necessary standard valve refer table 01.
- f. Apply thin coat of petroleum jelly over the connection terminals
- g. Ensure the wooden packing around batteries are intact and tight.

**Sensors in MEP ALCO locomotive:**

- a. Voltage sensors (5 nos.): These are non-contact type Hall Effect sensors.
  - i. TAV - Measures Traction Alternator Voltage (0 to 1500V)
  - ii. AGAV - Measures Aux. Gen. Armature voltage (0 to 100V)
  - iii. BATV - Measures Battery Voltage (0 to 100V)
  - iv. BKCPV - Measures Braking Potentio meter Voltage i.e. Dynamic Braking level.(0 to 100V)
  - v. LCPV - Measures Load Control Potentio meter voltage i.e. reference Voltage.(0 to 100V)
- b. Current sensors (14 nos.): These are non-contact type Hall effect sensors. It measures the current flowing through the cable/busbar through the sensor.
  - i. TAAI - Measures Traction Alternator Armature Current (0 to 5000 amps)
  - ii. TM1AI- TM6AI - Measure individual Traction Motor currents (0 to 2000 amps)
  - iii. EXAI - Measures Exciter Armature Current (0 to 300 amps), its function is similar to GFOLR in conventional locomotive.
  - iv. AGAI - Measures Aux. Generator Armature Current ( 0 to 300 amps)
  - v. BATI - Measures Battery Charging/ discharging current (0 to 300 amps)
  - vi. EXFI - Measures Exciter Field Current (0 to 10 amps)
  - vi. AGFI - Measures Aux. Gen. Field current (0 to 10 amps)
  - vii. TANGI - Measures Traction Alternator Neutral to Ground Leakage Current (0 to 10 amps). Its function is similar to GR1 i.e. to detect power circuit grounding in conventional locomotive.
  - viii. BANGI - Measures Battery Negative to ground leakage Current (0 to 10 amps). Its function is similar to GR2 i.e. to detect control circuit grounding in conventional locomotive.
- c. Pressure Sensors (7 nos.): These are basically Pizo-electric type pressure sensors.
  - i. MRPR - Measures Main Reservoir (MR) Pressure (0 to 21 kg). It s function is similar to EPG switch i.e. for MR cut in and cut out in conventional locomotive.
  - ii. BPP - Measures Brake Pipe pressure (0 to 14 kg).



- iii. BCP - Measures Brake Cylinder pressure (0 to 14 kg).
- iv. LOP - Measures Lube oil pressure (0 to 10 kg).
- v. FOP - Measures Fuel oil pressure (0 to 7 kg).
- vi. BAP - Measures Booster Air pressure (0 to 3.5 kg).
- vii. APR - Measures Atmospheric Pressure (0 to 3000 meters of altitude), it is used for HP correction.
- d. temperature sensors (3 nos.): These are Semiconductor type temperature sensors.
- i. AAT - Measures Ambient Air Temperature, it is used for HP correction.
- ii. EWT - Measures Engine Water Temperature, this is used for rotate the radiator Fan at pre defined temperatures.
- iii. LOT - Measures Lube Oil Temperature, this temperature will be taken as reference for engine Raising (optional) and also for rotate the radiator Fan in case of EWT sensor failure.
- e. Speed or RPM sensors (8 nos.): These are Hall Effect type magnetic sensors. It generates an electrical pulse whenever any Iron piece is moved in front of the sensor. The sensor is mounted over a rotating gear.
- i. SS1-SS6 (6nos.) - These sensors are mounted on gear of each motor to measure the wheel RPM which is used to calculate the Loco speed and to detect slipped or locked wheel.
- ii. ESS (2 nos.) - These sensors are used to measure the engine RPM. Two sensors used for redundancy.

#### Advantages of AC small motors over DC small motors and specifications:

In Diesel electric loco different small auxiliary DC motors are using like FPM, CCEM and DEM for various purposes. All the above motors are required high maintenance because of brush gear and commutator problems. Hence 3 phase AC induction motors are using in place of DC motors due to several advantages.

##### Advantages of AC motors:

- a. less maintenance
- b. high reliability
- c. Constant speed
- d. High voltage protection
- e. Over current protection
- f. Reverse polarity protection.

#### Safety devices available in ALCO locomotive:

##### **a) DEAD MANS RELAY: - [DMR]**

This relay is provided inside the control compartment. When ever PCS knocked out this relay will get de energized and engine will comes to idle, throttle will not respond.

##### **b) GROUND RELAY: - [GR]**

It is provided in control compartment. When ever there is earth faults in control circuits and in power circuits this relay will be operated. Resetting knob will be projected out and its pointer will co insides with red dot, bell will ring, white light will glow and engine will comes to idle and load meter will drops to ZERO.

##### **c) GFOLR [GENERATOR FIELD OVER LOAD RELAY]:**



This is provided in all AC/DC locos. It is provided in control compartment. When ever over load current flows to the rectifier panel and main generator [Alternator] shunt fields, GFOLR will be tripped and brings the engine to idle, load meter will come to ZERO and over load indication lamp will glow, bell will ring. To reset the GFOLR close the throttle, keep ECS in idle, press the GFOLR reset button. If the GFOLR does not get reset then reset manually. If the GFOLR trips more than three times it should not be reset and loco should be failed.

**d) OSTA [OVER SPEED TRIP ASSEMBLY]:**

This unit is provided in engine right side free end. When ever engine RPM exceeds its limit loco will shut down without indication to protects the engine from over speeding damages. With out resetting OSTA starting the diesel engine, engine will crank but not fire.

**Note:** If OSTA tripping, do not try to re crank several times otherwise batteries may be discharged.

**e) OPS 1 & 2 [OIL PRESSURE SWITCH]:**

These are provided in drivers cab. When ever lube oil pressure drops below  $1.3\text{kg/cm}^2$  in 1 to 6<sup>th</sup> notch, the OPS1 will operate and makes engine to shut down with indication (bell and low lube oil on LED panel). Similarly during 7<sup>th</sup> & 8<sup>th</sup> notch if lube oil pressure drops below  $3.5\text{kg/cm}^2$ , the OPS2 will operate and makes engine shut down with indication (bell and low lube oil on LED panel).

**f) LOW LUBE OIL BUTTON (LLOB):**

LLOB is available in wood ward governor. In WW governor locomotives, LLOB operation set at  $1.3\text{kg/cm}^2$  in idle and  $3.5\text{kg/cm}^2$  in 8<sup>th</sup> notch. Depends upon the notch working engine will shut down with indication. (Bell and green light glowing on LED panel).

**g) L.W.S. [LOW WATER SWITCH]:**

It is provided in expresser room. When ever water level in the expansion tank drops to one inch below from the bottom of the tank LWS will operate and makes engine to shut down with indication of HEA in LED panel.

**h) S.A.R. [SAFETY AUXILIARY RELAY] :**

This is provided in control compartment. This relay will get current from Tacho generator. It is provided in the G.E. governor locos only. When ever any electrical disconnection in the speed circuit then this relay will protect the engine from over speeding. This relay is connected in series with governor speed coil. It will be in energized condition when the engine is in running. In case of current reduction SAR will be de-energized and cut off the supply to the clutch coil and engine comes to shut down with out any indication.

**i) W.S.R. [WHEEL SLIP RELAY]:**

There are three wheel slip relays are provided in control compartment. These are connected in series parallel / parallel to the traction motor combination. When ever uneven current flows to the traction motors the particular WSR will be operated, power reduction in load meter and audio visual indication will come to alert the driver. Sanders will operate automatically. Immediately notches to be reduced as far as possible for a lap of time.



j) **BSR (MUSDR):**

This is provided in control compartment. This relay is provided to safe guard the batteries from repeated cranking incase of LLOB tripping or MUSDR switch is in stop position. When MUSDR switch is in stop position or LLOB tripped, this relay will pick up and makes the cranking contactors not to pick up.

k) **EXPLOSION DOOR:**

This is an operable door fitted on both the sides of the engine crank case in place of sump inspection door. Bursting of explosion door happens on two occasions.

- A. when the crankcase exhauster failed and further it is neglected by the driver for a long period of time.
- B. when any hot bearing or any other moving parts gets over heated and emitting heavy smoke inside the crankcase beyond the capacity of the crankcase exhauster motor then explosion door get opened. It opens and closes since it is a danger indication that some parts of engine over heated inside the crankcase.

l) **ETS [ENGINE TEMPERATURE SWITCH]:**

It is provided in expresser room. Whenever water temperature rises to 90°C this switch will operate and makes bell to ring and HOT engine indication will come to alert the driver.

**'Dynamic Braking' in ALCO locomotive:**

This is also called 'Rheostatic braking'. By using the momentum of train as prime mover, TMs can be run as generators. When there is load across generator (TM), there is retarding torque which opposes the actual direction of rotation of TM, which makes slow down the speed of TM. This is called dynamic braking or Rheostat braking. While applying dynamic braking, Braking transfer switch (BKT) will move to braking side, S1, P1, P21, P31, P32 power contactors & GFC will pick up and Engine speed will raised to 4<sup>th</sup> notch rpm i.e. 650 for better cooling to TMs. TM armatures circuit:

TM1 & TM4 armature are separated with their fields and both are connected in series with 4 grids with the help of P1 contactor and BKT contact.

TM2 & TM5 armature are separated with their fields and both are connected in series with 4 grids with the help of P31 contactor and BKT contact.

TM3 & TM6 armature are separated with their fields and both are connected in series with 4 grids with the help of P21 contactor and BKT contact.

TM fields circuit:

All 6TMs fields are connected in series with the help of S1, P1, P32 & BKT contacts and connected across main generator out put.

BKBL connection:

BKBL motor is connected across the tappings of each combination of grid sets. It is used to cool the grids.

DB Operation:

When DB applied, the above changes in TM connections will takes place. The TMs fields will be excited by the main generator. The excitation to all TMs is same as all the fields are connected in series. When there is a motion i.e. TMs are rotating with some speed and their fields are exciting, there is generation of current which will flow through grids. When there is grid current, retarding torque will be generated and braking will occur and BKBL motor also starts rotation. As there is braking speed of TMs comes down consequently grid current also reduces i.e. braking effect will be reduced. This grid current depends on loco speed and BKCP position. The maximum grid current will be limited to 800 amps, by excitation system.



### Functions of Governor:

Governor is a device that maintains a steady speed in a Diesel engine from No Load to Full Load. An Engine Governor is commonly a speed sensitive device that automatically controls the speed of the Engine by adjusting the amount of fuel fed to the engine. **Location:** Engine Right side Power takes off end.

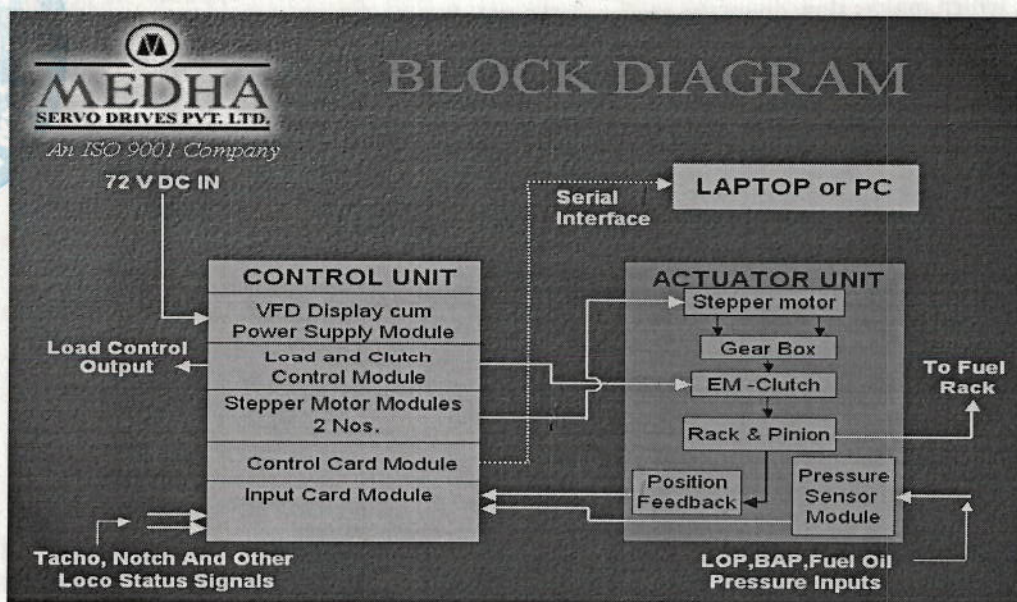
### Basic Functions:

1. cranks the engine when operator demands.
2. Increase / Decrease engine RPM as per the notch selection.
3. Maintain the engine RPM constant from no load to full load.
4. Provide load control signal to reduce over load on the engine to maintain constant engine RPM.
5. shuts down the engine on demand by operator or any safety device is operated.

### Types of governors:

1. Electro hydraulic governor (GE/ EDC)
2. Wood Ward Governor
3. Electronic governor (BHEL/ MEDHA)

### Block diagram of MCBG and Description :



### MCBG explanation and advantages:

Control unit consists of following modules,

- a. Control card consists micro controller
- b. Input card
- c. Load and Clutch control card
- d. Motor control card – 2 nos.
- e. Display control card


कुंजी बरिष्ठ मंडल यांत्रिक  
इंजीनियर (डिज़ल)  
द.म.रे., काजीपेट  
For Sr. D.M.E. (DSL)  
KAZIPET (SCR)



- In other governor certain notch RPMs are interdependent on other notch RPMs.
- k. Independent notch wise Low lube oil shut down Pressures.  
In GE/EDC governor only one setting from 1 to 8 notch  
In Woodward governor Idle and 8th notch settings only. Intermediate notch settings are not possible.
  - l. Tuning of governor is digital setting through Laptop.  
Against spring adjustments on trial and error in Woodward governor.
  - m. Dry run test facility to test free travel of the rack  
To test free travel of the fuel rack.
  - n. Mechanical OSTA test facility:  
Not available with Woodward Governor
  - o. Electrical OST:  
Additional feature over other governors.

#### **Microprocessor based Excitation system:**

- a. Excitation control system regulates the exciter field current through a transistor switch operated by the pulse width modulator.
- b. In the microprocessor based Excitation system continuously receives feedback signals from individual output devices like contactors & relays indicating their status.
- c. All the analog parameters like voltages, currents, pressures and temperatures are sensed through various sensors and are connected to microprocessor for monitoring.
- d. All the speed signals from traction motors and engine are connected as frequency input signals to microprocessor.
- e. Microprocessor has Programmable PWM output to perform the excitation control system. Here the ON to OFF ratio of PWM will be controlled through a set of instructions written in the ratio of algorithm and stored in the microprocessor. This variable /programmable PWM is connected to IGBT to control the Traction alternator excitation.
- f. The microprocessor dynamically computes the output that can be generated by the Engine at any instance of operation based on various inputs like site altitude, ambient Air temperature and Engine RPM. Then microprocessor calculates the voltage to be generated at that instance based on the Traction Alternator current and Alternator efficiency.
- g. Accordingly the microprocessor generates a PWM output signal, which drives the IGBT connected in Exciter field circuit. Accordingly, the exciter armature current varies, which in turn drives the traction alternator field current and hence its output power. Thus the traction alternator output power is controlled by the microprocessor to the required constant HP at each notch.

  
 कृते वरिष्ठ मंडल यांत्रिक  
 इंजीनियर (डीजल)  
 द.म.रे., काजीपेट  
 For Sr. D.M.E. (DSL)  
 K.A.71PFT (1000)



कुल बरिष्ठ मंडल यांत्रिक  
इंजीनियर (डीजल)  
द.म.रे., काजीपेट  
For Sr. D.M.E. (DSL)  
KAZIPET (SCR)





**Self load test procedure in MEP ALCO locomotive:**

System provides a self load box feature to ascertain healthiness of the engine. Test is done utilizing the Dynamic brake grids as resistive load to the alternator instead of water load. Isolation of traction motors and connection of dynamic brake grids to alternator is automatically done when the self load box option selected through display unit.

**Preparation:**

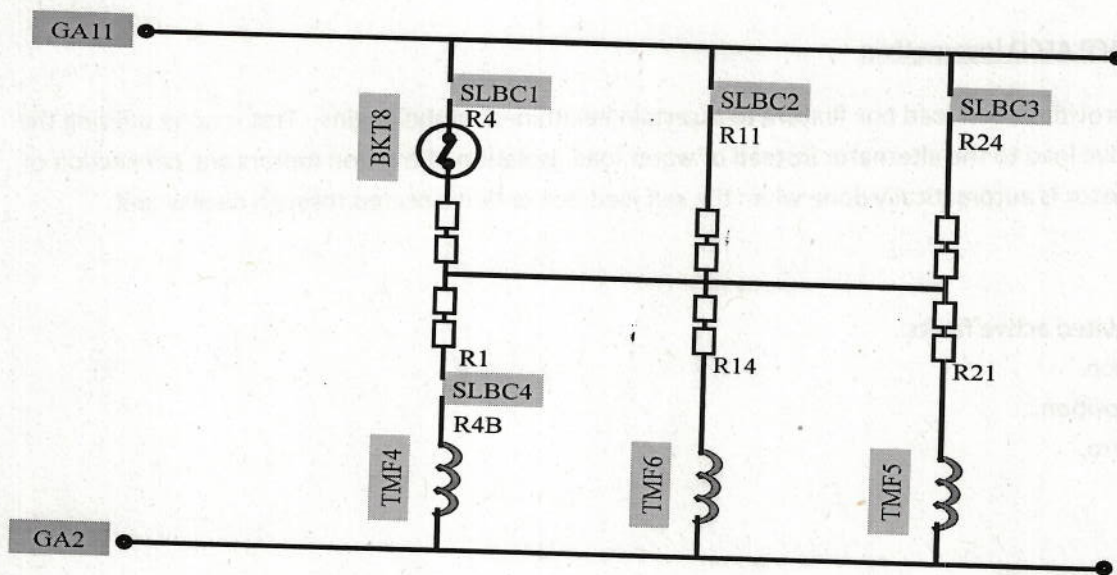
- a. Clear all Excitation related active faults.
- b. Keep TH in Idle position.
- c. Keep ECS is in RUN position.
- d. Ensure Loco speed zero.

**Procedure:**

- a. Press 'Menu' key in display unit.
- b. Select 'Test mode' by using arrow keys or select no.3 in key board.
- c. 'Enter Pass code' message will displayed, enter 1, 2, 3, 4, and 5 from key board.
- d. The sub menu in display will shows 5 options, select 'Self load test' option by pressing no.5 in number key board.
- e. Again submenu will come with two options,
  - i. Start Self Load Test
  - ii. End Self Load Test
 Select 'start Self load test' option.
- f. Display will show conditions for starting self load, after fulfilling those conditions press 'Enter' key.
- g. SLBR will pickup and self load box contactors 4 or 3nos will pickup and dynamic brake grids along with 3 TM fields (TM4, 5 & 6) are automatically connected across rectifier output through these four additional power contactors provided at the back side of the control panel.
- h. Switch ON both GF switches and put 1<sup>st</sup> notch, observe display for TA output and GHP and ensure BKBL is working, if not, bring the throttle to Idle and check for BKBL.
- i. Ensure BKBL is working.
- j. Raise the engine from 1<sup>st</sup> to 8<sup>th</sup> notch and note down the TA output and GHP readings.
- k. Also note down BAP, LOP & FOP.
- l. After conducting self load, again press 'Menu' key select 'Test mode'.
- m. Enter pass code and select 2<sup>nd</sup> option i.e. 'End self load test'.
- n. SLB contactors and SLB relay will drop and Loco will come to normal operation.

With self load box feature, the movement of the loco to the load box pit and preparation of the loco to load test are avoided. This will lead to saving of man power and time. During test, various parameters and the HP generated can be viewed on the display unit without doing any external metering.





#### Vigilance Control Device(VCD) MEP ALCO locomotive:

VCD means Vigilance Control Device. The purpose of VCD is to stop the train if driver is incapacitated. It will come in to action soon after circuit breakers MB1, MB2, MPCB, MCB1 & MCB2 are switched ON and BCP is less than 2.1 Kg. / Sq.cm.

VCD alerts the driver once in every 60 seconds through a Blinking LED, if none of the following activities are performed by the driver with in 60 sec.

- Increase / Decrease notch
- Application / Release of A9
- Application / release of DB
- Change of DB level.
- Operation of GF switches
- Change of RH position.
- Operation of Horn buttons
- Operation of Sander buttons
- Pressing of VCD reset button
- 

The Blinking LED continues for 08 seconds, if driver fails to do any of above loco operations.

- After 08 seconds, a buzzer is switched ON along with Blinking LED.
- A message 'VCD time out Press VCD reset' is displayed on the screen.
- The blinking LED and buzzer continues for another 08 seconds, if the driver still fails to do of above loco operations, After 76 (60+08+08) seconds, Penalty brakes are applied.
- A message 'VCD Applied Penalty Brakes' is displayed on the screen.
- VCD counter is increased by 1.
- Buzzer is switched OFF
- LED continues to blink for another 35sec.
- BP is reduced to 2.8 Kg./Sq.cm



- Loco / Formation brakes are applied
- Engine speed is brought to IDLE.
- GF contactor is dropped out.
- Power contactors dropped out after Master handle brought to IDLE.

**Measures to be taken to avoid malfunctioning of VCD:**

The following points to be ensured during schedule attention to avoid VCD malfunctioning in enroute.

- a. Ensure no air Leakages through VCD magnet valve.
- b. Ensure VCD is not coming into action when MCB1 & MCB2 are in OFF position.
- c. Ensure VCD is not coming into action when BC pressure is more than 2.1 kg/cm<sup>2</sup>.
- d. Ensure BCP sensor showing correct BC pressure as per gauge.
- e. Ensure VCD is resetting with Electrical Horns push buttons from both control stands.
- f. Ensure VCD is resetting with Sanders push buttons from both control stands.
- g. Ensure VCD is resetting when throttle moves from one notch to other notch.
- h. Ensure VCD is resetting when DB application and DB range changes.
- i. Ensure VCD is resetting with VCD reset push buttons from both control stands.

**REMMLOT:**

It means Remote Monitoring and Management of Locomotives and Trains.

REMMLOT consists of

1. Loconet Train Management System (LTMS):
  - a. LTMS is a centralized server connected to the Internet to communicate with Locomotive Remote Monitoring Systems.  
It provides Data with a single point access through Internet to all the Railway Staff at remote Locations.
  - b. LTMS is a 24 X 7 service provider.  
The objective of LTMS is to provide data globally and helping the Railway staff in Fault diagnosis and analyze Driver/Train performance, Locomotive Performance.
2. Locomotive Remote Monitoring System (LRMS):
  - a. LRMS is a Hardware unit with embedded Software remote interface located in Locomotive, which interacts with LTMS remotely.
  - b. LRMS interfaces with MEP\MAS\MCS to obtain Locomotive's health, fault diagnostics related data and other operational data. This data is transmitted to the remote server by using the commercially available GSM\CDMA Networks. The system also comprises of a GPS receiver from which the position information is acquired and the same will be transferred to LTMS.
  - c. To browse the LTMS go thru [www.loconet.in](http://www.loconet.in), Login page provides access to the Locomotive data with a valid User Name and Password entered by the user.



### TCAS system:

- i) Train Collision Avoidance System (TCAS) is to prevent train collisions, either Head-on or Rear-end in block sections and on running lines at stations and also to prevent the Signal Passing at Danger (SPAD).
- ii) TCAS is designed to primarily prevent overshoot of signals and avoid collisions when two trains are on the same track either accidentally or deliberately due to sabotage.
- iii) TCAS prevents these by triggering the application of brakes.
- iv) TCAS incorporates the features of Train Protection Warning System (TPWS) and Anti-Collision Device (ACD)

- Loco TCAS unit comprises of following modules:

- a) On-Board Vital Computer (MIE)
- b) TFT Display
- c) Radio Interface Module
- d) RFID Reader
- e) Event Recording Unit
- f) Digital Input & Output Modules
- g) Speed Sensor Signal Conditioning Module
- h) Vital Output & Brake Interface Unit
- i) Power Supply Module

- Station TCAS unit comprises of following modules:

- ☐ Station Unit Vital Computer Module
- ☐ Vital Input Module
- ☐ Communication Interface Module
- ☐ Event Logger Module
- ☐ Station Master's Operation and Indication Panel
- ☐ Power Supply Module & Battery Charger

- ◆ Station TCAS communicates with the Loco TCAS units by using radio communication.
- ◆ The system shall use a radio with hot standby for higher availability.
- ◆ The Radio shall be capable of communicating with the Loco TCAS within the radius of 3.5 Km.
- ◆ Antenna for station/ IBS/ mid-section interlocked Gate unit will be combination of vertically polarized omni and/ or directive antennae.
- ◆ Height of Tower for Radio communication shall be 30 meter.
- ◆ The Microprocessor Intelligent Equipment (MIE) is vital processing unit in Loco TCAS.
- ◆ Vital information acquired by the MIE is processed and decisions are made.
- ◆ Vital Computer module shall be designed as a Dual Electronic Structure based on composite fail-safety with fail-safe comparison.
- ◆ Two independent computing channels with identical Hardware and common Software perform the safety checking and compare the outputs of two computing channels through inter-processor communication.
- ◆ Station TCAS communicates with the Loco TCAS units by using radio communication.
- ◆ The system shall use a radio with hot standby for higher availability.
- ◆ The Radio shall be capable of communicating with the Loco TCAS within the radius of 3.5 Km.
- ◆ Antenna for station/ IBS/ mid-section interlocked Gate unit will be combination of vertically polarized omni and/ or directive antennae.
- ◆ Height of Tower for Radio communication shall be 30 meter.

Power supply:

- ◆ Power supply module work with a voltage range of +24VDC (+30%, -20%)
- ◆ Generate voltages required for the operation all modules.
- ◆ Generate voltages required for voltage and health monitoring circuit



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- ♦ The Battery Charger will provide the power supply to the Station TCAS units in the event of power failure.
- ♦ Battery shall be capable to provide power to the Station equipment up to 24 hours continuously.

**Steps to be taken during schedule attention on electrical side to prevent fire accidents:**

- Ensure no foreign material in BKT and REVERSER.
- Ensure no oil near Alternator power cables.
- Ensure no oil near TM cables in under truck.
- Ensure no short ckt. of measuring leads while taking No load voltage.
- Ensure no oil when welding job is doing and water to be readily available.

**Schedule:**

Schedule is a periodical interval checking of various locomotives as per particular time period. Depending on period locomotives schedules will be carried out and attending of driver remarks, downloading bookings, IRC bookings in particular schedule period by technician. Various standard schedules given by RDSO according to periodicity of locomotive.


**RDSO standard schedules for ALCO Locomotive:**

SCHEDULE CODE	PERIODICITY	OLD EQUIVALENT SCHEDULE (for ref.)
T-20	20 Days	Trip (T1)
T-40*	40 Days	Trip (T2*)
M -2	60 Days	Ist Monthly
T- 20	80 Days	Trip (T1)
T- 40*	100 Days	Trip (T2*)
M - 4	4 Months	I Quarterly
M - 8	8 Months	II Quarterly
M - 12	12 Months	I Half Yearly
M - 16	16 Months	III Quarterly
M - 20	20 Months	IV Quarterly
M - 24	24 Months	I Yearly
M - 48	48 Months	Three Yearly
M - 72	72 Months	II Yearly
M - 96	96 Months	POH



Electrical readings during IRC and their limits in MEP ALCO locomotive:

Sl. No.	Parameter to be measured	Unit	WDG3A
1.	C – E	Mega ohms	>1 MΩ
2.	P- E	Mega ohms	>1 MΩ
3.	C – P	Mega ohms	>2 MΩ
4.	Engine Speed (Idle / 8th Notch)	RPM	400±30 / 1050±10
5.	OSTA Tripping	RPM	1220±20
6.	BAT. Voltage	Volts	65-71
7.	AG Voltage	Volts	67-73
8.	Cranking time	Time (sec)	10-15
9.	Raising time	Time(sec)	15-22
10.	Easing time	Time(sec)	12-20
11.	FPM I	Amp	9-10
12.	CCEM I	Amp	2-3
13.	Deadrack	Milli meter	0
14.	Dryrun	Milli meter	17-18
15.	NO Load Voltage	Volts	1100±50
16.	BKCP	%	0 – 100 (gradually increasing)
17.	TM field I	Amps	800
18.	First Notch Current	Amps	300
19.	TM currents	SP (Amp) P (Amp)	300-400 100-200
SLB readings			
Load voltage		800V	
Load current		2350	
GHP		3100	
LCP		5.30	
FOP		4kg/cm <sup>2</sup>	
BAP		1-2kg/cm <sup>2</sup>	
Fuel Rack		25-30mm	
Surge rpm		1155-1175	
LOP at 90°		5.5 – 6.5	
CDT		<4min	

  
इंजीनियर (डीजल)  
द.म.रे., काजीपेट  
For Sr. D.M.E. (DSL)  
KAZIPET (SCR)




**Readings to be taken in WDG4 locomotive during IRC:**

Sl.No	Parameter to be measured	Unit	IDLE	8 <sup>th</sup> notch load
1	Engine speed (EPU) Low Idle -	RPM		
2	BATV	DC volts		
3	Batter dip voltage	DC volts		
4	Bat. Leakage voltage (+ve to Ground)	DC volts		
5	Bat. Leakage voltage (-ve to Ground)	DC volts		
6	AGAV	DC volts		
7	FPM current	DC amps		
8	TLPM current	DC amps		
9	GBP motor current	DC amps		
10	Dust blower motor current	AC amps		
11	Aux. Gen. O/P current measure at BCA	Phase A , AC amps Phase B , AC amps Phase C , AC amps		
12	TCC blowers 1 & 2 currents		TCC Blow. 1	TCC Blow. 2
		Starting, AC amps Phase A , AC amps Phase B , AC amps Phase C , AC amps		
13	Radiator fan 1 & 2 currents		RF1	RF2
			Slow - Fast	Slow - Fast
		Starting, AC amps Phase A , AC amps Phase B , AC amps		



		Phase C, AC amps		
14	<b>DB readings</b>		<b>1st</b>	<b>8th</b>
	DCLV	DC volts		
	MGA	DC amps		
	Grids KW	KW		
	Grid 1A	DC amps		
	Grid 2A	DC amps		
	Grid Blower 1	DC amps		
	Grid Blower 2	DC amps		
	Eng. RPM	RPM		
	TL 24 / DB %	DC volts / %		
15	BP	DC volts		
	AUX-C	DC volts		
	Phase A-B	AC volts		
	Phase B-C	AC volts		
	Phase C-A	AC volts		
16	<b>PRG &amp; PSMs Readings</b>	<b>1<sup>st</sup> notch</b>	<b>8<sup>th</sup> notch load</b>	
	PRG	I/P DC volts		
		O/P DC volts		
	PSM 300	I/P DC volts		
		O/P DC volts		
	PSM 310	I/P DC volts		
		O/P +ve DC		
		O/P - ve DC		
	PSM 320	I/P DC volts		
		O/P +ve DC		
		O/P - ve DC		

  
 कृते वरिष्ठ मंडल यॉन  
 इंजनीयर (डीजल)  
 द.म.रे., काजीपेट  
 For Sr. D.M.E. (DSL)  
 KAZIPET (SCR)



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				f. Check for any water entry into CAC and arrest with RTV sealant.
6.	Auxiliary generator/ TM blower	Trip/Mont hly	Running	a. Check for any unusual sounds from auxiliary generator. b. Check Aux Gen covers are properly fitted and not rubbing against the shaft. c. Check the condition of TM blower and MA blower.
7.	Dynamic brake motor/ radiator cooling fan motor	Trip/Mont hly	Running	a. Check for any unusual sounds from motor during computer self test. b. Check for any water traces on DB motors and ensure RTV sealant on DB fan mounting bolts. c. Check for any arcing on commutator of DB motor during self test d. Visually inspect the condition of radiator fan motor power supply cables.
8.	TCC electronic blower motor, dust bin blower motor etc	Trip/Mont hly	Running	a. Check for any unusual sounds from motor and blower assembly during engine run. b. Check the condition of connector and receptacles and ensure proper locking. c. Check condition of air ducts and clamps.
9.	Motors (fuel pump motor/TLPM/governor booster pump motor/ starter motor etc)	Trip/Mont hly	Running /stopped	a. Check and ensure normal functionality of FPM/ TLPM and governor booster pump motor (in PAC locos). b. Check for any unusual sounds from FPM/TLPM/Gov. Booster pump motor. c. Check starter motors for pinion /ring gear damage, intactness of mounting bolts. d. Check for motor guard whether intact.
10.	Traction motor and cables	Trip/Mont hly	Stopped	a. Inspect all cables (Power, sensor and earthing) for insulation damage or cut marks. b. Inspect all cable cleats for broken studs, excessive tightness and rubber cleat damage. c. Inspect all sensor (Speed &Temp) plugs for correct locking. d. Inspect all air ducts (TM Bellows) and fixing bolts for damage. e. Inspect all motors for any hit marks, physical damage and presence of all end shield cover bolts. f. Inspect cable junction plates and umbrella boots for signs of damage or overheating. g. Ensure all cables are routed properly and there is no excess/short cable over hangs. h. Apply insulation/spacers at all locations where cables are rubbing each other and with locomotive body. i. Blow all the traction motors with dry compressed air.
11.	Radar	Trip/Mont hly	Stopped	a. Ensure Radar mounting Angle is not disturbed and mounting bracket bolts are tight and intact. b. Inspect and clean Radar face plate with soap water c. Ensure Radar Safety Guard is intact and no damages. d. Ensure Radar connector is properly locked e. Conduct Radar Self Test and verify f. Ensure Radar Air Blast Pipe nozzle is directed to Radar faceplate and air blast is working
12.	Battery	Trip/Mont hly	Stopped	a. Ensure all vent plugs are intact. b. Check the lock assembly of Covers.



				<ul style="list-style-type: none"> <li>c. Blow out all the dust.</li> <li>d. Clean with water thoroughly.</li> <li>e. Check for low voltage grounding.</li> <li>f. Visual check-up of Cables / Terminals for tightness.</li> <li>g. Check for Leakages from cells</li> <li>h. Ensure adequate packing between batteries against rubbing.</li> <li>i. Check battery containers for damage.</li> <li>j. Check &amp; Record Specific Gravity.</li> <li>k. Record Electrolyte level. (Before water topping)</li> <li>l. Record Cell voltages (Engine dead &amp; On load)</li> <li>m. Record details of water added in each cell. (Add water when Engine is running)</li> <li>n. Record make, SI No.</li> <li>o. Provide terminal guard plates for all lead acid batteries.</li> </ul>
21.	Control stand covers, ECC1, ECC2 and ECC3 cabinets, E-locker(WDG5), Head light resistance covers, IPRS, grids, ECC1 cabinet, EM 2000 chassis and power supply chassis, all electrical cabinets and both the control stands and cab.	90 days	Stopped	<ul style="list-style-type: none"> <li>a. Attend the bookings</li> <li>b. Open control stand covers and blow out all the dust.</li> <li>c. Blow out all the dust in ECC1, ECC2, ECC3 and E-locker (WDG5) cabinets</li> <li>d. Open head light resistance covers and blow.</li> <li>e. Blow out all the dust inside the IPRS</li> <li>f. Blowout dust inside the grids and remove any waste</li> <li>g. Thoroughly clean ECC1 cabinet, E-locker (WDG5), EM2000 chassis and Power supply chassis.</li> <li>h. Clean all electrical cabinets with moist cloth.</li> <li>i. Clean both the control stands and cab thoroughly.</li> </ul>
22.	Control stands	90 days	Stopped	<ul style="list-style-type: none"> <li>a. Check for any loose or overheated connections in all the terminal boards.</li> <li>b. Check all the switches for loose connections and free operation.</li> <li>c. Check indication panels for loose or improper connections.</li> <li>d. Check slide switches for correct operation.</li> <li>e. Provide missing screws, nuts and bolts.</li> <li>f. Renew defective switches or any other components</li> <li>g. Open bezel assembly of controllers check for missing springs, screws, damaged sleeve, readout drum etc and attend.</li> <li>h. Check bezel for free wipers movement, damage etc.</li> <li>i. Replace missing or damaged latches.</li> <li>j. Check Parking Brake Pressure Switch (PBPR) (WDG5)</li> </ul>
23.	ECC1, E-locker(WDG5)	90 days	Stopped	<ul style="list-style-type: none"> <li>a. Check all circuit breakers for loose or overheated connections.</li> <li>b. Check all panel mounted modules for broken connecting plugs, missing jackscrews etc.</li> <li>c. Check power supply modules for damaged pins and screws.</li> <li>d. Inspect power supply chassis for signs of bent pins, loose connectors and pushed back</li> </ul>







26.	Miscellaneous (Electrical)	90 days	Stopped	<ul style="list-style-type: none"> <li>a. Check terminal board behind head light assemblies</li> <li>b. Check IPRS for damage and overheating.</li> <li>c. Provide spacers for IPR cables wherever touching to metal body and looming bars.</li> <li>d. Check battery knife switch and connections for slackness.</li> <li>e. Check headlight resistances and connections for slackness.</li> <li>f. Check grid cables for damage, rubbing and overheating.</li> <li>g. Check grids for displaced resistor element and flash marks on insulator and cracked insulators.</li> <li>h. Check EPU, TPU, MRPT and other sensors for clearance and connector locking</li> <li>i. Inspect VCU and connectors</li> <li>j. Clean cab light assembly &amp; provide all maintenance room and exterior lamps.</li> <li>k. Inspect MU receptacles on both ends</li> <li>l. Renew dyna cell filters (180 days)</li> <li>m. Replace Condenser filter, Return air filter &amp; Fresh air filter of AC unit (WDG5)</li> </ul>
27.	Main alternator & companion alternator	90 days	Stopped	<ul style="list-style-type: none"> <li>a. Open cover and blow off dust from TA, Aux. Gen. DB motors FPM, TLPM &amp; GBPM at low pressure.</li> <li>b. Brush condition &amp; brush arm assembly</li> <li>c. Pig tail overheating</li> <li>d. Spring tension</li> <li>e. Slip ring fixing bolts</li> <li>f. Condition of fuse indicators</li> <li>g. Slip ring condition, cabling.</li> <li>h. Clean companion alternator O/P TB and ensure connections are intact.</li> <li>i. Open TG O/P bus bar guards and clean with dry cloth.</li> <li>j. Inspect diode fuse indicators and ensure diode bank is cleaned.</li> <li>k. Reversal of CA field polarity once in every 90 days.</li> <li>l. Reversal of CA and MA field polarity once in every 180 days.</li> </ul>
28.	Auxiliary generator/ radiator fan motor	90 days	Stopped/Running	<p>Auxiliary generator:</p> <ul style="list-style-type: none"> <li>a. Inspect diode plate and clean with cleaning solvent for electrical machines if necessary.</li> <li>b. Check for intactness of covers with bolts.</li> <li>c. Check for any unusual sound &amp; rubbing marks</li> </ul> <p>Radiator fan # 1 &amp; 2:</p> <p>Check for any unusual sounds and intactness of cables.</p>
29.	Dynamic brake motor	90 days	Stopped/running	<ul style="list-style-type: none"> <li>a. Check for proper function of DB motors/record currents</li> <li>b. Check for any sparks during DB self test at stabling.</li> <li>c. Condition of brush arm assembly</li> <li>d. Ensure the RTV sealing on fan mounting bolts</li> </ul>

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					e. Rotate fan by hand and check for free rotation f. Check carbon brush, spring tension by hand and condition of commutator (scoring/ overheating marks etc)
30.	Fuel pump motor / TLPM/governor booster pump motor	90 days	Stopped/running		a. Ensure the intactness of terminal box & cable conduit b. Check for loose base bolts. c. Check for any unusual sounds from motors d. Measure FPM current & TLPM current
31.	TCC electronic blower motor/ dust bin blower motor	90 days	Stopped/running		a. Check for proper operation of motors and any unusual sounds from motor and blower assembly. b. Check foundation bolts, connectors and receptacles. c. Check hose pipes & clamps.
32.	Traction motor blower	90 days	Stopped/running		a. Intactness of fasteners, intake ring, guard. b. Check for any unusual sound during engine run.
33.	Starting motor	90 days	Stopped		a. Check the condition of drive gear and ring gear. b. Check for intactness of cables and clean. c. Check intactness of motor guard. d. Lubricate bushes with SAE 20/40 oil e. Clean starter motors & cables
34.	Sizes brush and spring tension TA, TM and TLPM.	90 days	Stopped		Note down sizes brush and spring tension
35.	Fault archive	90 days	-		Verify fault archive and driver repair books for following faults: a. Ground relay power/dynamic brake. b. Speed sensor or locked axle faults. c. Temperature sensor or hot traction motor faults. d. Radar feedback and DC link over voltage faults. e. Inverter output over current and GTO/IGBT monitoring faults. f. Unusual sounds from under truck and jerks on run in power or DB or in both.
36.	Traction motor and cables	90 days	Stopped		If any of these faults are recorded a thorough inspection of cables, bellows, connectors, cleats, IR value and motor winding resistance measurements may be required. a. Thoroughly clean and Inspect all cables (Power, sensor and earthing) for insulation damage or cut marks. b. Inspect all cable cleats for broken studs, excessive tightness and rubber cleat damage. c. Inspect all sensor (Speed &Temp) plugs for correct locking. d. Inspect all air ducts (TM Bellows) for damage and fixing bolts. e. Inspect all motors for any hit marks, physical damage and presence of all end shield cover bolts f. Inspect cable junction plates and umbrella boots for signs of damage or overheating.

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				<p>g. Ensure all cables are routed properly and there is no excess/short cable over hangs.</p> <p>h. Apply insulation/spacers at all locations where cables are rubbing each other and with locomotive body.</p> <p>i. Open inspection covers, inspect windings for any damage and presence of foreign material and blow with light compressed air</p> <p>j. Open motor and car body connection umbrella boots and inspect cable lugs for signs of overheating.</p>
37.	Radar	90 days	Stopped/ running	<p>a. Verify Radar mounting Angle with inclinometer and record.</p> <p>b. Inspect and clean Radar, face plate and bracket with soap water</p> <p>c. Ensure Radar Safety Guard and mounting bracket are intact, all fasteners are tight and no damages.</p> <p>d. Ensure Radar connector is properly locked</p> <p>e. Conduct Radar Self Test and verify</p> <p>f. Ensure Radar Air Blast Pipe nozzle is directed to Radar faceplate and air blast is working</p> <p>g. Verify Radar status flag is 'Zero, while moving the locomotive at speed above 4 kmph.</p>
38.	Battery	90 days	Stopped/ running	<p>a. Ensure all vent plugs are intact.</p> <p>b. Check the lock assembly of Covers.</p> <p>c. Thoroughly Blow out all the dust.</p> <p>d. Clean with Washing Soda &amp; water.</p> <p>e. Apply petroleum jelly to terminals</p> <p>f. Check for low voltage grounding.</p> <p>g. Visual checkup of Cables / Terminals for tightness.</p> <p>h. Check for Leakages from cells</p> <p>i. Ensure adequate packing between batteries against rubbing.</p> <p>j. Check battery containers for damage.</p> <p>k. Put oil to all latches and hinges.</p> <p>l. Check &amp; Record Specific Gravity.</p> <p>m. Check &amp; Record Electrolyte level. (Before water topping)</p> <p>n. Record Cell voltages (Engine stopped &amp; on load)</p> <p>Battery bank 1</p> <p>Battery bank 2</p> <p>Charging voltage (Eng running)</p> <p>o. Record details of water added in each cell. (Add water when engine is running)</p>
47.	Control stand covers, ECC1, ECC2 and ECC3 cabinets, E-locker, Head light resistance covers,	Yearly	Stopped	<p>a. Remove the controller to overhauling section.</p> <p>b. Remove EM2000 display, all modules from EM2000 and power supply chassis and hand over to module room in anti static covers.</p>



	IPRS, grids, ECC1 cabinet, EM2000 chassis and power supply chassis, all electrical cabinets and both the control stands and cab.			<ul style="list-style-type: none"> <li>c. Blow out all the dust inside the ECC1, ECC2 and ECC3 cabinets, or, E-locker (WDG5).</li> <li>d. Open control stand covers and blow out all the dust.</li> <li>e. Open head light resistance covers and blow.</li> <li>f. Blow out all the dust inside the IPRS</li> <li>g. Blowout all the dust inside the grids.</li> <li>h. Handover speedometers &amp; TE/BE meters to calibration section.</li> <li>i. Remove DBGR, FLSHR and GR and handover to overhauling section.</li> <li>j. Remove ST contactor and handover to overhauling section.</li> <li>k. Remove headlight resistor clean, check the value and refit.</li> <li>l. Take megger readings [ensure all modules, x-plugs, breakers &amp; knife switch open] of grid path 1, 2; TCC1, TCC2 I/P cables, TA, TM1, TM2, TM3 and same for truck 2.</li> </ul>
48.	Control stand	Yearly	Stopped	<ul style="list-style-type: none"> <li>a. Clean both the control stands thoroughly.</li> <li>b. Inspect all components and connections for signs of overheating and stress and replace if necessary.</li> <li>c. Check all the switches for loose connections and free operation.</li> <li>d. Check indication panels for loose or improper connections.</li> <li>e. Check slide switches for correct operation.</li> <li>f. Provide missing screws, nuts and bolts.</li> <li>g. Load the overhauled controller given by section.</li> <li>h. Check controller for free movement, power and DB operation etc.</li> <li>i. Replace missing or damaged latches.</li> <li>j. Ensure sealant applied around BP pipe is intact.</li> <li>k. Provide calibrated speedometers and TE/BE meters.</li> </ul>
49.	ECC1	Yearly	Stopped	<ul style="list-style-type: none"> <li>1. Thoroughly clean the cabinet with soap water.</li> <li>2. Check and tighten all circuit breakers connections.</li> <li>3. Check all panel mounted modules connectors for damage, missing jackscrews, guide pins etc and replace.</li> <li>4. Ensure insulation provided for module wire bunch against rubbing is intact.</li> <li>5. Load tested DBGR, FLSHR and GR.</li> <li>6. Check power supply chassis connectors for pushed back pins, damage, missing jackscrews, guide pins etc and replace.</li> <li>7. Check EM2000 chassis connectors for pushed back pins, damage, missing jackscrews, guide pins etc and replace..</li> <li>8. Inspect EM2000 chassis for damaged module slots, bent pins and damaged threads of module jack screw nuts etc.</li> <li>9. Inspect flat power supply cables for correct locking and application of insulation to prevent rubbing.</li> <li>10. Check all the contactors and switchgears for loose connections, sparking and correct</li> </ul>











				<p>14. Ensure cleanliness of clean air chamber.</p> <p>15. Clean companion alternator O/P cable TB and ensure connections are intact.</p> <p>16. Check IR value and record (min. 1 MQ)</p> <p>17. Measure field circuit resistance of CA and MA at slip ring (in ohms): CA (between 1 &amp; 2) MA (between 3 &amp; 4)</p>
55.	Auxiliary generator/ radiator fan motor	Yearly	Stopped	<p>1. Auxiliary generator:</p> <p>a) Check diode plate and clean with cleaning solvent for electrical machines.</p> <p>b) Check for intactness of covers with bolts.</p> <p>c) Check for any unusual sound &amp; rubbing mark on shaft.</p> <p>d) Check aux. gen o/p cables, its routing.</p> <p>2. Radiator fan # 1 &amp; 2:</p> <p>Check for any unusual sounds from motor and intactness of cables and clean.</p> <p>3 Check RTV sealant on rotor to stator mounting bolts.</p>
56.	Dynamic brake motor	Yearly	Stopped	<p>1. Check for proper function of DB motors.</p> <p>2. Condition of commutator &amp; terminal posts.</p> <p>3. Condition of brush arm assembly.</p> <p>4. Ensure the RTV sealing on fan mounting bolts.</p> <p>5. Rotate fan by hand and check for free rotation-cracked blades, loose bolts etc.</p> <p>6. Check carbon brushes, spring tension and replace if necessary.</p> <p>7. Check IR value and record (min. 1 MQ)</p>
57.	Fuel pump motor / TLPm / governor booster pump motor	Yearly	Stopped	<p>1. Replacement of fuel pump motor with over hauled motor.</p> <p>2. Ensure the intactness of terminal box &amp; cable conduct.</p> <p>3. Check for loose base bolts.</p> <p>4. Check for any unusual sounds from motors</p> <p>5. Measure FPM current.</p> <p>6. Check inverter and clean heat sinks.</p>
58.	TCC electronic blower motor/ dust bin blower motor	Yearly	Running/ stopped	<p>1. Check for proper operation of motors and any unusual sounds from motor.</p> <p>2. Check foundation bolts.</p> <p>3. Check air ducts &amp; clamps.</p> <p>4. Check for any unusual sounds during initial run check.</p> <p>5. Check connectors and receptacles and replace if found damaged.</p> <p>6. Clean blower and motor.</p>
59.	Traction motor blower	Yearly	Stopped	<p>1. Intactness of fasteners, intake ring, guard and housing mounting bolts.</p> <p>2. Ensure and record gap between intake ring and blower (above 3 to 5 mm.)</p> <p>3. Check for any unusual sound during IRC.</p> <p>4. Intactness of TM blower housing to aux.gen bracket mounting bolts.</p> <p>5. Remove blower guard and clean dust from blower coupling sleeve.</p>




60.	Starting motor	Yearly		<ol style="list-style-type: none"> <li>1. Check drive gears and ring gear for any damages.</li> <li>2. Check for intactness of cables, routing and tightness of mounting bolts and clean cables &amp; motor.</li> <li>3. Lubricate bush.</li> <li>4. Check intactness of guard.</li> <li>5. Special drive: check for proper engagement of starter motor pinions with ring gear and measure clearance between pinion tooth and ring gear slot (3 to 4 mm).</li> </ol> <p>Note down sizes of brush and spring tension.</p>
61.	Sizes brush and spring tension TA, TM, GBPM and TLPM	Yearly	Stopped	
62.	Slip rings	Yearly	Stopped	Check ovality of slip rings & record.
63.	CA and MA	Yearly	Stopped	Measure IR value at 1000 V.
65.	Carbody plates, carbody cables etc.	Yearly	Stopped	<ol style="list-style-type: none"> <li>1. Open all carbody and junction plates</li> <li>2. Clean and paint all the plates</li> <li>3. Check the condition of carbody cables</li> <li>4. Check and ensure proper colour code and availability of heat shrinks.</li> <li>5. Check and ensure the condition of cable supplying cleats and replace if necessary.</li> <li>6. Check and ensure the condition of umbrella boots.</li> <li>7. Check and ensure the condition of terminal lugs both at carbody side and motor side for any overheating or discolourisation.</li> <li>8. Disconnect all the traction motor connections</li> <li>9. Ensure cable support holding plates for continuous welding. Provide additional clamps if necessary.</li> </ol>
66.	Radar	Yearly	Stopped	<ol style="list-style-type: none"> <li>1. Open Radar and Radar safety guard.</li> <li>2. Clean Radar, Radar safety guard, face plate and base of Radar and paint guard and base of Radar.</li> <li>3. Check and ensure the condition of Radar base fixing bolts.</li> <li>4. Check and ensure Radar angle 37.5°</li> <li>5. Check and ensure Radar back plate</li> <li>6. Check and ensure condition of Radar safety guard</li> <li>7. Check and ensure Radar plug condition and clean thoroughly.</li> <li>8. Check and ensure the position of Radar air blast pipe nozzle to Radar face plate.</li> <li>9. Refix the Radar and conduct Radar self test.</li> </ol>
67.	TM and cables	Yearly	Stopped	<ol style="list-style-type: none"> <li>1. Provide all carbody and junction plates.</li> <li>2. Record IR and winding resistance of all TMs.</li> <li>3. Replace defective items if necessary (like heat shrinks, colour code, lugs, cleats etc.)</li> </ol>



				<p>4. Reconnect all the TM cables.</p> <p>5. Check terminal connections of TM for overheating and loosening.</p> <p>6. Check that car body cable and TM cable is properly secured.</p> <p>Cable routing</p> <p>1. Check all TM sensors (speed &amp; temperature) and locking plugs</p> <p>2. Check all TM cables for any excessive hanging and improper routing</p> <p>3. Check Sensor cables and earthing cables.</p> <p>4. Provide cable cleats and spacers wherever necessary.</p> <p>5. Secure cables with cable ties.</p> <p>Bellow attention</p> <p>1. Check and ensure the condition of TM bellows.</p> <p>2. Check all the bottom side fixing bolts for proper tighten and missing of bolts provide if necessary.</p> <p>3. Renew the bellow if necessary.</p> <p>4. Record all bellow Sl. No. and make.</p> <p>TM inspection</p> <p>1. Open all the TM inspection covers and ensure no foreign body present inside the TM.</p> <p>2. Blow with dry compressed air (4.5-5 kg/cm sq.) from inspection window and gear case end opening.</p> <p>3. With a hand lamp, check the motor winding for any foreign body entry and broken/burnt winding insulation etc.</p> <p>4. Check all TMs for any hit marks and external damage.</p> <p>5. Check all TMs for any gear case oil entry or grease oozing.</p> <p>6. Provide back all the inspection covers.</p> <p>Torquing and cleaning</p> <p>1. Check and torque NDE end shield cover bolts (18mm) with a value 70 Nm.</p> <p>2. Check and torque both DE and NDE side bolts (36mm) with a value of 680 Nm.</p> <p>3. Scrap all motors with wire brush.</p> <p>4. Clean all the power cables, sensor cables and earth cables by surf water.</p> <p>5. Record all TM serial Nos. and make.</p>
68.	Battery	Yearly	Stopped	<p>1. Ensure all vent plugs are intact.</p> <p>2. Clean all terminals with spray, examine support plates and tighten connections</p> <p>3. Remove covers and thoroughly blow out all the dust inside the cabinet.</p> <p>4. Clean with washing soda &amp; water.</p> <p>5. Clean covers, lubricate latches &amp; hinges</p>



				6. Ensure free operation of latch assemblies 7. Check battery containers for damage and leakages from cells 8. Ensure adequate packing between batteries against rubbing. 9. Check battery box mounting bolts and torque. 10. Apply battery terminal coating spray. 11. Check for low voltage grounding. 12. Check & record specific gravity. 13. Record cell temperature (when engine is running) 14. Check & record electrolyte level (before water topping) 15. Record cell voltages (engine dead & on load) Battery bank 1 volts - Battery bank 2 volts - 16. Charging voltage (eng running)- 17. Record details of water added in each
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 K. J. P. E. T. (GCH)



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**Electrical parameters to be measured and recorded during the load test:** The following readings to be note down for each notch.

- a. Engine RPM
- b. Load Voltage
- c. Load Current
- d. LCR position
- e. Rack in mm
- f. Lube Oil Pressure
- g. Fuel Oil Pressure
- h. Booster Air Pressure
- i. Exhaust temperature
- j. Inlet Temperature,

And also note down the Surge RPM and OSTA RPM.

**Steps to be taken during schedule attention on electrical side to prevent fire accidents:**

- a. Ensure no foreign material in BKT and REVERSER.
- b. Ensure no oil near Alternator power cables.
- c. Ensure no oil near TM cables in under truck.
- d. Ensure no short ckt. of measuring leads while taking No load voltage.
- e. Ensure no oil when welding job is doing and water to be readily available.

**Safety precautions to be taken during working in side shed:**

Provide "MAN AT WORK" board at both side of the loco.

- During schedule, place thick paper in CK1 & CK2 contactor and keep MB1 & MB2 Circuit breaker in off position
- Be careful while working on the locomotive.
- Always wear helmets and boots while working on locomotive.
- Do not wear loose clothes, slippers, brace-lets etc.
- After Initial Testing, shut down the Engine and Keep battery knife switch in "off" position before doing any work on locomotive.
- Do not leave any tool, cotton cloth or any other foreign material on the locomotive.
- Count all the tools and keep them in a proper tool bag.
- Hand lamp working voltage should not be more than 72 Volts.
- Regularly check the condition of hand lamp lead and its wire.
- Drain air pressure before removing any pneumatic equipment.
- Always, discharge the meggered circuit to ground with the help of flexible insulated wire after meggering.
- If OHE is above diesel locomotives roof, please ensure Switch off OHE Supply before climbing/ accessing to the roof of the locomotive.
- Place the proper wheel skids on both end wheels.
- During shed shunting ensure speed should not be more then 5 Kmph.
- Prior to start the loco shout loudly "KHBARDAR" and ring the bell three times and ensure no person is working in Radiator room and Expresser room.
- Always use ladder provided in loco for accessing to the roof of the locomotive.
- Clean the hands and sole of the shoes to avoid slipping before climbing on the ladder.
- After completion of the work, the concerned supervisor satisfying himself all staff, tools, ladder etc. has been removed.

**WHILE WORKING UNDER TRUCK OF LOCOMOTIVE**

- Ensure that locomotive is in Shut down condition for electrical side work

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- Provide proper wheel skids on both side of the loco, and apply loco Hand brakes before going in loco under truck.
- Do not drop oil/ grease in pits as staff may slip and get injured.
- Do not leave released brake blocks and other hardware inside the pits.
- Isolate bogie-isolating cocks before working on brake

#### TM isolation procedure:

##### 1. In conventional loco:

Defective motor can be isolated by Motor Cut out Switch (MCOS) provided in front breakers panel and only one motor can be isolated at a time.

##### 2. In MEP ver. 2.0 loco:

Defective motor can be isolated by individual toggle switch provided inside of front panel. Any number of motors can be isolated by individual toggle switches.

##### 3. In MEP ver. 3.0 loco:

In MEP ver. 3.0 loco defective TM can be isolated only through Display unit as there are no toggle switches. For isolation of TM the following steps to be followed.

- Ensure Reversal Handle in neutral, Throttle Handle in Idle and Loco speed zero.
- Press 'Main Menu' key in display unit.
- Select TM cutout option by 'F3' key.
- TM status screen will come, select 'change' option by 'F3' key.
- Select 'Motor' to be isolated by using UP and DOWN arrow keys and select CUTOFF option by 'F3' key.
- 'TM cutout conditions' screen will come with Reversal Handle in neutral, Throttle Handle in Idle and Loco speed zero conditions. Select 'Enter' option by 'F3' key.
- System will ask Password, enter 6000 by using number key pad and select 'OK' by F3 key.
- The selected motor status will change from 'CUT IN' to 'CUTOFF' i.e. that selected motor is isolated.
- Select Exit option by F3 key.
- In this way any no. of motors can be isolated.

#### Trouble shooting procedure for engine not starting in WW governor AC/DC locomotive:

##### a. Engine not cranking:

Ensure Battery knife switch closed, MB1, MB2, MFPB1, MFPB2, CEB & FPB are ON condition.

##### 1. CK1, CK2 & CK3 not picking up:

- ECS may be in RUN
- Either S/H or L/H MUSD switch may be in STOP position.
- GR2 may be in tripped condition.
- Check CKC picked up or not,
  - If CKC picked up check main tips for proper contact.
  - If CKC not picked up, check CKR1 picked up or not.  
If CKR1 picked up, check for bad contact of CKR1 interlock (43F-43G) or GR2 interlock (71-43F).  
If CKR1 not picked up, check for

BSR N/C interlock (71-43) bad contact,  
ECS Idle contact (43-43A) bad contact,  
P22 N/C interlock (43A-43AA) bad contact,

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S1 N/C interlock (43AA-43B) bad contact,  
START button (43B-43E) may be defective.

**2. CK1 & CK2 picking up but CK3 not picking up:**

- a. CK1 interlock (71-43J) may be defective.
- b. CK2 interlock (43J-43K) may be defective.

**3. CK1, CK2 & CK3 fluttering:**

- a. Weak Batteries.

**4. CK1, CK2 & CK3 picking up but Engine not cranking:**

- a. CK3 main contacts may not closing properly.
- b. Main bearings may be seized.
- d. Mechanical obstruction to rotate engine crank shaft.

**b. Engine not firing:**

- 1. LWS may be operated, check for hot Engine indication.
- 2. OSTA may be tripped.
- 3. Stop button may be stuckup.
- 4. Governor linkage may be defective.
- 5. Governor may be defective.

**c. Engine not holding:**

- 1. Lube oil pressure may be less than 1.6 kg/cm<sup>2</sup>.
- 2. Governor may be defective.

**Trouble shooting procedure for "Throttle not responding of Engine speed not raising in WW Governor AC/DC locomotive:**

- a. Check ECS, it should be RUN condition.
- b. Check GR1/ GFOLR condition – reset if tripped.
- c. Check BP pressure, it should be above 4 kg/ cm<sup>2</sup>.
- d. Check DMR picked up or not. If not picked up
  - i. Switch 'ON' MCB1 & MCB2 if they are in OFF/ Tripped condition.
  - ii. Keep both control stands TH in IDLE position & SH in motoring position..
  - iii. If air brake system is normal, short 16PD & 30K terminals at PCS or switch on PCS/DMR toggle switch provided in front control panel.
  - iv. CPR diode (16PC-16PD) may be opened.
  - v. PCS1N/C contact (30K-162) bad contact (in dual brake loco only)
  - vi. PR3 interlock (162-4) may be defective.
  - vi. If DMR dropping in 1st notch, check DMR self interlocks (16-16F& 16F-16).
- b. If DMR dropping in 1st notch, check DMR self interlocks (16-16F & 16F-16) for bad contact.
- c. Check ERR picked up or not, if not picked up
  - i. ECS RUN contact (16BB-16B) may be defective.
  - ii. GFOLR N/C interlock (16-16BB) may be defective.

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- iii. GR1 interlock (16B-16C) may be defective.
- iv. STOP button N/C contact (16C-16E) may be defective.
- v. LWS N/C contact (16E-16 H) may be defective.
- c. Control stand may be defective, notch up from other control stand.
- d. Check governor amphenol plug for slackness.

**Trouble shooting procedure for Load Meter not responding:**

**I) Loco moving:**

- i. LM defective.
- ii. Wire cut at LAS.
- iii. TM 5 is in isolated position.
- iv. S1 power contactor not picking up.

**II) Loco not moving i.e. No power:**

- a. Ensure ECS in RUN position, GR1/GFOLR in normal position & both GF switches are in ON position.
- b. Both S1, S21, S31 & GFC are not picking up:
  - i. Either GF switch may be defective.
  - ii. Control stand may be defective, operate from other control stand.
- c. S1, S21 & S31 power contactors are not picking up:
  - i. Ensure control air pressure 5 Kg/ cm<sup>2</sup>.
  - ii. Ensure BKT moved to motoring side and REV moved as per RH direction, if not operate manually.
  - iii. Check for BKT interlock (8AA-8E) & REV interlock (0/8-8A) for proper contact.
  - iv. Check BKR3 (8A-8C) and BKR1 (8C-8D) interlocks for proper contact.
  - v. Check for bad contact of ECS RUN contact (8D-8AA).
  - vi. Check for bad contact of TR & GF interlocks (8E-8F).
  - vii. Check MCO may be disturbed position, keep it correctly.
  - viii. Check for bad contact of P1 interlock (8FF-8M).
- d. GF Contactor not picking up:
  - i. Check for bad contact of BKT interlocks (6-6A) & (6D-6E).
  - ii. Check for bad contact of ECS RUN contact (6A-6B).
  - iii. Check for bad contact of TR interlock (6E-6F).
  - iv. Check for bad contact of CK1 (6E-6F) or CK2 (6F-6H) interlock. CK3 (6F-6H) for AC/DC locos.

If above all OK, pack GFC.
- e. S1, S21, S31 & GFC picking up but LM not responding:
  - i. Check all excitation cards for slackness.
  - ii. Excitation cards 253 or 186 or 188 or 293 may be defective.
  - iii. FCP wire may get disconnected or burnt.
  - iv. BKR interlocks (22E-32D) and (32C-32D) may have bad contact.
  - v. LCR in governor may not be touching with commutator causing reference

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- voltage to increase and excitation become zero.
- vi. N/O interlock of WSRs may be welded condition.
  - vii. Exciter may be defective.

- In A/C dc loco in addition to above,
- i. Check slip ring condition for any cable cut or burnt.
  - ii. Check Brushes condition, replace if necessary.

#### Trouble shooting procedure for DB not working:

Ensure BKR's picking up when SH kept in 'OFF' position. If not operate from other control stand.

1. BKT not throwing to braking side when SH kept in Big 'B' position:
  - a. Check DMR picked up or not, if not troubleshoot.
  - b. Check P22 (23-23B) or P2 (23B-23C) N/C interlocks for bad contact.
  - c. If above are OK, operate from other control stand.
2. If BKT moved to braking side but PCs not picking up check,
  - a. MCO may be isolated position.
  - b. Bad contact of BKT (23A-6A) interlock.
  - c. Bad contact of BKR1 (6B-8D) interlock.
  - d. Bad contact of BKT (8AA-8S) interlock.
3. P1, P21 & P31 picking up but S1 & P32 not picking up check,
  - a. Bad contact of BKT (6D-8P) interlock.
  - b. Bad contact of P1 (8P-8M) interlock.
4. If P32 alone not picking up, check
  - a. Bad contact of S1 (8M-8Y) interlock.
  - b. Bad contact of BKR3 (8Y-8V) interlock.
5. PCs picking up but GF contactor not picking up:
  - a. Bad contact of P32 (6D-6F) interlock.

#### Trouble shooting procedure for AFL coming during A9 application:

- a. P1 switch drop out setting may less than P2 switch.
- b. P1 switch may be stuck up in pickup position.

#### Wheel slip logic in MEP locomotive:

- The MEP-660 microprocessor based control system, provides a superior control over wheel slip which improves the adhesion substantially.
- RPMs of all 6 Wheel are measured by individual speed sensors and compared with each other.
- In case any wheel is tending to slip, the amount of slip is calculated precisely by the MEP-660 control system.
- The excitation is controlled through PI (Proportional and Integral) Control algorithm in such a way as to control wheel slip and at the same time deliver maximum possible tractive effort with the available adhesion at that point of time.
- Automatic Wheel Diameter Calibration is done at periodic intervals while the loco is coasting with out any brake application to avoid furious signals of wheel slip due to difference of wheel diameters.
- If any speed sensor is defective, the wheel slip is detected by difference of currents drawn by the traction motors. The changeover is automatic. (Fault Tolerance)



### Target Outage calculation:

A shed is homing 102 locos, in which 2 locos are accident locos, 20 are link locos, calculate shed target outage.

Net holding = Total holding – Accident locos & Ineffective locos

Heavy Repairs = 10%

Net available locos = Net holding – Heavy repairs

Locos for freight = Net available – Link locos

Light repair locos = 10%

Target outage = Locos for freight - Light repair locos

### Shed target outage:

Net holding = Total holding – Accident locos & Ineffective locos =  $102 - 2 = 100$

Heavy Repairs = 10%

Net available locos = Net holding – Heavy repairs =  $100 - 10 = 90$

Locos for freight = Net available – Link locos =  $90 - 20 = 70$

Light repair locos = 10% = 7

Target outage = Locos for freight - Light repair locos =  $70 - 7 = 63$

### BENEFITS OF MICROPROCESSOR CONTROL SYSTEMS in ALCO locomotive:

- Better management of parasitical loads .Higher input to traction as unused auxiliary power is added - up to 100 hp.
    - ❖ The auxiliaries on diesel loco consume approx 270 horse-power, although all are not always on. In E-Type control system this 270 hp has to be reserved for auxiliaries of loco & therefore not used for traction power even if auxiliaries are off. Microprocessor control system diverts the unused auxiliaries' power for the traction purpose. This also has led to philosophy of the Control being shifted from Utilizing Gross Power instead of just ensuring the power to Traction is made available, as every bit of Engine Generated Power is utilized with Microprocessor.
  - Higher adhesion – 5-8% more over the existing value.
  - Step-less and smooth excitation control providing no loss of traction power, Reduced electrical stresses & enhanced life of electrics, improved smoke emission and better fuel efficiency..
  - Improved Wheel Slip Slide Control & enhanced wheel life.
  - Thermal protection of traction machine leading to longer life.
  - Easy trouble shooting due to fault logging, retrieval and self diagnostics for maintenance staff and crew.
  - Lesser number of electrical interlocks of relays/contactors, increasing reliability.
  - Improved performance due to elimination of flash over in power contactors.
  - Flexibility in operation and maintenance due to user settable parameters.
  - Various operational benefits are inherent in the microprocessor control system like: Crew can not reverse the power if loco is moving in one direction which in turn protects the traction motors / bull gear pinions, feasibility of DB application along with the Train / loco brakes etc.
- Flexibility for incorporation of RSRC recommended safety feature like:

- ❖ Auto flasher light (AFL) for warning in case of train parting accidents
- ❖ Vigilance Control Device (VCD)
- ❖ Event Recorder
- ❖ Automatic Emergency Braking (AEB) etc.

➤ Flexibility for incorporation of new features like:

- ❖ Interface to MCBG,
- ❖ Pre/Post - lubrication for enhanced life of engine components re lube pump
- ❖ Tractive Effort Limitation etc.
- ❖ Self load testing by dissipation of engine power in DBR grids for testing of loco.
- ❖ Utilization of upgraded engine power through user variable programming parameters in microprocessor control system software.
- ❖ Traction machines thermal protection through continuous simulation of motor temperature based on actual current /voltage conditions in real time.

**MU SETUP FOR SINGLE CAB HHP LOCOS:**

DESCRIPTION	LEADING LOCO		TRAILING LOCO
	WORKING CONSOLE	NON-WORKING CONSOLE	BOTH CONSOLES
Reverser handle	Neutral	Neutral	Neutral
Throttle / Selector handle	Idle	Idle	Idle
Automatic brake (A9) handle	Run	Full service	Full service
Direct brake (SA9) handle	Full application	Release	Release
Lead/trail selector switch	Lead	Trail	Trail
	L/H CONSOLE		L/H CONSOLE
Engine Run (ER) switch	ON		OFF
Generator Field (GF) switch	ON		OFF
FP & Control switch	ON		ON
	ENGINE CONTROL PANEL		ENGINE CONTROL PANEL
ISOLATION SWITCH	ON		ON

**MU SETUP FOR SINGLE CAB (LEAD) & DUAL CAB (TRAIL) LOCOS:**

	LEADING LOCO (SINGLE CAB)	TRAILING LOCO (DUAL CAB)
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DESCRIPTION	WORKING CONSOLE	NON-WORKING CONSOLE	CAB ATTACHED TO LEAD LOCO	CAB ATTACHED TO FORMATION
Reverser handle	Neutral	Neutral	Neutral	Neutral
Throttle / Selector handle	Idle	Idle	Idle	Idle
Automatic brake (A9) handle	Run	Full service	Full service	Full service
Direct brake (SA9) handle	Full application	Release	Release	Release
Lead/trail selector switch	Lead	Trail	Trail	Trail
	<b>L/H CONSOLE</b>		--	--
Engine Run (ER) switch	ON		OFF	ON
Generator Field (GF) switch	ON		OFF	ON
FP & Control switch	ON		ON	ON
	<b>ENGINE CONTROL PANEL</b>			
Isolation Switch	RUN		RUN	RUN
BL KEY	--		OFF	ON
	<b>CIRCUIT BREAKER PANEL</b>		<b>CIRCUIT BREAKER PANEL</b>	<b>CIRCUIT BREAKER PANEL</b>
Genarator Field circuit Breaker	ON		OFF	ON

**MU SETUP FOR DUAL CAB (LEAD) & SINGLE CAB (TRAIL) LOCOS:**

DESCRIPTION	LEADING LOCO(DUAL CAB)		TRAILING LOCO (SINGLE CAB)
	WORKING CAB	CAB ATTACHED TO TRAIL LOCO	BOTH CONSOLES
Reverser handle	Neutral	Neutral	Neutral
Throttle / Selector handle	Idle	Idle	Idle
Automatic brake (A9) handle	Run	Full service	Full service
Direct brake (SA9) handle	Full application	Release	Release
Lead/trail selector switch	Lead	Trail	Trail
			<b>L/H CONSOLE</b>
Engine Run (ER) switch	ON	OFF	OFF
Generator Field (GF) switch	ON	OFF	OFF
FP & Control switch	ON	ON	ON
	<b>ENGINE CONTROL PANEL</b>		<b>ENGINE CONTROL PANEL</b>
Isolation Switch	RUN	RUN	RUN

BL KEY	ON	OFF	--
	CIRCUIT BREAKER PANEL		
Genarator Field circuit Breaker	ON	OFF	ON
Remaining circuit breakers	ON	ON	ON

**MU SETUP FOR DUAL CAB LOCOS:**

DESCRIPTION	LEADING LOCO(DUAL CAB)		TRAILING LOCO(DUAL CAB)	
	WORKING CAB	CAB ATTACHED TO TRAIL LOCO	CAB ATTACHED TO LEAD LOCO	CAB ATTACHED TO FORMATION
Reverser handle	Neutral	Neutral	Neutral	Neutral
Throttle / Selector handle	Idle	Idle	Idle	Idle
Automatic brake (A9) handle	Run	Full service	Full service	Full service
Direct brake (SA9) handle	Full application	Release	Release	Release
Lead/trail selector switch	Lead	Trail	Trail	Trail
Engine Run (ER) switch	ON	OFF	OFF	ON
Generator Field (GF) switch	ON	OFF	OFF	ON
FP & Control switch	ON	ON	ON	ON
	ENGINE CONTROL PANEL		ENGINE CONTROL PANEL	
Isolation Switch	RUN	RUN	RUN	RUN
BL KEY	ON	OFF	OFF	ON
	CIRCUIT BREAKER PANEL		CIRCUIT BREAKER PANEL	
Generator Field Breaker	ON	OFF	OFF	ON
Remaining circuit breakers	ON	ON	ON	ON

**Electrical parameters to be measured and recorded during the load test:**

The following readings to be note down for each notch.

- Engine RPM
- Load Voltage
- Load Current
- LCR position
- Rack in mm
- Lube Oil Pressure
- Fuel Oil Pressure
- Booster Air Pressure



- i. Exhaust temperature
- j. Inlet Temperature,

And also note down the Surge RPM and OSTA RPM.

**Electrical modifications required to upgrade the schedule periodicity to 30/ 40 days:**

1. Microprocessor based control and monitoring system (MBCS).
2. Microcontroller based engine governor (MCBG).
3. Low maintenance Battery which requires no topping up of water up to 45 days.
4. AC small motors (FPM, CCEM, DEM), which requires no maintenance i.e. commutator and Brushes condition checking.
5. Pressurization of electrical control cabinet i.e. tight sealing of Doors in front & back control panel which arrests dust accumulation on electrical control components. Hence no frequent blowing / cleaning is required.
6. LED type marker lights.
7. LED type Flasher lights.
8. Standardization of dipstick with min. 38mm & max. 54mm to avoid oil leakages in Alternator gear case.
9. Provision of RSB motors.

**EM 2000 COMPUTER and Other MODULES functions:**

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.

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

**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 Alert vigilance system also.

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

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

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

**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.

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

**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.

**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.



### 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.

**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.

**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.

**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 negative 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.

**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.

**DVR 300:** Digital Voltage Regulator – DVR regulates AG. field for maintaining a constant 55V 30 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.

### WDG4 LOCOMOTIVE BATTERIES:

The locomotive is fitted with 500 AH 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), specify 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.

### ELECTRICAL CONTROL CABINETS IN HHP LOCOMOTIVE:

**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 equipment 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:

#### **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.

#### **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.

**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.

#### **WDG4 locomotive SALIENT FEATURES:**

- a. WDG4 is a 4000/ 4500 GHP locomotive is a high speed loco with high tractive and braking effort capabilities.
- b. The schedule interval period of this loco was 45/90 days with less running maintenance as this loco having majority of AC motors and generators.
- c. This loco provides fuel savings and additional tonnage capability.
- d. This loco fitted with AC traction technology which is simple, robust motor design & highly reliable traction converters.
- e. This locomotive is fitted with computer controlled braking (CCB) system.

#### **Salient features:      Electrical:**

- a. AC 3 phase Traction Alternator with output voltage of 2600 volts DC.
- b. AC 3 phase Companion Alternator with output voltage of 230 volts AC for excitation to main TA, supply to TCC blower motors, Radiator Fan motors and Filter blower motor.
- c. AC auxiliary Generator with output voltage of 55 volts AC and regulated to 74 volts DC for Battery charging and control circuits.
- d. AC 3 phase Induction motors for traction purpose which are having less maintenance and high reliability. There are 6 traction motors provided in this loco, 3 for each truck.



- e. Traction Control converters (TCC) with GTO/ IGBT technology to control Traction motors with variable voltage and frequency. There are 2 TCCs provided in EMD & Siemens control system fitted locos and 6 nos. TCCs in Medha control system locos.
- f. Dynamic Braking with AC traction motor powered to Grids.
- g. Engine starting system with 2 DC starter motors of 64 volts operating.
- h. Lead acid batteries of 500 AH for engine starting and for supply to control circuits.
- i. EM 2000 computer for loco control i.e., engine control, excitation control and interface with CCB system.
- j. EM 2000 display for displaying crew and fault messages, for conducting self tests.
- k. RADAR for locomotive speed signal to computer.
- l. 2 Radiator fans driven with 3 phase AC induction motors.
- m. 2 DB motors for cooling DB grids.
- n. Heavy discharge Fuel pump motor and Turbo lube pump motor.
- o. 2 nos. TCC blower motors in EMD & Siemens locos and 6 nos. in Medha loco for TCCs cooling.

**Mechanical:**

1. Two stroke fuel efficient engine
2. High horse power – 4500HP
3. Extended schedule periodicity
4. Power assembly can be changed as a set
5. Unit injectors
6. Lash mechanism – no frequent tappet adjustment
7. Gear and exhaust gas driven turbo super charger
8. Oil cooled turbo
9. Educator mechanism for CCV
10. Water cooled compressor
11. AC-AC transmission system
12. Computer Control Brake System
13. HTSC (High Tensile Cast) bogie
14. High adhesion and tractive effort
15. Highly improved maintainability compared to Alco locomotive
16. High availability and reliability
17. Low fuel and lube oil consumption
18. Less emissions

**Technological upgradations in ALCO locos:**

1. MBCS (Micro controller based control system)
2. MCBG (Micro controller based control Governor)
3. AC small motors (FPM, CCEM, DEM), which requires no maintenance.
4. Pressurization of electrical control cabinet.
5. LED type marker lights.
6. LED type Flasher lights.
7. Standardization of dipstick with min. 38mm & max. 54mm to avoid oil leakages in Alternator gear case.
8. Provision of RSB motors.
9. REMMLOT
10. APU
11. CReDI
12. TCAS

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**Technological Electrical upgradations in HHP locos:**

1. IGBT TCC
2. Dual CAB
3. APU
4. DPCS
5. REMMLOT
6. Inverter control RF operation

**WDG4 MODIFICATIONS SHED LEVEL:**

S. NO	DESCRIPTION OF MODIFICATION
1	EFCO & FPR pickup/ dropout logic modification to avoid EFCO & FPR relay failures.
2	FPR & FLSHR Interlock modification from series to Parallel to avoid interlocks failures.
3	Governor Amphenol modification (sleeve and Elbow) to avoid rubbing of wires inside conduit and Elbow.
4	TM car body cables securing with additional insulation plate (FELT) to avoid GR tripping.
5	Additional VCD lamp/ Horn button at L/H Control stand to LP comfort.
6	Dual VCD Buzzer modification to better audibility to LP.
7	S/H Head light resistor shifting to avoid overheating of wiring.
8	ECC2 door additional latch modification in EMD locos to avoid unwanted opening of ECC2 door in case of latches fail.
9	RFCBs tripping feedback Alarm and LED indication wiring provision for awareness to LP.
10	TA/CA silicon rubber grommet provision to avoid cable rubbing and grommet failure due to temperature.
11	L/H C/L drain holes to vent out water to avoid control grounding.
12	Battery knife Switch handle provision for easy opening of door.
13	Modified RADAR guards provision to avoid damage from foreign materials.
14	Bat. Knife switch movable arm fixing bolt (brass) replacing with M.S. bolt, to avoid BKS failures.
15	Removing of Dummied wires in Diode panels of TA, to avoid GRs tripping.

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**WDG4 ELECTRICAL MODIFICATIONS proposed by RDSO:**

S. no	Description
1	Modifications to relocate the Engine Start switch "FP/ ES" from Engine room to cab of WDG4 DE locomotives fitted with EM2000.
2	Provision of upgraded cables for Radiator cooling fan assembly of EMD locomotives.
3	Use of modified capacitors in the transient voltage suppression system (surge capacitors) in WDG4/ WDP4/ WDP4B locomotives.
4	Configuration of MU 27 pins on EMD /ALCO DE locomotives.
5	Removal of RC circuits (snubber circuits) in existing Traction Alternators fitted in 4000/ 4500 HP EMD locomotives
6	<p><b>Modifications in EMD locomotives (WDG4 AND WDP4) to improve their reliability and maintainability.</b></p> <ol style="list-style-type: none"> <li>Insulation over harness in ECP to prevent power grounding. (Harness is wrapped with insulation around the corner-points to prevent direct rubbing of Harness with cabinet body)</li> <li>Provision of spacer for cable harness of IPRs (power cables are isolated from the direct contact with looming bar by providing suitable insulated cable spacers bearing EMD part no.8451802).</li> <li>Application of color coded heat shrinks for TM1 &amp; TM6 power cables at the cleat on the bogie frame and for TM no. 2, 3, 4 &amp; 5 near the Junction plates.</li> <li>Application RTV sealant for all the split cabinet insulators at the back of ECC-1 top side.</li> <li>Provision of Drain holes at the bottom of long hood classification light cabinets for draining of water.</li> <li>Insulation plate (Hylum sheet) below Umbrella boot of TM cable connection joint.</li> <li>Flat cable rubbing in back panel –ECC1 (Insulation is wrapped around the 4 nos. of flat cables connected from power chassis to EM 2000 back panel with cable cleat at the corner point touching the car body and thus preventing direct rubbing of cables with loco body).</li> <li>Crimping of large square type contact for head light positive wire of 823C plug in ECC-3.</li> </ol>
7	<p><b>Modifications in EMD loco (WDG4 and WDP4) for control equipments to improve their reliability and maintainability.</b></p> <ol style="list-style-type: none"> <li>Shifting of Rear cover latches of control stands from inside to outside (Rear cover of control stand fitted with sliding latch)</li> <li>Use of Transparent covers over EFCO switches fitted above both fuel tanks</li> <li>Provision of separate terminal board for high voltage cables (7 nos.) of 3G2A plug to be provided at back side of ECC1.</li> <li>Modification of Radar Protection Guard (present Guard covered with 3 sides which should be made covering all sides of Radar)</li> <li>Provision of Terminal Guards for Batteries (Nickel coated MS plates to be used between Batteries terminal plates and Nuts/ bolts).</li> </ol>
8	<p><b>Prevention of cable failure in EMD locomotives (WDG4 and WDP4).</b></p> <p>(Self fusing tape should be wrapped over the outgoing cables of TCC-2, TA Batteries &amp; IPR passing through duct of the chassis inside the TA compt. are rubbing with sharp corner of the duct of the chassis due to vibration resulting in cutting the cable insulation which further results in power grounding)</p>
9	Provision of M16 studs in place M10 studs for mounting of Inverter Protection Resistors in 4000/ 4500 HP EMD Locomotive to prevent their breakage.
10	Provision of higher rating contactors for Radiator cooling fan assembly of EMD locomotive.



	(for FCS - in place of 150A, 250 or 325 A and for FCF - 325 A to be used in all type of locos)
11	Modification of VCD vigilance cycle suppression logic on HHP locomotives subsequent to reduction of B.C. pressure from 4.4 kg/cm <sup>2</sup> to 1.8 kg/cm <sup>2</sup> on synchronous brake application. (VCD vigilance cycle should be suppressed when BC pressure $\geq 1.7$ kg/cm <sup>2</sup> and should be activated when BC pressure $\leq 1.7$ kg/cm <sup>2</sup> )
12	Modification of IGBT based TCC Phase modules of 4500 hp HHP locomotives equipped with MAS696 AC- AC traction system.
13	Braiding of shunt cables from Radiator fan circuit breaker to contactor used in ECC3 cabinet of EMID AC-AC traction system locomotives.
14	Provision of metallic cable sleeve on starting motor side positive and negative cables in HHP locomotives.
15	Deletion of Low coolant level switch in 4500hp locomotives. (Beri make switch)
16	Relocation of Alarm Bell in Control console 1 & 2 in WDG4/ WDP4B locomotives.
17	Modification in end terminal of Head Light Resistor 3.75 ohms, 400 watts for Dim. (Use of Eye hole type terminals in head light end terminal in place of plug / fasten type end terminals.
18	Modifications in the circuit of failure prone Relays. (series to parallel Inter lock modification for FLSHR, Two relays parallel for PCR & Relay pickup/dropout logic change for EFCO & FPR relays)
19	VCD reset control on locomotive (VCD Reset should not be ALP)
20	Application on AESS on HHP locomotive fitted with M/s Medha AC- AC traction system.
21	MRPT sensor input supply (24 to 15 volts) modification

  
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**Trouble shooting for common fault messages in HHP EMD locomotive:**

s. no	Problem	Fault message	Action to be taken
1	Eng. not cranking	"Start fuse open" fault	Ensure Start fuse is in good condition. Replace with new start fuse and crank the loco.
		"Eng. Shutdown low oil pressure" fault	Reset LLOB in WW governor and ensure Low water switch is not projected out in EPD (Don't crank if Low crank case switch projected, contact shed).
		"No start- start motor abutment condition" and "ST failed to pickup" faults	a. Wait for 2 minutes for Start motors cooling. b. Ensure Start motors pinions are not stuckup condition with main gear and manually check for free movement of pinions.
		"Low water" fault	a. Check battery knife switch for proper closing and any melting marks or flashes in knife switch plates. b. Batteries may be weak, contact shed.
2	Eng. Shutdown during cranking	"Eng. Shutdown low oil pressure"	Reset LLOB in WW governor and Ensure Low water switch is not projected out in EPD (Keep pressing Low water switch till eng. Cranking and holding if repeatedly tripping)
3	Eng. Shutdown on run	No crew/ fault message	a. Reset OSTA if tripped (normal position is 11'o clock). b. Ensure FPM is working condition.
		Eng. Shutdown low oil pressure	Reset LLOB in WW governor and Ensure Low water switch is not projected out in EPD
		TCC protection messages	Recycle computer breaker and re-crank.
4	TE meter not responding	"GR – power" fault message.	Isolate trucks one by one and locate in which truck GR is tripping.
		"GR-DB" fault message	Isolate DB by DB slide switch provided in engine control panel.
		'#1 - #6 locked wheel detected', 'Failed feedback - TM 1 - 6rpm', 'TCC#1 /2 Reset-DC link over voltage', TCC# 1/2 warning- speed sensor fault axle-6. fault messages	This may be due to Defective Traction motor speed sensor. <b>DISABLE</b> the concern defective speed senso.
		"#1 locked wheel/ speed sensor/pinion slip fault"	a. Pinion may be slipped. b. Isolate the truck and work further.
5	Less Hauling power	a. "Hot engine power limited to 6 <sup>TH</sup> notch" fault  b. Traction motor may be isolated condition.	Check Engine water temperature (ETP1 / ETP2) in Display. If temp. is more than 96 degrees check Radiator fan circuit breakers RFCB1 & RFCB2 in ECC3 for tripping. Reset if tripped and wait till eng. temp. reduced to below 90 degrees. Refer logbook remarks for Traction motor isolation.



# Electrical Rotating machines of ALCO locomotive details:

S.No	Machine Name	Machine type	Model no.	Ratings				No. of poles	Bearings		Brush grade
				HP	Volts	Amps	RPM		CE-Bearing	NCE-Bearing	
1.	FPM (AC)	3 phase Induction motor with built in inverter	FP-3-72	1.5	40V, 60HZ	--	1728	4	6305ZZ	6305ZZ	--
2.	CCEM (AC)	3 phase Induction motor with built in inverter	CC-3-72	0.5	40V, 50HZ	--	2880	2	6305ZZ-DE side	6204ZZ-NDE side	--
3.	DEM(AC)	3 phase IM with built in inverter		0.87	40V, 50HZ	--	2880	2			--
4.	Aux. Generator	Shunt field	AG 3101 AY	19KW	75	250	950-2380	6	6313 Z/L9	NU314 E/L4	EG 251
5.	Exciter Gen.	Shunt field	AG 3101 AY	19KW	75	250	950-2380	6	6313 Z/L9	NU314 E/L4	EG 251
6.	Traction motor	Series	4906AZ, 4907AZ/BZ Short term continuous	278 KW 280 KW	305 325	1060 1000	395 430	4	NU320	NU330	EG 14D
7.	Traction Alternator	3 Phase, STAR connected	10102 CW / 10102 DW / 10102 EV Short time Continuous Maximum	1942 KW 1936 KW	525 1100 1130	3700 1760 4400	1050 1050	10	--	NU 330	HM6 MORGAN
8.	ECC (BHEL)	--	EC 9005/2/M	60 KW	600	--	1000	--	--	2310	EG 0
9.	BKBL	Series	DY 3423 M Continuous 3423M	52.5 KW 47 KW	325 315	175	3500	4	--	6409	EG 16 K
10.	Tacho GEN.	3phase alternator	AG 1404 AZ	--	105-130	--	1000	6	6306 (free end)	NU306 (pinion end)	EG 16 K --

  
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 For S.D.M.E. (OSL)

**Grades of brushes used in Electrical Rotating machines of ALCO locomotive , their new and Condemning sizes:**

S.No	Machine Name	Model no.	Brush grade	Brush new size in mm (LXBXH)	Brush condemn size in mm
1.	Auxiliary Generator	AG 3101 AY	EG 251	24.96x40x16	15
		AG 51 M	EG 225	44.3x31.6x12.7	
2.	Exciter Generator	AG 3101 AY	EG 251	24.96x40x16	15
		AG 51 M	EG 225	44.3x31.6x12.7	
3.	Traction Motor	165M (continuous)	EG 14D	46x57.15x18.97	28
		4906AZ, 4907AZ/BZ Short term Continuous	EG 14D	52x57.15x19	28
4.	Traction Alternator	10102 CW / 10102 DW / 10102 EV Short time Continuous Maximum	HM6 MORGAN	38.1x50.8x25.4	35
5.	ECC (BHEL)	EC 9005/2/M	EG 0	23x9.5x9.5	9.5
6.	BKBL	DY 3423 M Continuous	EG 16 K	45x32x12.5	23

**Recycling Procedure in HHP locos:**

**Recycling procedure: EMD IGBT LOCO'S**

- TH Idle
- Reverser in Neutral
- Keep the isolation switch in isolate position
- Switch OFF the Computer Control Breaker
- Switch OFF TRACTION CONTROL Circuit Breaker
- Switch OFF Circuit Breaker IGBT SUPP # 1
- Switch OFF Circuit Breaker IGBT SUPP # 2
- Do not switch OFF MICRO AIR BRAKE Circuit Breaker for TCC related Problems
- Wait for 20 seconds
- Switch ON Circuit Breaker IGBT SUPP # 2
- Switch ON Circuit Breaker IGBT SUPP # 1
- Switch ON TRACTION CONTROL Circuit Breaker
- Switch ON the Computer Control Breaker
- Recover the BP by keeping the A9 in FS for 10 sec
- After recovering BP ensure Reverser in Neutral for Min 20s

**Recycling procedure: SIEMENS LOCO'S**

- TH Idle
- Reverser in Neutral
- Keep the isolation switch in isolate position
- Switch OFF the Computer Control Breaker
- Switch OFF Circuit Breaker TCC PS
- Switch OFF Circuit Breaker PS -5
- Do not switch OFF MICRO AIR BRAKE Circuit Breaker for TCC related Problems
- Wait for 20- 30 seconds



- Wait for 20- 30 seconds
- Switch ON Circuit Breaker PS -5
- Switch ON Circuit Breaker TCC PS
- Switch ON the Computer Control Breaker
- Recover the BP by keeping the A9 in FS for 10 sec
- After recovering BP ensure Reverser in Neutral for Min 20Sec.

#### REMMLOT:

RDSO developed online monitoring system of locomotives and trains REMMLOT (Remote Monitoring and Management of Locomotives and Trains) which makes available the real time data from the microprocessor of the loco, including the location of the loco, to authorized personnel. REMMLOT system has already been tested and running on a large number of HHP & ALCO locos. With this system, predictive maintenance is possible. With predictive maintenance, not only the cost of maintenance is reduced & availability is increased and also reliability is improved. Following are the main actions being taken at present with the help of REMMLOT.

- a) Monitoring of loco parameters by the shed to plan schedule/of course attention to loco at near shed.
- b) Advising LP to take timely action to prevent online failure/detention to loco, on the basis of faults noticed on line.

#### APU:

Analysis of locomotive data has shown that most of the run time of the goods trains is spent IDLING for want of line clear signals on the station & yards for prolonged periods of time. While the diesel engine is idling at 400 RPM, the engine consumes roughly 25 to 30 liters of diesel oil per hour. The diesel engine performs two functions while idling at stand still; the compressor maintains MR pressure and the auxiliary generator charges the locomotive batteries. These two functions do not require much power. However as the full engine runs to cater this requirement, the energy consumed is very large. To cater to above requirement APU system has been developed as per RDSO specification. During APU mode, Locomotive engine will be shut down and APU engine will start working which in turn consumes very less fuel i.e. 5 liters per hour.

#### LOAD BOX TEST:

Load Box test is a test to check the capability and performance of the engine by simulating the actual working condition of the locomotive at rated output, in static condition. During load box test, the output of the engine is measured in terms of electrical parameter (volt and ampere). In this the output of the generator is connected across a set of resistances instead of connecting it with the Traction Motors. The output of the engine is dissipated in terms of heat across resistance during Load Box test.

Types of Load Box

1. Grid Resistance Load Box.
2. Water Resistance Load Box

Load Box test is conducted to

To match the generator demand with the engine output.

1. To find certain parameters which could not be found by normal test methods.
2. To assess the condition of the components.

When to conduct Load test:

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For Sr. D.M.E. (DSL)  
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2. During components change which effect the engine output
3. During low BAP and low hauling power problem

During Load Box test, the following readings have to be recorded notch wise.

Notch	Volt	Current	HP	LCR	Rack	RPM	BAP	LOP	FOP	Exh. gas temp.

**Reasons for BAP dropping or Hauling power poor:**

1. Fuel oil pressure dropping
2. Exhaust gasket between head and manifold may be given up
3. Exhaust manifold may be cracked
4. Turbo super charger may be defective
5. Turbo to after cooler housing flange joint may be given up
6. Intermediate casing joint gasket may be given up
7. After cooler housing to engine block joint gasket may be given up
8. After cooler to after cooler housing joint gasket may be given up
9. Air inlet elbow top & bottom gasket may be given up
10. BAP gauge may be defective
11. BAP pipe line may be damaged

**Reasons for Hot engine alarm:**

Due to LWS:

1. Malfunctioning of LWS
2. 3 way clock may be closed
3. Water level drops below one inch from the bottom of the tank

Due to ETS:

1. Water temperature above 90° C
2. Radiators may be choked
3. Radiator room door may be open
4. ECC may be defective
5. Radiator fan not working
6. Continuous load on engine
7. Less water in expansion tank
8. Atmospheric air temperature may be high
9. Right angle gear box may be defective
10. R1 and r2 contactors may be defective
11. TS1, TS2 and ETS switches may be defective or malfunctioning or set wrongly
12. Water pump may be defective

**DPCS (Distributed Power Control System):**

Indian railways can increase throughput by running longer trains which require more motive power. More locomotives bunched together cause unacceptably high coupler forces. This situation can be overcome by distributing the locomotives throughout the consist of the train which will require a means of synchronizing actions on locos based on driver inputs in the lead locomotive. DPC system can provide real time communication between lead and remote locos through wireless data radio to synchronize all locomotives in the train.

**Advantages of DPCS (Distributed Power Control System):**

1. Longer Trains with increased hauling capacities



1. Longer Trains with increased hauling capacities
2. Reduced coupler forces – lesser fatigue failures
3. Reduced crew requirements
4. Faster synchronized braking – Reduced stopping distance
5. Wireless radio control – Reduces clumsy wire connections
6. Safe handling of radio communication failures
7. Suitable for A and/or DC traction.

**CReDI:**

Common Rail Electronic Direct Injection fuel system is second generation Electronic fuel injection system which leads to substantial reduction in specific fuel consumption and present levels of emissions. CReDI consists of a low pressure and high pressure fuel system. Salient feature of this system is that there are only two reciprocating 4 cylinder inline high pressure pumps which maintain a high fuel pressure for injection, approximately 1600 bar, in the fuel common rail. The injectors are solenoid operated, controlled through an interfaced ECU with traction excitation control. Governor, OSTA, FIP and control rack are the components that get eliminated from a conventional pump line nozzle loco.

**Advantages of CReDI:**

1. Reduced NOx emissions.
2. Reduced black smoke emissions
3. Reduced fuel consumption
4. Improvement in reliability of diesel engine.
5. On board diagnostic potential

**Short notes on i) Stock Items ii) Ordinary Stores iii) Emergency Stores:**

- i) **Stock Items:** Stock items will be kept in the custody of the stores department which are frequently and regularly required and whose unit cost justifies incurring inventory carrying cost associated with these items. Such items will be known as 'Stock Items'.
- ii) **Ordinary Stores:** Ordinary stores are generally such items of stores for which there is a regular turnover caused by constant demand and which are stocked by the department in its depot. Ex: oil, grease, steel raw material, paints, loco and C&W components.
- iii) **Emergency Stores:** Emergency Stores are the stores which are not required frequently, but still stocks have to be maintained for ready use. Such items are not readily available in the market and as such would require long time for procurement in case they are not stocked. The stock out cost would be quite high if such items are not readily available in the stores when required. Ex: Spare parts of machinery & plant, components of Rolling stock and locos etc.

**Short notes on i) Non Stock Items ii) Special Stores iii) Surplus Stores:**

- i) **Non Stock Items:** The items which are essentially of one time or occasional requirement for which reasonable time will be available for procurement and hence no stock of such items is maintained. Such items are called Non stock Items.
- ii) **Special Stores:** These are stores required for works and other special purposes i.e. other than for 'operation' or 'ordinary maintenance and repairs' and which are ordinarily dispatched directly to the requisitionist without being stocked in a stores depot.
- iii) **Surplus Stores:** These are of two kinds, 'Movable' and 'Dead'.  
Movable surplus stores comprise items of stores which have not been issued for a period of 24 months, but which, it is anticipated, will be used in the near future. Dead surplus stores



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**Procedure for stocking an item:**

1. For stocking an item, the user department should first identify the need for stocking an item and then submit a stocking application to the stores department.
2. The consignee will prepare stocking application in 6 copies and send to the stores depot office with all necessary details like Description of the Item, Anticipated Annual Consumption (AAC), Rate, Value, No. of components etc.
3. The Ledger section will scrutinize the stocking application and ensures for the following.. Whether the item is available in other depots, facility to stock the item and availability of space.
4. Then from the Ledger section, stocking requisition will be sent to COS/HQ.
5. COS/HQ will give PL No. and tenders will be called for.
6. Once the supplier is selected, then Purchase Order will be released and it will be sent to Ledger section.
7. From the Ledger section Purchase Order will be forwarded to progress section. PO particulars will be entered in progress register. Formal reminder will be given to supplier by the progress section.

**Salient features of official language rules 1976:**

- a. Communication to states etc. other than central govt. offices.
- b. Communication between central govt. offices.
- c. Replies to communications received in Hindi.
- d. Use of both Hindi & English.
- e. Application, representations.
- f. Proficiency in Hindi.
- g. Working knowledge of Hindi.
- h. Manuals, codes other procedural literature, articles of stationary.
- i. Responsibility for compliance.

**Regions as per official language act of India:**

Region A" means the States of Bihar, Haryana, Himachal Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand, Uttarakhand, Rajasthan and Uttar Pradesh and the Union Territories of Delhi and Andaman and Nicobar Islands.

"Region B" means the States of Gujarat, Maharashtra and Punjab and the Union Territory of Chandigarh, Daman and Diu and Dadra and Nagar Haveli.

"Region C" means the States and the Union Territories other than those referred to in Region A & Region B.

**Documents covered under section 3(3) of official language act 1963:**

Under the provision of Section 3(3) of Official Language Act, 1963 the following documents shall be issued both in Hindi and English languages:-

Resolutions, General Orders, Rules, Notifications, Administrative & other Reports, Press Communiqués, Administrative and other reports and official papers to be laid before a House or the Houses of Parliament, Contracts, Agreements, Licenses, Permits, Tender Notices, Tender Forms.

**Proficiency in Hindi:**

An employee shall be deemed to possess proficiency in Hindi if:-

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For Sr. D.M.E. (DSL)  
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**Proficiency in Hindi:**

An employee shall be deemed to possess proficiency in Hindi if:-

- he has passed the Matriculation or any equivalent or higher examination with Hindi as the medium of examination ; or
- he has taken Hindi as an elective subject in the degree examination or any other examination equivalent to or higher than the degree examination; or
- he declares himself to possess proficiency in Hindi in the form annexed to these rules.

**Working Knowledge of Hindi:**

An employee shall be deemed to have acquired a working knowledge of Hindi -

- If he has passed -
  - the Matriculation or an equivalent or higher examination with Hindi as one of the subjects ; or
  - the Pragma examination conducted under the Hindi Teaching Scheme of the Central Government or when so specified by that Government in respect of any particular category of posts, any lower examination under that Scheme ; or
  - any other examination specified in that behalf by the Central Government; or
- if he declares himself to have acquired such knowledge.

**TM Overhauling:**

a. **INITIAL RUNNING CHECK**

Check for the unusual sound and condition of the bearings and record details in FR/TMA/21

b. **DISMANTLING:**

Dismantle the all the parts and armature from magnetic frame and record the details of dismantling in FR/TMA/21. Also send the grease samples for laboratory and record the results in FR/TMA/02

c. **CLEANING :**

Blow with dry compressed air and clean with cleaning solvent.

d. **INSPECTION:**

Sl. No.	Component description	Parameter to be checked	Mode of inspection	Disposal
1	Magnet frame, Armature, Pinion	External damages	Visual	Renew
2	Bearings	Pitting and damage	Visual and magnifying glass	Renew
3	All parts of armature	External Damages	Visual	Renew

a) Check pinion for cracks in zyglon test.

b) After inspection insulation paint to be done to the frame and armature.

e. **TESTING :**

Perform the Tan Delta test for the armature whose value should be between 0.02 to 0.08 and the UST of PE and CE inner races.

f. **ASSEMBLING:**

a) Assemble all the parts of the traction motor and the following critical parts to be checked.

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Sl. No.	Component description	Parameter to be checked	Standard value	Mode of inspection	Disposal
1.	Magnet frame/Armature	Insulation resistance	$\geq 20 \text{ M.}\Omega$	Megger	Attend
2.	Armature	H.P test	1.3 KV	HP Test Kit	Sent to shops
3.	Armature	Drop test	All should be equal	Drop Test kit	attend
4.	Brush arm	Spring tension	4.5 to 5.0 kg/cm <sup>2</sup>	Tension gauge	Attend
5.	Traction motor	Endplay	0.008" to 0.016"	Dial gauge	attend
6.	Traction Motor	Collar Clearance	$> 0.010''$	Feeler guage	Attend or replace

g. The parameters of parts to be measured during assembly to be recorded.

h. FINAL RUNNING CHECK:

a) Check the Traction Motor visually in final running check.

**Overhauling of TRACTION GENERATOR/ TRACTION ALTERNATOR (ALCO):**

a. DISMANTLING

a) Remove gear case, Bull gear from the Alternator and separate the Rotor from the Stator.

b. CLEANING :

Clean with Kerosene Oil/Orion 77 solvent .Blow and clean the Rotor with cleaning solvent and bake it in an Oven for IR value improvement.

c. INSPECTION:

a) Check the IR Values of Stator and Rotor.

b) Check the following parameters of alternator and record.

Sl. No.	Component description	Parameter to be checked	Standard value	Mode of inspection	Disposal
1.	Stator/ Rotor	Physical damages	--	Visual	Attend/ Sent to shops
2.	Stator/ Rotor	Insulation resistance	$\geq 1 \text{ M.}\Omega$	Megger	Attend/ Sent to shops
3.	Bearings	Pitting marks and damages	--	Visual	Renew

c) If the above parameters are not satisfied send the Alternator to the shops.

d) After inspection bake the Stator and Rotor and apply insulated paint

d. ASSEMBLING:

Assemble all the parts of Alternator.

**Cranking procedure of WDG4/WDP4 locos:**

WDP4 / WDG4 Locomotive Cranking Procedure


1. Put on the hand brake.

2. Check oil and coolant water levels.

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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.
11. On the circuit breaker panel • Put on all circuit breakers.
12. On Computer select starting system
  - Main Menu, • Data Meter • Starting system
13. TLPR shows on (Turbo Cooling Cycle Starts), now engine is ready for cranking.
14. 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 to 20 minutes and try again.
15. 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.
16. Turn the Engine PRIME / ENGINE START switch to ENGINE START side, 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.

  
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