

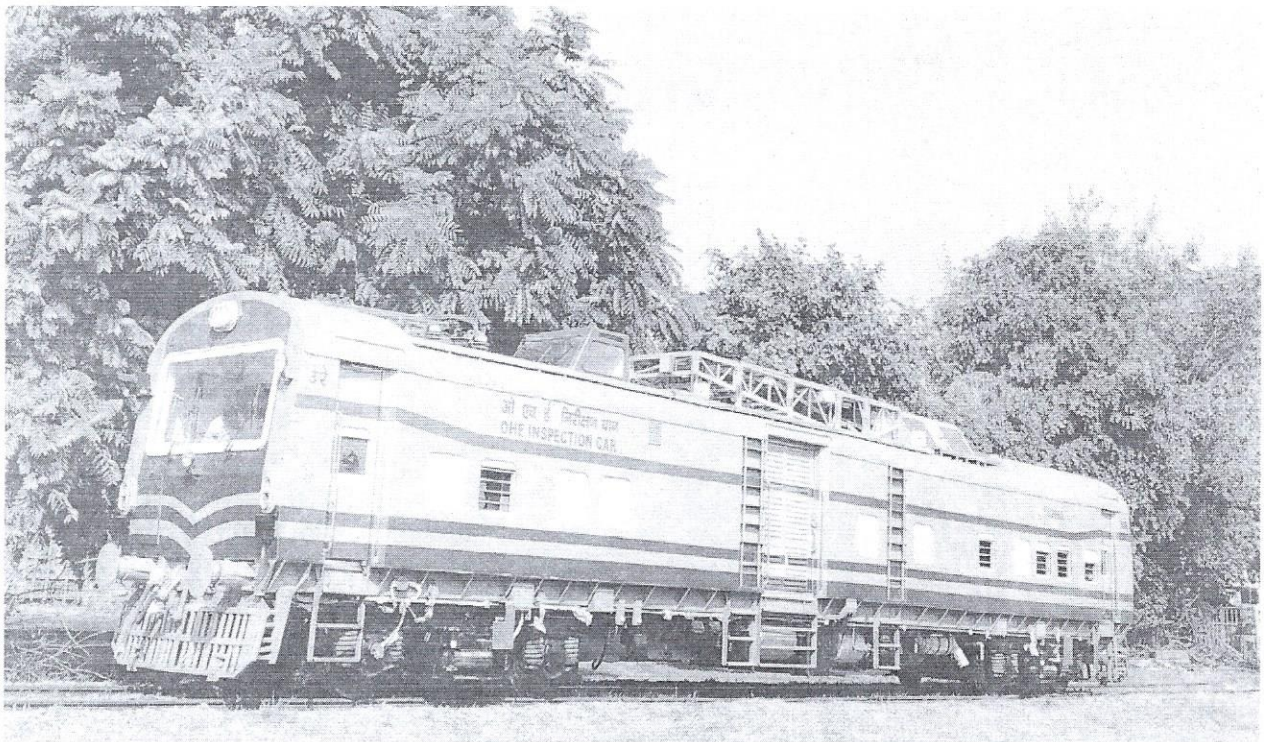


भारतीय रेल

INDIAN RAILWAYS

डीजल रेलइंजिन आधुनिकीकरण कारखाना, पटियाला

DIESEL LOCO MODERNISATION WORKS, PATIALA



**HISTORY & TESTING RECORD OF 8W-DIESEL
ELECTRIC TOWER CAR**

DETC NO.	: 200031
TYPE	: 8 WHEELS
RAILWAY/DIVISION	: HWH/ER
ELECTRIC TRACTION	: BHEL

निर्माण रिकार्ड



डीजल रेलइंजिन आधुनिकीकरण कारखाना, पटियाला

DIESEL LOCO MODERNISATION WORKS, PATIALA

DETC NO. 200031

RAILWAY/SHED: HWH/ER

DOD: NOVEMBER 2020

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DIESEL LOCO MODERNISATION WORKS, PATIALA
Testing & Commissioning Format For 8W Diesel Electric Tower Car (DETC)

DETC no. M-83

PROJECT	Diesel Electric Tower Car with Under-Slung Propulsion
CUSTOMER	DMW, PATIALA
DETC DMW NO.	<u>M-83</u> (200031)
DETC RLY/SHED	NER Sr. DEE/TRD/HWH.
Date of Dispatch	19-11-2020

DETC COMMISSIONING PROTOCOL :

SUBMITTED BY CGL/BHEL: ✓ Kamlesh Yadav

Name

Date

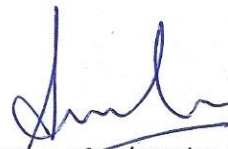
Signature

VERIFIED BY DMW: AMBER SHARMA 19-11-2020

Name

Date

Signature


Signature of JE/SSE (Testing)

DIESEL LOCO MODERNISATION WORKS, PATIALA
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1.0 DETC Installed & Tested Equipments:

Equipment	Make	Serial No.
Diesel Engine -1	CUMMINS	25455271
Diesel Engine -2	CUMMINS	25455749
Traction Alternator-1	BHEL	4746271
Traction Alternator-2	BHEL	4746272
Power Rectifier- 1	BHEL	582220225
Power Rectifier-2	BHEL	582220226
Traction Motor-1		
Traction Motor-2		
Traction Motor-3		
Traction Motor-4		
Auxiliary Alternator-1	BHEL	200571537
Auxiliary Alternator -2	BHEL	200571531
Rectifier Regulator Unit- 1	KEL/BHEL	200571C536
Rectifier Regulator Unit -2	KEL/BHEL	200571C532
Control Cubicle-1	BHEL	200CAB1030
Control Cubicle-2	BHEL	200CAB2030
Driver Desk-1	BHEL	20000DD061
Driver Desk-2	BHEL	20000DD062
Master Controlleer-1	BHEL	STMC-0220-0567
Master Controlleer-2	BHEL	STMC-0220-0572
Driver Control Switch-1	BHEL	06200515
Driver Control Switch-2	BHEL	06200520
MSGC	BHEL	200MSG027
Resistor Panel	BHEL	582220307/308

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2.0 SEQUENTIAL TEST

Purpose

Sequence test of control circuits.

Measuring and Testing Equipment, Auxiliary Equipment

- Digital Multimeter
- Continuity tester
- Wago connector
- DCS key
- Master Controller Unlock key
- DC Ammeter
- Insulation Tester
- All Electrical Circuit Schematics

Test Status

Individual test performance is recorded against each test performed.

Test Implementation

The fully completed routine test record is the only valid document to demonstrate that the routine test has been successfully completed. The Performed ok column in this routine test instruction merely serves the purpose of engaging the tester to verify the test progress.

All test steps in a chapter must have been successfully performed. If a test has been unsuccessful, the cause or causes must be established and remedied so that the test item can subsequently be tested with possible result. Before testing sequence test, all continuity test points are to be cleared.

Procedural Notes:

1. Disconnect all electronic system prior to Megger, Hi pot test and during welding.
3. Use DIGITAL multimeter only to check continuity and to read test point voltages.
4. Ensure that test lead does not touch body or ground during measurement of low voltage sources.

2.1 Visual Inspection

2.1.1 Rotating Equipment

Operation	Performed
• Inspect the rotating equipment for the following (Tr. Alternator, Tr. Motor, Aux alternator)	<input checked="" type="checkbox"/>

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• No unwanted materials should be lying inside the machines.	<input checked="" type="checkbox"/>
• No loose wires/ terminals should be available near the machines.	<input checked="" type="checkbox"/>
• Ensure that the mounting bolts have been properly torque checked and marked.	<input checked="" type="checkbox"/>
• Ensure that High Voltage electrical terminals are not exposed.	<input checked="" type="checkbox"/>
• Check availability of warning boards	<input checked="" type="checkbox"/>

2.1.2 Control Equipment and Wiring

Operation	Performed
• There should not be any loose hanging wires near the equipment / terminal boards.	<input checked="" type="checkbox"/>
• Ensure all components are loaded and connections are intact.	<input checked="" type="checkbox"/>
• Ensure all connectors are coupled tightly.	<input checked="" type="checkbox"/>

2.1.3 Checking of TM chain cleat arrangement between TM Junction box to TM

S.No.	Equipment	Available	Not Available
1.	Traction motor1	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2.	Traction motor2	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3.	Traction motor3	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4.	Traction motor4	<input checked="" type="checkbox"/>	<input type="checkbox"/>

2.1.4 Inspection of Air ducts & Bellows before lowering DETC on bogies

Operation	Performed
• Traction Motor ducts are free from dirt and any foreign particle	<input checked="" type="checkbox"/>
• No welding pore holes found in the TM bellows	<input checked="" type="checkbox"/>
• Traction Motor bellows are free from damages	<input checked="" type="checkbox"/>

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2.1.5 Inspection of Availability and Integration of Fuses

S.No.	Location	Fuse Rating	Available	Not Available
1	EQ.PANEL, 308-341	63A	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2	CC1, 341 – 311	32 A	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3	EQ Panel, 307 – 308	63 A	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4	CC1, 300 – 320	63 A	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5	Power Rectifier 1, F1-F9	550 A	<input checked="" type="checkbox"/>	<input type="checkbox"/>
6	Power Rectifier 2, F1-F9	550 A	<input checked="" type="checkbox"/>	<input type="checkbox"/>

3.0 Continuity Test

NOTE: CP and Driver desk are pre wired and continuity is already checked. Only external wiring and sensors cables continuity needs to be checked.

3.1 Grounding Cables Check

S.No.	EQUIPMENT	QUANTITY	AVAILABILITY	TIGHTNESS
1.	Tr. Alternator 1	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2.	Tr. Alternator 2	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3.	Power Rectifier 1	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4.	Power Rectifier 2	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5.	Traction Motor 1	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
7.	Traction Motor 2	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
8.	Traction Motor 3	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

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9.	Traction Motor 4	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
10.	Control Cubicle 1	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
11.	Driver Desk 1	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12.	Control Cubicle 2	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
13.	Driver Desk 2	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
14.	MSGC	2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

4.0 IR & HV Test for Power Circuit

4.1 Control Circuit

Operation	Performed
• Disconnect battery cables at the battery terminals of Control battery	<input checked="" type="checkbox"/>
• Close the battery switch BIS110	<input checked="" type="checkbox"/>
• Keep battery Switch (BCS 24) in open condition	<input checked="" type="checkbox"/>
• Switch ON all switches and circuit breakers on the CP&DD	<input checked="" type="checkbox"/>
• Open ground cut out switches GRCO-1 & 2	<input checked="" type="checkbox"/>
• Insert DCS key and turn ON	<input checked="" type="checkbox"/>
• Insert MC key and turn ON	<input checked="" type="checkbox"/>
• Move ECS Switch to "RUN" position	<input checked="" type="checkbox"/>
• Move Reverser handle to Forward or Reverse position	<input checked="" type="checkbox"/>
• Move the Master Handle (MH) to 6th notch position on DD	<input checked="" type="checkbox"/>
• Remove LCC 1 and LCC 2 connections	<input checked="" type="checkbox"/>
• Disconnect LED panel from the circuit	<input checked="" type="checkbox"/>
• Remove connector for Power rectifier 1 and 2	<input checked="" type="checkbox"/>

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4.2 Power Circuit

Operation	Performed
<u>Rectifier</u>	
• Disconnect positive (+ve) and negative (-ve) cables at the rectifier.	<input checked="" type="checkbox"/>
• Short rectifier positive (+ve) and negative (-ve) terminals.	<input checked="" type="checkbox"/>
• Short all the cables which are disconnected from rectifier.	<input checked="" type="checkbox"/>

The insulation resistance test is carried out with 1000 V Megger. Measure insulation resistance between shorted power cables at rectifier and body.

4.3 Procedure

4.3.1 Control circuit

The insulation resistance test is carried out with 500V Megger. Measure insulation resistance between wire terminals 300/100 and body

4.3.2 Power circuit - Rectifier

The insulation resistance test is carried out with 1000V Megger. Measure insulation resistance between shorted power cables at rectifier and body.

4.3.3 Observation

Test Condition	Acceptance Criteria	Observed
Power.Circuit IR	> 5M Ohm	2000 M-Ω
Control Circuit (DC 110V and 24V)	> 1M Ohm	3 M-Ω

5.0 High Voltage test

5.1 Procedure

5.1.1 Control Circuit

High Voltage test is carried out at 2.5 KV AC voltages. The test voltage is applied between wire terminals 300/100 and body and should withstand for 01 minute.

5.1.2 Power Circuit

High Voltage test is carried out at 2.5 KV AC voltages. The test voltage is applied between shorted power cables at rectifier and body and should with stand for 01 minute.

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5.1.3 Observation

HV tester should not trip within 60 seconds in each of the above tests

Parameter	Control circuit		Power Circuit	
	Acceptance Criteria	Observed	Acceptance Criteria	Observed
Voltage Applied	1300 V AC	OK	2500 V AC	OK
Leakage Current	100mA	OK	100 mA	OK
Time Applied	60 Second	OK	60 Second	OK

5.1.4 Post Test Operations

Operation	Performed
• Remove all shorting wires on the terminals	<input checked="" type="checkbox"/>
• Restore all power cable connections	<input checked="" type="checkbox"/>
• Connect the all removed connectors	<input checked="" type="checkbox"/>

5.1.5 Batteries (110V & 24V)

Operation	Performed
• Ensure that interconnecting cables between each battery is connected and are tight.	<input checked="" type="checkbox"/>
• Check the polarity of each battery and ensure that all are connected in series.	<input checked="" type="checkbox"/>
• Connect the battery cable 308 at battery positive and 300 at battery negative terminal for 110V Battery.	<input checked="" type="checkbox"/>
• Connect the battery cable 201 at battery positive and 200 at battery negative terminal for 24V Battery.	<input checked="" type="checkbox"/>
• Measure the voltage of the battery at equipment panel or at battery charging socket using digital Multimeter. The voltage should be more than 100V across 308 and 300 terminals.	<u>110 V DC</u>

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- Measure the voltage of the battery at equipment panel or at Knife Switch using digital Multimeter. The voltage should be more than 24V across 201 and 200/210 terminals.

24 V DC

Wait for one or two minutes after switching ON each Circuit breaker and observe for any overheating symptoms like smell, smoke, temperature etc. from the wire bunches. If any such symptoms are noticed there might be short circuit in wire bunch, check continuity in suspected area. Switch ON the following Circuit Breakers and ensure the circuit functionality is correct.

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6.0 SEQUENCE TEST (Auxiliary Circuit)

Sr.no	Operation	Effect	Location	Performed in Cab-1
1	Turn 110 V BCS in 3 o'clock position and measure voltage between Cable No. 311 and 300	≈ 110 V	311 as positive.	<input checked="" type="checkbox"/>
2	Turn ON EL+ MCB and check voltage between wire EL+ with respect to EL-.	≈ 110 V	EL- as negative	<input checked="" type="checkbox"/>
3	Turn ON CFD MCB and CFDS toggle switch	≈ 110 V	Cab Fan Driver side should operate	<input checked="" type="checkbox"/>
4	Turn ON LLD MCB and LLDS toggle switch	≈ 110 V	Cab Light Driver side should operate	<input checked="" type="checkbox"/>
5	Turn ON SPLD/SPLG MCB followed by Turn On SPLDS & SPLGS toggle switch	≈ 110 V	Spot light Driver side should operate. Spot light Guard side should operate	<input checked="" type="checkbox"/>
6	Turn ON Aux MCB and HLS,SM,V MCB and switch on 110 Voltmeter toggle switch	≈ 110 V	The voltmeter should read 110V approx.	<input checked="" type="checkbox"/>
			Speedometer should turn ON.	<input checked="" type="checkbox"/>
			110V Supply should be available at HLS on Control Cubicle and Driver Desk.	<input checked="" type="checkbox"/>
			Horn Push Buttons on Driver side and Guard Side should operate.	<input checked="" type="checkbox"/>
			Foot operated horn Switch should work.	<input checked="" type="checkbox"/>
6.1	Turn ON Aux MCB and Tail light/Flasher Light MCB and switch on Tail light Toggle switch on Driver Desk.	≈ 110 V	Tail light should operate	<input checked="" type="checkbox"/>
	Turn ON Flasher Light Toggle Switch on Driver Desk.		Flasher Light should operate at both converters.	<input checked="" type="checkbox"/>

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6.2	Turn ON Aux MCB and Marker light MCB and Marker light toggle switch on Driver Desk.	≈ 110 V	Marker light should operate	<input checked="" type="checkbox"/>
6.3	Turn ON Aux MCB and Head Light MCB and Toggle switch in Driver Desk	≈ 110 V	Head Light Should ON/OFF in Converter-1 and Dim/Bright	<input checked="" type="checkbox"/>
		≈ 110 V	Head Light Should ON/OFF in Converter-2 and Dim/Bright	<input checked="" type="checkbox"/>
6.3.1	Turn ON Aux MCB and Head Light MCB and Toggle switch in Driver Desk and Turn OFF Tail Light Toggle switch in Rear Cab.	≈ 110 V	Tail Light Should ON/OFF in Rear Side (Converter-1).	<input checked="" type="checkbox"/>
		≈ 110 V	Tail Light Should ON/OFF in Rear side (Converter-2).	<input checked="" type="checkbox"/>
6.4	Turn ON Aux MCB and HT Sensor MCB	≈ 110 V	Green LED should glow in HT Sensor Display unit.	<input checked="" type="checkbox"/>

6.1 SEQUENCE TEST (Control Circuit 110V & 24V)

S.No.	Operation	Condition	Performed in Cab- I
1	Ensure 110V Supply across Cable No. 1600 & 320.	SUPPLY(+) FROM BATTERY+BCS(4 POLE) ON+SYSTEM CONTROL MCB-ON & SUPPLY (-) FROM BATTERY THROUGH 63A FUSE	<input checked="" type="checkbox"/>
2	Supply to MASTER CONTROLLER(MC)	OPERATION1+CONTROL MCB ON+CONTROL ON/OFF SWITCH ON (Ensure the +ve 110V supply at 1602).	<input checked="" type="checkbox"/>
3	EMY RELAY (EMR) ON	OPERATION1+CONTROL MCB ON+CONTROL ON/OFF SWITCH ON+EMY TRACTION CUT-OFF PB ON	<input checked="" type="checkbox"/>
4	DMR RELAY ON	OPERATION1+DMMV MCB ON (Ensure 110V +ve available at Cable Nos. 1732 and 1734).	<input checked="" type="checkbox"/>
5	DEAD MAN VALVE-ACTIVE	OPERATION 1+DMMV MCB ON+EMY RELAY ON+DEAD MAN RELAY ON+Operate F/R Switch on MC+Operate Master Handle on MC.	<input checked="" type="checkbox"/>
6	GOV1 EXC RELAY (ER1) ON	OPERATION1+EXC MCB ON+DCS ON+TSS(TEST)+EXC ON/OFF SWITCH ON+ECS (RUN)+GOV1 CONTROL MCB ON+EMR ON+R11 RELAY ON+S11 ON	<input checked="" type="checkbox"/>

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S.No.	Operation	Condition	Performed In Cab- I
7	GOV2 EXC RELAY (ER2) ON	OPERATION1+EXC MCB ON+DCS ON+TSS(TEST)+EXC ON/OFF SWITCH ON+ECS (RUN)+GOV2 CONTROL MCB ON+EMR ON+R12 RELAY ON+S12 QN	<input checked="" type="checkbox"/>
8	EXC CONTROL RELAY-1 (ECR-1) ON	OPERATION1+CONTROL MCB ON+CONTROL ON/OFF SWITCH ON+Operate F/R in MC+MC(Notch-1 to 8) +ALT EXC MCB ON +GFR INOPERATIVE+ER1 ON+SR1 OFF+{LC1(CLOSE)/LC3(CLOSE)}	<input checked="" type="checkbox"/>
9	EXC CONTROL RELAY-2 (ECR-2) ON	OPERATION1+CONTROL MCB ON+CONTROL ON/OFF SWITCH ON+Operate F/R in MC+MC(Notch-1 to 8) +ALT EXC MCB ON +GFR INOPERATIVE+ER2 ON+SR2 OFF+{LC1(CLOSE)/LC3(CLOSE)}	<input checked="" type="checkbox"/>
10	RCFR1 RELAY ON	OPERATION1+FAULT INDICATION MCB ON+DCS ON+RCFR-1 Toggle Switch {SS-4 SWITCH ON}	<input checked="" type="checkbox"/>
11	SAFETY RELAY1 ON	OPERATION1+FAULT INDICATION MCB ON+DCS ON+ {LPR RELAY ON/ RCFR1 RELAY ON/R11 RELAY ON/ RL21 RELAY ON}	<input checked="" type="checkbox"/>
12	RCFR2 RELAY ON	OPERATION1+FAULT INDICATION MCB ON+DCS ON+{SS-5 SWITCH ON}	<input checked="" type="checkbox"/>
13	SAFETY RELAY 2 ON	OPERATION1+FAULT INDICATION MCB ON+DCS ON+ {LPR RELAY ON/ RCFR2 RELAY ON/R12 RELAY ON/ RL22 RELAY ON}	<input checked="" type="checkbox"/>
14	PARKING BRAKE APPLICATION MAGNET VALVE ACTIVE	OPERATION1+PARKING BRAKE MCB ON+DCS ON+PRESS PARKING BRAKE APPLICATION BUTTON ON	<input checked="" type="checkbox"/>
15	PARKING BRAKE RELEASE MAGNET VALVE ACTIVE	OPERATION1+PARKING BRAKE MCB ON+DCS ON+PRESS PARKING BRAKE RELEASE PUSH BUTTON	<input checked="" type="checkbox"/>
16	COMPRESSOR -1/2 UNLOADER VALVE ACTIVE	OPERATION1+COMPRESSOR UNLOADER MCB ON+COMPRESSOR GOVERNOR ACTIVE	<input checked="" type="checkbox"/>
17	AIR DRIER ACTIVE	OPERATION1+COMPRESSOR UNLOADER MCB ON+ COMPRESSOR GOVERNOR INACTIVE	<input checked="" type="checkbox"/>
18	CUT OUT RELAY (COR1 &2) ON	OPERATION1+OPERATION2+MC (NOTCH 4 & 8)+MCS1/MCS2 OPERATE	<input checked="" type="checkbox"/>

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S.No.	Operation	Condition	Performed In Cab- I
19	PANTO MAGNET VALVE ACTIVE	OPERATION-1+CONTROL MCB ON+DCS ON+ +PANTO UP DOWN PRESSURE SWITCH ON+PANTO UP INDICATION	<input checked="" type="checkbox"/>
20	SUPPLY TO CAMERA UNIT	OPERATION1+CCTV MCB ON	<input checked="" type="checkbox"/>
21	SUPPLY TO TELEPHONE EXCHANGE SYSTEM	OPERATION1+TELEPHONE EXCHANGE MCB ON+AUX MCB ON	<input checked="" type="checkbox"/>
22	CFG ON	OPERATION1+[F+] MCB ON+CFG MCB ON+CFG SWITCH ON	<input checked="" type="checkbox"/>
23	LLG ON	OPERATION1+[L+] MCB ON+LLG/CL MCB ON+LLGS SWITCH ON	<input checked="" type="checkbox"/>
24	CLS ON	OPERATION1+LLG/CL MCB ON+CL SWITCH ON	<input checked="" type="checkbox"/>
25	BM1 MOTOR ON	Ensure Supply at Cable No. 305 & 300+BM1 MCB ON	<input checked="" type="checkbox"/>
26	BM2 MOTOR ON	Ensure Supply at Cable No. 306 & 300+BM2 MCB ON	<input checked="" type="checkbox"/>
27	AAFR1 RELAY ON	Ensure Supply at Cable No. 301 and 300.	<input checked="" type="checkbox"/>
28	AAFR2 RELAY ON	Ensure Supply at Cable No. 301 and 300.	<input checked="" type="checkbox"/>
29	BATTERY CHARGING(120 AH)	OPERATION1	<input checked="" type="checkbox"/>
30	SUPPLY TO HEATER UNIT	OPERATION1+HEATER MCB ON	<input checked="" type="checkbox"/>
31	AEFR RELAY ON	OPERATION1+FAULT INDICATION MCB ON+DCS ON+AEFR-AUX (OFF)+AEFR CO CLOSE	<input checked="" type="checkbox"/>
32	AEFR-AUX RELAY ON	OPERATION1+ DCS ON+ FAULT INDICATION MCB ON+AEFR RELAY ON	<input checked="" type="checkbox"/>
33	SUPPLY TO CHARGING SOCKET	OPERATION1+CHARGING SOCKET MCB ON	<input checked="" type="checkbox"/>
34	SUPPLY TO CHARGING SOCKET (DESK)	OPERATION1+CHARGING SOCKET MCB ON	<input checked="" type="checkbox"/>
35	SUPPLY TO 24V SYSTEM	SUPPLY TO BATTERY CHARGER+BIS (CLOSE)+ENG1 PROTECTION MCB ON+ENG2 PROTECTION MCB ON+Ensure 24V across Cable No. 201 & 210.	<input checked="" type="checkbox"/>
36	FOG LIGHT ON	OPERATION 35+24V -VE AUX MCB ON+FGL MCB ON+TURN ON FOG LIGHT TOGGLE SWITCH	<input checked="" type="checkbox"/>

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37	SEARCH LIGHT ON	OPERATION 35+24V -VE AUX MCB ON+SL MCB ON+TURN ON SEARCH LIGHT TOGGLE SWITCH	<input checked="" type="checkbox"/>
38	BATTERY CHARGING AMMETER 1 READING	SUPPLY TO BATTERY CHARGER+BIS (CLOSE)	<input checked="" type="checkbox"/>
39	BATTERY CHARGING AMMETER 2 READING	SUPPLY TO BATTERY CHARGER+BIS (CLOSE)	<input checked="" type="checkbox"/>
40	SUPPLY TO SPU1	OPERATION 35+R81 RELAY ON+R91 RELAY ON+S11 RELAY ON+TR11 TIMER (OFF)+ENG 1 SPU MCB ON	<input checked="" type="checkbox"/>
41	SUPPLY TO SPU2	OPERATION 35+R82 RELAY ON+R92 RELAY ON+S12 RELAY ON+TR12 TIMER (OFF)+ENG 2 SPU MCB ON	<input checked="" type="checkbox"/>
42	LOCAL RESET RELAY1 (LRR1) ON	OPERATION 35+LOCAL REMOTE SWITCH1(L)+LOCAL ENG-1 OFF PB(OFF)+PRESS LOCAL RESET PB ENG1(US)	<input checked="" type="checkbox"/>
43	LOCAL RESET RELAY2 (LRR2) ON	OPERATION 35+LOCAL REMOTE SWITCH2(L)+LOCAL ENG-2 OFF PB(OFF)+PRESS LOCAL RESET PB ENG2(US)	<input checked="" type="checkbox"/>
44	LOCAL ON/OFF RELAY 1 (R81) ON	OPERATION 35+ FC21 RELAY (OFF)+LOCAL REMOTE SWITCH1 (L)+LOCAL ENG-1 OFF PB(OFF)+PRESS LOCAL ENG-1 ON PB(US)	<input checked="" type="checkbox"/>
45	LOCAL ON/OFF RELAY 2 (R82) ON	OPERATION 35+ FC22 RELAY (OFF)+LOCAL REMOTE SWITCH2 (L)+LOCAL ENG-2 OFF PB(OFF)+PRESS LOCAL ENG-2 ON PB(US)	<input checked="" type="checkbox"/>
46	REMOTE ON/OFF RELAY1 (R91) ON	OPERATION 35+LOCAL REMOTE SWITCH1 (R)+OPERATE DCS ENG-1 ON SWITCH+S11 RELAY ON	<input checked="" type="checkbox"/>
47	REMOTE ON/OFF RELAY2 (R92) ON	OPERATION 35+LOCAL REMOTE SWITCH2 (R)+OPERATE DCS ENG-2 ON SWITCH+S12 RELAY ON	<input checked="" type="checkbox"/>
48	TR11 TIMER (ON)+TR21 TIMER (ON)+HM1(ACTIVE)	OPERATION 35+R81 RELAY (ON)/R91 RELAY (ON)	<input checked="" type="checkbox"/>
49	TR12 TIMER (ON)+TR22 TIMER (ON) +HM2(ACTIVE)	OPERATION 35+R82 RELAY (ON)/R92 RELAY (ON)	<input checked="" type="checkbox"/>
50	R31 RELAY (HCWT-1 IND) ON	OPERATION 35+ENG1 SAFETY MCB1 ON+TS11(91°C) CONTACT (CLOSE)	<input checked="" type="checkbox"/>
51	R32 RELAY (HCWT-2 IND) ON	OPERATION 35+ENG2 SAFETY MCB1 ON+TS12(91°C) CONTACT (CLOSE)	<input checked="" type="checkbox"/>
52	R11 RELAY (HCWT-1) ON	OPERATION 35+ENG 1 SAFETY MCB1 (ON)+ TS11(96°C) CONTACT (CLOSE)+{RR1 RELAY(ON)/LRR1 RELAY(ON)}	<input checked="" type="checkbox"/>

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S.No.	Operation	Condition	Performed In Cab- I
53	R12 RELAY (HCWT-2) ON	OPERATION 35+ENG 2 SAFETY MCB1 (ON)+ TS11(96°C) CONTACT (CLOSE)+{RR2 RELAY(ON)/LRR2 RELAY(ON)}	<input checked="" type="checkbox"/>
54	R41 RELAY (LLOP-1) ON	OPERATION 35+ENG 1 SAFETY MCB1 (ON)+{RR1 RELAY(ON)/LRR1 RELAY(ON)/PS11 CONTACT(CLOSE)}	<input checked="" type="checkbox"/>
55	R42 RELAY (LLOP-2) ON	OPERATION 35+ENG 2 SAFETY MCB1 (ON)+{RR2 RELAY(ON)/LRR2 RELAY(ON)/PS12 CONTACT(CLOSE)}	<input checked="" type="checkbox"/>
56	R51 RELAY (OS-1) ON	OPERATION 35+ENG1 SAFETY MCB1(ON){RR1 RELAY(ON)/LRR1 RELAY (ON)+LM CONNECTOR TO BE CONNECTED IN LCC B1	<input checked="" type="checkbox"/>
57	R52 RELAY (OS-2) ON	OPERATION 35+ENG2 SAFETY MCB1(ON){RR2 RELAY(ON)/LRR2 RELAY (ON)+ LM CONNECTOR TO BE CONNECTED IN LCC B1	<input checked="" type="checkbox"/>
58	R71 RELAY (HOF-1) ON	OPERATION 35+ENG 1 SAFETY MCB1(ON)+{RR1 RELAY (ON)/LRR1 RELAY(ON)+LIMIT SWITCH AT HYDRAULIC TANK(DE-ENGAGED)	<input checked="" type="checkbox"/>
59	R72 RELAY (HOF-2) ON	OPERATION 35+ENG 2 SAFETY MCB1(ON)+{RR2 RELAY (ON)/LRR2 RELAY(ON)+ LIMIT SWITCH AT HYDRAULIC TANK(DE-ENGAGED)	<input checked="" type="checkbox"/>
60	FC21 RELAY (ENG-1 TRIP) ON	OPERATION 35+ENG 1 SAFETY MCB1(ON)+{R21 RELAY(OFF)/R41 RELAY(OFF)/R51 RELAY(OFF)/R61 RELAY(OFF)/R71 RELAY (OFF)}	<input checked="" type="checkbox"/>
61	FC22 RELAY (ENG-2 TRIP) ON	OPERATION 53+ENG 2 SAFETY MCB1(ON)+{R22 RELAY(OFF)/R42 RELAY(OFF)/R52 RELAY(OFF)/R62 RELAY(OFF)/R72 RELAY (OFF)}	<input checked="" type="checkbox"/>
62	R21 RELAY (LHOL) ON	OPERATION 53+ENG 1 SAFETY MCB2(ON){RR1 RELAY (ON)/LRR1 RELAY(ON)}	<input checked="" type="checkbox"/>
63	R22 RELAY (LHOL) ON	OPERATION 53+ENG 2 SAFETY MCB2(ON){RR2 RELAY (ON)/LRR2 RELAY(ON)}	<input checked="" type="checkbox"/>
64	R61 RELAY (LCWL-1) ON	OPERATION 53+ENG 1 SAFETY MCB2(ON){RR1 RELAY (ON)/LRR1 RELAY(ON)}	<input checked="" type="checkbox"/>
65	R62 RELAY (LCWL-2) ON	OPERATION 53+ENG 2 SAFETY MCB2(ON){RR2 RELAY (ON)/LRR2 RELAY(ON)}	<input checked="" type="checkbox"/>
66	S11 RELAY (ENG-1 ON) ON	OPERATION 1+ENGINE CONTROL SUPPLY MCB(ON)+DCS ON+ECS(IDLE)+OPERATE ENG1 ON SWITCH(ON)+ FC21 RELAY(OFF)	<input checked="" type="checkbox"/>

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67	S12 RELAY (ENG-2 ON) ON	OPERATION 1+ENGINE CONTROL SUPPLY MCB(ON)+DCS ON+ECS(IDLE)+OPERATE ENG2 ON SWITCH(ON)+ FC22 RELAY(OFF)	<input checked="" type="checkbox"/>
68	RR1+ RR2 RELAYS (REMOTE READY TO START) ON	OPERATION1+CONTROL MCB(ON)+READY TO START MCB(ON)+Ensure +ve 110V supply at Cable No. 1661+ OPERATE READY TO START SWITCH IN DCS	<input checked="" type="checkbox"/>
69	S13 RELAY (ENG-1 OFF) ON	OPERATION1+ENGINE CONTROL SUPPLY MCB(ON)+DCS ON+ECS(IDLE)+OPERATE ENG-1 OFF SWITCH IN DCS	<input checked="" type="checkbox"/>
70	S14 RELAY (ENG-2 OFF) ON	OPERATION1+ENGINE CONTROL SUPPLY MCB(ON)+DCS ON+ECS(IDLE)+OPERATE ENG-2 OFF SWITCH IN DCS	<input checked="" type="checkbox"/>
71	TRACTION CONTROL SUPPLY ON LED(ON)	OPERATION1+CONTROL MCB ON +LAMP TEST MCB ON+LAMP TEST SWITCH ON+CONTROL ON/ OFF SWITCH ON	<input checked="" type="checkbox"/>
72	ENGINE 1 ON LED(ON)	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+LAMP TEST SWITCH ON+ DCS ON+S11 RELAY ON	<input checked="" type="checkbox"/>
73	ENGINE 2 ON LED(ON)	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+LAMP TEST SWITCH ON+ DCS ON+S12 RELAY ON	<input checked="" type="checkbox"/>
74	ENGINE 1 TRIP LED(ON)	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+FC21 RELAY ON	<input checked="" type="checkbox"/>
75	ENGINE 2 TRIP LED(ON)	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+FC22 RELAY ON	<input checked="" type="checkbox"/>
76	MOTOR EARTH FAULT LED(ON)	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON +DCS ON+GR RELAY ON	<input checked="" type="checkbox"/>

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S.No.	Operation	Condition	Performed In Cab- I
77	PARKING BRAKE APPLICATION LED	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+OPERATE PBG APPL SWITCH	<input checked="" type="checkbox"/>
78	ALTERNATOR1 EXCTATION ON LED(ON)	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+ECR1 RELAY ON	<input checked="" type="checkbox"/>
79	ALTERNATOR2 EXCTATION ON LED(ON)	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+ECR2 RELAY ON	<input checked="" type="checkbox"/>
80	HCWT ENG1 LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+R31 RELAY OFF	<input checked="" type="checkbox"/>
81	HCWT ENG2 LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+R32 RELAY OFF	<input checked="" type="checkbox"/>
82	AUX ALT 1 FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+AAFR1 RELAY OFF	<input checked="" type="checkbox"/>
83	AUX ALT 2 FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+AAFR2 RELAY OFF	<input checked="" type="checkbox"/>
84	RECT1 FUSE FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+RL11 RELAY ON(In Rect-1)	<input checked="" type="checkbox"/>
85	RECT2 FUSE FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+RL12 RELAY ON(In Rect-2)	<input checked="" type="checkbox"/>

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S.No.	Operation	Condition	Performed In Cab- I
86	RECT1 COOL FAN FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON +DCS ON+RCFR1 RELAY OFF	<input checked="" type="checkbox"/>
87	RECT2 COOL FAN FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON +DCS ON+RCFR2 RELAY OFF	<input checked="" type="checkbox"/>
88	GOV-1 SUPPLY FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+ER1 RELAY OFF	<input checked="" type="checkbox"/>
89	GOV-2 SUPPLY FAILURE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+ER2 RELAY OFF	<input checked="" type="checkbox"/>
90	TRACTION MOTOR OVERLOAD LED ON	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+{MOLR1/MOLR2/MOLR3/MOLR4} RELAY ON	<input checked="" type="checkbox"/>
91	PANTO UP LED ON	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+PANTO GOVERNOR CONTACT(CLOSE)RELAY ON	<input checked="" type="checkbox"/>
92	DEAD MAN BRAKE APPL LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+DMR RELAY OFF	<input checked="" type="checkbox"/>
93	AUX EARTH FAULT LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+AEFR ON+AEFR(AUX) RELAY ON	<input checked="" type="checkbox"/>
94	LOW LUBE OIL PRESSURE ENG1 LED ON	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+R41 RELAY OFF	<input checked="" type="checkbox"/>
95	LOW LUBE OIL PRESSURE ENG2 LED ON	OPERATION1+FAULT INDICATION MCB ON+ LAMP TEST MCB ON+DCS ON+R42 RELAY OFF	<input checked="" type="checkbox"/>

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96	ENGINE1 IDLE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON +DCS ON+ECR1 RELAY OFF+S11 RELAY (ON)	<input checked="" type="checkbox"/>
97	ENGINE2 IDLE LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON +DCS ON+ECR2 RELAY OFF+S12 RELAY (ON)	<input checked="" type="checkbox"/>
98	EMY TRACTION CUT OFF LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+EMR RELAY ON	<input checked="" type="checkbox"/>
99	LUBE OIL TEMP TOO HIGH ENG1 LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+LUBE OIL TEMP SW ENG1(OPEN)	<input checked="" type="checkbox"/>
100	LUBE OIL TEMP TOO HIGH ENG2 LED ON	OPERATION1+FAULT INDICATION MCB ON+LAMP TEST MCB ON+DCS ON+LUBE OIL TEMP SW ENG2(OPEN)	<input checked="" type="checkbox"/>
101	REV1 FOR(ON)	TO GIVE EXTERNAL AIR PRESSURE (5-7 kg/SqCm) TO EQUIPMENT GOVERNOR+OPERATION1+OPERATION2+ECS- RUN(CLOSE)+MASTER CONTROLLER(19-20)	<input checked="" type="checkbox"/>
102	REV1 REV(ON)	TO GIVE EXTERNAL AIR PRESSURE TO EQUIPMENT GOVERNOR+OPERATION1+OPERATION2+{ECS- RUN(CLOSE)/TSS(ON)}+MASTER CONTROLLER(23-24)	<input checked="" type="checkbox"/>
103	LC1+LC3 (ON)	TO GIVE EXTERNAL AIR PRESSURE TO EQUIPMENT GOVERNOR+{OPERATION 99/OPERATION 100}+SS1 ON+SS2 ON+SS3 ON+GROUND RELAY(OFF)+SAFETY RELAY1(OFF)+MOLR1(OFF)+ MOLR3(OFF)+MCS1(OFF)	<input checked="" type="checkbox"/>
104	LC2+LC4 (ON)	TO GIVE EXTERNAL AIR PRESSURE TO EQUIPMENT GOVERNOR+{OPERATION 99/OPERATION 100}+SS1 ON+SS2 ON+SS3 ON+GROUND RELAY(OFF)+SAFETY RELAY2(OFF)+MOLR2(OFF)+ MOLR4(OFF)+MCS2(OFF)	<input checked="" type="checkbox"/>

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7.0 Engine Cranking Prerequisites

Operation	Effect/Observation	Location	Performed In ENG-1
• Switch on BCS 110 V to power up the 110V control circuit		CC1	<input checked="" type="checkbox"/>
• Switch on 24V Knife Switch to power up the 24V control Circuit		CC1	<input checked="" type="checkbox"/>
• Switch all the Control and Aux MCBs (24V & 110V)	• Availability of power supply at the input terminals of LCCs.	CC1	<input checked="" type="checkbox"/>
• Turn ON DCS key	• LED Panel will power up and display the default indications	DD	<input checked="" type="checkbox"/>
• Keep ECS in IDLE Position		DD	<input checked="" type="checkbox"/>
Ensure following:			
• Excitation Control Switch is off.		DD	<input checked="" type="checkbox"/>
• Check 24 V battery status.	• 24 V voltmeter should show 24 V approx.	CC1	<input checked="" type="checkbox"/>
• Check 110 V battery status	• 110 V voltmeter should show 110 V approx.	CC1	<input checked="" type="checkbox"/>
• Check the master controller	• Master controller handle should be at 0 position	DD	<input checked="" type="checkbox"/>
• Check Engine RPM meters	• 'ENG RPM' should indicate 0	CC1	<input checked="" type="checkbox"/>
• There should be no active faults in the system.	• No Fault indications on the LED Panel.	DD	<input checked="" type="checkbox"/>
• Operate Ready to Start Toggle Switch for a second to reset and release.	• All the relays will retain their healthy state. • All the fault Indications will disappear in LED Panel.	CC1 DD	<input checked="" type="checkbox"/>

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<ul style="list-style-type: none"> Operate Engine <u>1/2</u> Start toggle switch for 3 to 4 Seconds and Release. 	<ul style="list-style-type: none"> Engine will crank and Engine RPM shows 700 RPM in RPM Meter <u>1/2</u>. 	CC1 &2	<input checked="" type="checkbox"/>
	<ul style="list-style-type: none"> Engine <u>1/2</u> ON relay picks up 	CC1	<input checked="" type="checkbox"/>
	<ul style="list-style-type: none"> Eng <u>1/2</u> ON and Eng <u>1/2</u> Idle indication will appear in LED Panel. 	DD	<input checked="" type="checkbox"/>

7.1 Engine Shutdown procedure:

Operation	Effect/Observation	Location	Performed in ENG-1
<ul style="list-style-type: none"> Take the Master Handle to 0 notch and Reverser Switch to Neutral Position. 	<ul style="list-style-type: none"> Engine RPM will reduce to 700 RPM viewed at RPM Meter and Eng Idle Indication will appear in LED Panel 	CC and DD	<input checked="" type="checkbox"/>
<ul style="list-style-type: none"> Press Engine <u>1/2</u> Off toggle switch. 	<ul style="list-style-type: none"> Engine <u>1/2</u> Trip indication appears in the LED panel. 	DD	<input checked="" type="checkbox"/>

7.2 Engine Safety Checks
Low Hydraulic Oil Level

Operation	Effect/Observation	Location	Performed in ENG-1
<ul style="list-style-type: none"> Ensure Engin <u>1/2</u> is running. 	<ul style="list-style-type: none"> Engine <u>1/2</u> ON and Eng <u>1/2</u> Idle Indication in the LED panel. 	DD	<input checked="" type="checkbox"/>
<ul style="list-style-type: none"> Connect a jumper wire between Cable No. LHOL 1A and LHOL 1B at Level Sensor End. 	<ul style="list-style-type: none"> LHOL indicator displays LO 	CC1	<input checked="" type="checkbox"/>
	<ul style="list-style-type: none"> Engine will shutdown 	Under Frame	<input checked="" type="checkbox"/>
	<ul style="list-style-type: none"> Engine 1 trip indication will be displayed. 	LED Panel	<input checked="" type="checkbox"/>
<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> In LHOL, LO indication disappears. 	CC1	<input checked="" type="checkbox"/>

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Remove the jumper wire.			<input checked="" type="checkbox"/>
• Re Crank the Engine As per Procedure mentioned above.			<input checked="" type="checkbox"/>

High Cooling Water Temperature Fault Test

Operation	Effect/Observation	Location	Performed in ENG-1
• Ensure Engine <u>1 / 2</u> is running.	• Engine <u>1 / 2</u> ON and Alt- <u>1 / 2</u> Exc. ON indication in the LED panel.	DD	<input checked="" type="checkbox"/>
• Disconnect the TS11 and TS12 at Engine end.	• HCWT-1 Indication appears, Engine-1 Excitation will cut-off and Eng-1 Idle Indication will appear	DD	<input checked="" type="checkbox"/>
• Restore the TS11 and TS12 at the Engine and Re Crank the Engine	• Engine trip indication will disappear in the LED panel and Eng-1 ON and Eng-1 Idle Indication will appear	DD	<input checked="" type="checkbox"/>

Low Lube Oil Pressure Fault Test

Operation	Effect/Observation	Location	Performed in ENG-1
• Ensure Engine <u>1 / 2</u> is running.	• Engine <u>1 / 2</u> ON and Eng <u>1 / 2</u> Idle Indication in the LED panel.	DD	<input checked="" type="checkbox"/>
• Disconnect the PS11 at Engine end.	• Low Lube Oil Pressure Eng <u>1 / 2</u> indication will appear in LED Panel	DD	<input checked="" type="checkbox"/>
	• Engine will shutdown	Under Frame	<input checked="" type="checkbox"/>
	• Engine <u>1 / 2</u> trip indication will be displayed.	LED Panel	<input checked="" type="checkbox"/>

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• Restore the PS11 at Engine end and Engage Ready to Start Switch in DCS	• Low Lube Oil Pressure Eng <u>1/2</u> and Engine <u>1/2</u> trip indication will disappear	DD	<input checked="" type="checkbox"/>
• Re Crank the Engine As per Procedure mentioned above.			<input checked="" type="checkbox"/>

Low Coolent Level fault Test

Operation	Effect/Observation	Location	Performed in ENG-1
• Ensure Engine <u>1/2</u> is running.	• Engine <u>1/2</u> ON and Eng <u>1/2</u> Idle Indication in the LED panel.	DD	<input checked="" type="checkbox"/>
• Connect a jumper wire between Cable No. LCWL 1A & LCWL 1B for ENG-1 and LCWL 2A & 2B for ENG-2 at Level Sensor End.	• LCWL <u>1/2</u> indication displays LO	CC1	<input checked="" type="checkbox"/>
	• Engine will shutdown	Under Frame	<input checked="" type="checkbox"/>
	• Engine 1 trip indication will be displayed.	LED Panel	<input checked="" type="checkbox"/>
• Remove the jumper wire.	• In LCWL, LO indication disappears.	CC1	<input checked="" type="checkbox"/>
• Re Crank the Engine As per Procedure mentioned above.			<input checked="" type="checkbox"/>

8.0 LOAD TEST

Load test is carried out to check the performance of power pack installed in the DETC coach along with interconnected control system. It ensures that the power pack delivers rated output in each notch at rated speed as per the designed requirement.

Load test can be a fountain of valuable information revealing engine trouble such as low horse power, black smoke in the exhaust, hunting under load, and as well as some electrical problems like power circuit ground detection (Grounding of Alternator, Rectifier and cables up to CP can be detected).

Diesel engine (CUMMINS/BHEL) and Traction Alternator, Rectifier along with LCC shall be used for this test. After setting up the load bench, move Master Handle (MH) from IDLE to 8th notch in steps while keeping Reverser Handle (RH) in F/R position. In Load test, notch wise engine rpm and output power in kilowatts is maintained by the LCC under power limit mode.


Signature of JE/SSE (Testing)

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8.1 Test Status

Record test results in the format given below.

8.2 Test Equipment

- Digital Multimeters
- DCS key
- Master Controller Unlock key
- DC Clamp Ammeter

8.4 Test Programme

8.4.1 Test Preparations

Operation	Performed in ENG-1
• Ensure Engine is OFF and all circuit breakers and battery isolation switches are OFF.	<input checked="" type="checkbox"/>
• Connect the load bank between wire no. P5(Eng-1)/P6(Eng-2) and G0.	<input checked="" type="checkbox"/>
• Connect the Digital Multimeters(10A) in LCCs for measuring Actuator and Field Current.	<input checked="" type="checkbox"/>
• Connect the Digital Multimeter for voltage and Digital Clamp meter for current measurement at load Bank.	<input checked="" type="checkbox"/>
• Crank the Engine as per the instructions provided above.	<input checked="" type="checkbox"/>
• Allow engine to run for 15 minutes before loading.	<input checked="" type="checkbox"/>

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8.4.2 Traction Alternator Load Test

8.4.2.1 Notch wise Load Test

Operation	Performed in
	ENG-1
Start the power pack at notch-0 with load bank plate slightly dipped into the water and adjust the plate so that voltage and current LED in the LCC does not glow.	<input checked="" type="checkbox"/>
Turn ON the excitation switch and change the notch position to 1 st . Measure the DC current/DC voltage and calculate the power output i.e. kW reading.	<input checked="" type="checkbox"/>
If the kW is lower than required, rotate the kW pot in LCC against 1 st notch in clockwise direction (Load ramp-Up LED glows while adjusting the knob in LCC) until the kW matches with the required value. If kW is not increasing after 2-3 rotations, dip the plate into water to increase the load capacity and again check the kW.	<input checked="" type="checkbox"/>
If kW is higher than required, rotate the kW pot against the 1 st notch in anti-clockwise direction (Load ramp-Down LED glows) until the kW output matches the required value.	<input checked="" type="checkbox"/>
Repeat the above steps for each of the notches.	<input checked="" type="checkbox"/>
Cross-check the readings after restart and in both ascending & descending orders of notch.	<input checked="" type="checkbox"/>
Record the actuator current, excitation current, Load voltage and current.	<input checked="" type="checkbox"/>

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8.4.2.2 Notch wise Load Test Report

Load Test Engine A

Diesel Engine S. no.	25455749	Traction Alternator S. no.	4746272
LCC Control module S. no.	419QVU002	LCC Power module S. no.	6240R82014

Engine Safety Check

Item	Action	Performed	Remarks
HWT 1	LED INDICATION	<input checked="" type="checkbox"/>	
HWT 2	EXCITATION OFF	<input checked="" type="checkbox"/>	
LLOP	ENGINE TRIP	<input checked="" type="checkbox"/>	
OS	ENGINE TRIP	<input checked="" type="checkbox"/>	
LCWL	ENGINE TRIP WITH DELAY	<input checked="" type="checkbox"/>	
LHOL	ENGINE TRIP WITH DELAY	<input checked="" type="checkbox"/>	
HOFF	ENGINE TRIP	<input checked="" type="checkbox"/>	
RCFR	EXCITATION OFF	<input checked="" type="checkbox"/>	
RFF	EXCITATION OFF	<input checked="" type="checkbox"/>	

Prior to load testing ensure following:

- FP pressure should be between 5-7 kg/cm²
- Hydraulic oil pressure should be between 130-140 psi at 1800 rpm

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Load test chart (Engine A)

Notch position	Engine speed	V ref	V	I ref	I	P ref	P	P reference (kW)		Upper limits				I actuator	I field
								Lower limit	Upper Limit	V ref	V msrd	I ref	I msrd		
	Rpm	(V)	(V)	(A)	(A)	(kW)	(kW)							(A)	(A)
1	700	100	150	150	155	15	23	14.6	15.5	130	175	350	350	1.28	0.48
2	1000	150	175	210	220	31	39	30	32	230	260	400	450	1.32	0.45
3	1200	170	230	420	350	71	79	69	73	330	360	460	510	1.39	0.51
4	1300	200	280	490	380	98	106	95	101	400	450	500	570	1.44	0.61
5	1400	230	360	565	390	130	138	126	134	460	490	580	630	1.46	0.77
6	1500	260	400	620	425	162	170	157	167	533	550	650	700	1.53	0.91
7	1650	300	420	626	470	188	196	182	194	620	600	720	770	1.58	0.93
8	1800	330	440	630	490	208	216	202	214	640	680	780	810	1.62	0.89

LCC Parameters:

ACCEL	50	RESET	50	GAIN	45
DECEL	50	DROOP	10	STAB	50
L. STAB	50	L. RAMP	70	L. GAIN	70
L. DERIV	0	WHEEL SLIP	0	-	

After setting power, voltage & Current; include thermostatic valve and operate the engine in full power. Run engine till full hydraulic pressure is attained. During this time monitor Engine Coolant Temperature; NO temperature fault should pop up. Note down final reading of following gauges:

Gauge	Value	Unit
EWT	80	°C
LOT	85	°C
LOP	45	psi

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Load Test Engine B

Diesel Engine S. no.	25455271	Traction Alternator S. no.	4746271
LCC Control module S. no.	9120RPL018	LCC Power module S. no.	9080R70019

Engine Safety Check

Item	Action	Performed	Remarks
HWT 1	LED INDICATION	<input checked="" type="checkbox"/>	
HWT 2	EXCITATION OFF	<input checked="" type="checkbox"/>	
LLOP	ENGINE TRIP	<input checked="" type="checkbox"/>	
OS	ENGINE TRIP	<input checked="" type="checkbox"/>	
LWL	ENGINE TRIP WITH DELAY	<input checked="" type="checkbox"/>	
LHOL	ENGINE TRIP WITH DELAY	<input checked="" type="checkbox"/>	
HOFF	ENGINE TRIP	<input checked="" type="checkbox"/>	
RCFR	EXCITATION OFF	<input checked="" type="checkbox"/>	
RFF	EXCITATION OFF	<input checked="" type="checkbox"/>	

Prior to load testing ensure following:

- FP pressure should be between 5-7 kg/cm²
- Hydraulic oil pressure should be between 130-140 psi at 1800 rpm

DIESEL LOCO MODERNISATION WORKS, PATIALA
Testing & Commissioning Format For 8W Diesel Electric Tower Car (DETC)

DETC no. M-83

Load test chart (Engine B)

Notch position	Engine speed	V ref	V	I ref	I	P ref	P	P reference (kW)		Upper limits				I actuator	I field
								Lower limit	Upper Limit	V ref	V msrd	I Ref	I msrd	(A)	(A)
1	700	100	150	150	155	15	23	14.6	15.5	130	175	350	391	1.28	0.48
2	1000	150	176	210	222	31	39	30	32	230	261	400	450	1.32	0.45
3	1200	170	230	420	350	71	79	69	73	330	360	460	510	1.39	0.51
4	1300	200	280	490	380	98	106	95	101	400	450	500	570	1.44	0.61
5	1400	230	361	565	390	130	138	126	134	460	491	580	630	1.46	0.77
6	1500	260	400	620	425	162	170	157	167	533	550	650	702	1.53	0.91
7	1650	300	421	626	472	188	196	182	194	620	600	720	770	1.58	0.93
8	1800	330	441	630	492	208	216	202	214	640	680	780	810	1.62	0.89

LCC Parameters:

ACCEL	50	RESET	70	GAIN	60
DECEL	50	DROOP	10	STAB	60
L. STAB	50	L. RAMP	70	L. GAIN	70
L. DERIV	0	WHEEL SLIP	0	-	

After setting power, voltage & Current; include thermostatic valve and operate the engine in full power. Run engine till full hydraulic pressure is attained. During this time monitor Engine Coolant Temperature; NO temperature fault should pop up. Note down final reading of following gauges:

Gauge	Value	Unit
EWT	80	°C
LOT	85	°C
LOP	45	psi

DIESEL LOCO MODERNISATION WORKS, PATIALA
Testing & Commissioning Format For 8W Diesel Electric Tower Car (DETC)

DETC no. M-83

9.0 MOVEMENT TEST

9.1 Purpose

To ensure DETC movement in right direction as per Reverser Handle position.

9.2 Measuring Equipments and Test Setup

- Multimeter
- Wago connector
- DCS key
- Master Controller Unlock key

9.3 Test Status

Record the test results in the table given below

9.4 Test Implementation

Forward and Reverse movement about 10 kmph has been taken with all Traction Motors. Individual Traction Inverter data is recorded by performing the bogie cut out of each Line Contactor in MSGC. Forward and Reverse movement of Traction Motors performed and data is recorded. Based on recorded data, we verified the performance of the motor during movement test.

SAFETY AND BYPASS CHECKS (Before Movement)

SN	Test	Readings/Result	Remarks
1.	SA9 Brake Apply and release physical check at all wheels	OK	
2.	A9 Brake Apply and release physical check at all wheels	OK	
3	Parking Brake Apply and release physical check at designated wheels	OK	
4	Equipment Governor Bypass	OK	
5	Rectifier Cooling Fan - 1 Failure Bypass	OK	
6	Rectifier Cooling Fan - 2 Failure Bypass	OK	
7	Brake Pressure Control Governor Bypass	OK	
8	Parking Brake Governor Bypass	OK	
9	Functioning of Movement Restriction at 10KMPH interlock while Lifting platform is in up condition. (Excitation Off)	OK	

DIESEL LOCO MODERNISATION WORKS, PATIALA
Testing & Commissioning Format For 8W Diesel Electric Tower Car (DETC)

DETC no. M-83

10	Power Ground fault in Power Pack-1 and Resetting	OK	
11	Power Ground Fault in Power pack-2 and Resetting	OK	
12	Control Circuit Earth fault (+)	OK	
13	Control Circuit Earth fault (--)	OK	

LOCAL MOVEMENT TEST FROM CAB-1

SN	Test	Readings/Result	Remarks
1.	Forward movement with engine-1 in ON condition + TM-1 Traction Motor only Included (10Kmph) Notch-1	TM-1 <u>220</u> A	
2.	Reverse movement with engine-1 in ON condition + TM-1 Traction Motor only Included (10Kmph) Notch-1	TM-1 <u>220</u> A	
3	Forward movement with engine-1 in ON condition + TM-3 Traction Motor only Included (10Kmph) Notch-1	<input checked="" type="checkbox"/>	
4	Reverse movement with engine-1 in ON condition + TM-3 Traction Motor only Included (10Kmph) Notch-1	<input checked="" type="checkbox"/>	
5	Forward movement with engine-1 in ON condition + Both Traction Motors Included (10Kmph) Notch-1 TM-1 Current	TM-1 <u>160</u> A	
6	Reverse movement with engine-1 in ON condition + Both Traction Motors Included (10Kmph) Notch-1 TM-1 Current	TM-1 <u>160</u> A	
7	Forward movement with engine-2 in ON condition + TM-2 Traction Motor only Included (10Kmph) Notch-1	TM-2 <u>150</u> A	
8	Reverse movement with engine-2 in ON condition + TM-2 Traction Motor only Included (10Kmph) Notch-1	TM-2 <u>150</u> A	
9	Forward movement with engine-2 in ON condition + TM-4 Traction Motor only Included (10Kmph) Notch-1	<input checked="" type="checkbox"/>	
10	Reverse movement with engine-2 in ON condition + TM-4 Traction Motor only Included (10Kmph) Notch-1	<input checked="" type="checkbox"/>	
11	Forward movement with engine-2 in ON condition + Both Traction Motors Included (10Kmph) Notch-1 TM-2 Current	TM-2 <u>220</u> A	
12	Reverse movement with engine-2 in ON condition + Both Traction Motors Included (10Kmph) Notch-1 TM-2 Current	TM-2 <u>220</u> A	
13	Forward movement with both engines are in ON condition + All Traction Motors are Included (10Kmph) Notch-1	TM-1 <u>160</u> A TM-2 <u>150</u> A	
14	Reverse movement with both engines are in ON condition + All Traction Motors are Included (10Kmph) Notch-1	TM-1 <u>160</u> A TM-2 <u>150</u> A	

DIESEL LOCO MODERNISATION WORKS, PATIALA
Testing & Commissioning Format For 8W Diesel Electric Tower Car (DETC)

DETC no. M-83

15	Speedometer over speed alarm function working (Ensure WD : 952mm)	<input checked="" type="checkbox"/>	
16	Braking Performance SA9	<input checked="" type="checkbox"/>	
17	Braking Performance A9	<input checked="" type="checkbox"/>	
18	Deadman Braking Performance	<input checked="" type="checkbox"/>	
19	Emergency Braking Performance	<input checked="" type="checkbox"/>	
20	Head light both beams glowing with proper focusing	<input checked="" type="checkbox"/>	
21	Driver and Guard side both Tail Lights glowing	<input checked="" type="checkbox"/>	
22	Driver and Guard side both Marker Lights glowing	<input checked="" type="checkbox"/>	
23	Flasher Light working properly	<input checked="" type="checkbox"/>	
24	Search Light glowing	<input checked="" type="checkbox"/>	
25	Fog light Glowing	<input checked="" type="checkbox"/>	

LOCAL MOVEMENT TEST FROM CAB-2

SN	Test	Readings/Result	Remarks
1.	Forward movement with both engines are in ON condition + All Traction Motors are Included (10Kmph) Notch-1	TM-1 <u>160</u> A	
		TM-2 <u>160</u> A	
2.	Reverse movement with both engines are in ON condition + All Traction Motors are Included (10Kmph) Notch-1	TM-1 <u>150</u> A	
		TM-2 <u>150</u> A	
3.	Head light both beams glowing with proper focusing	<input checked="" type="checkbox"/>	
4.	Driver and Guard side both Tail Lights glowing	<input checked="" type="checkbox"/>	
5.	Driver and Guard side both Marker Lights glowing	<input checked="" type="checkbox"/>	
6.	Flasher Light working properly	<input checked="" type="checkbox"/>	
7.	Search Light glowing	<input checked="" type="checkbox"/>	
8.	Fog light Glowing	<input checked="" type="checkbox"/>	
9.	Braking Performance SA9	<input checked="" type="checkbox"/>	
10.	Braking Performance A9	<input checked="" type="checkbox"/>	

DIESEL LOCO MODERNISATION WORKS, PATIALA
Testing & Commissioning Format For 8W Diesel Electric Tower Car (DETC)

DETC no. M-83

11.	Deadman Braking Performance	<input checked="" type="checkbox"/>	
12.	Emergency Braking Performance	<input checked="" type="checkbox"/>	

HV SENSOR, HL-TL AND LOCAL ON/OFF PERFORMANCES IN CAB I & II

SN	Test	Readings/Result	Remarks
1	Headlight-Tail light Interlock performance	<input checked="" type="checkbox"/>	
2	H.V Sensor Performance	<input checked="" type="checkbox"/>	
3	Engine- 1 local On / Off Function	<input checked="" type="checkbox"/>	
4	Engine- 2 local On / Off Function	<input checked="" type="checkbox"/>	

ALL GOVERNORS PERFORMANCE

Equipment Governor Pressure Setting (Brake Team Scope)			MR Governor(ADV Setting) SAN Scope		
Cut-in	4.2Kg/SqCm	<u>OK</u>	Cut-in	6Kg/SqCm	<u>OK</u>
Cut-off	3.4Kg/SqCm	<u>OK</u>	Cut-off	7Kg/SqCm	<u>OK</u>
BPC Governor Pressure Setting (Brake Team Scope)			Parking Brake Apply and Release		
				DCS Switch Configuration	Function
4.2Kg/SqCm	4.2Kg/SqCm	<u>OK</u>	Apply	<u>OK</u>	<u>OK</u>
3.4Kg/SqCm	3.4Kg/SqCm	<u>OK</u>	Release	<u>OK</u>	<u>OK</u>

DIESEL LOCO MODERNISATION WORKS ,PATIALA

DETC NO- M83			
Sr.No.	Description	MAKE	Sr. No.
1	CAB HEATER (CAB-1)	Top grip	651
2	CAB HEATER (CAB-2)	Top grip	622
3	SPEEDOMETER (CAB -1)	Telpro	M2009044
4	SPEEDOMETER (CAB -2)	Telpro	S2009046
7	Control Cubical -1	BHEL	200CAB1030
8	Control Cubical-2	BHEL	200CAB2030
9	RRU-1	KEL	200571C536
10	RRU-2	KEL	200571C532
11	Battery 24	STAR PLUS	647
12	Battery 110v	HBL	V2860
13	MSG	BHEL	2000MSG027
14	Resistor Panel	BHEL	58222 0307/308


SSE/TRS


JE/TRS

Air-brake equipments details of DETC- M83

S.No.	Description	QPL /Nos.	Supplier	Item Sr. no.	Warranty
1	Distributor Valve	1	Faiveley	19116006	As per IRS/PO conditions
2	A9 brake Valve	2	Faiveley	-	
3	SA9 brake valve	2	Faiveley	-	
4	C2 Relay Valve	1	Faiveley	B20-5308	
5	Auto Drain valve	3	Faiveley	-	
6	Air whistle	4	Faiveley	-	
7	PRV Limiting valve	4	Faiveley	-	
8	Safety valve	1	Faiveley	-	
9	Wiper motor	4	Elgi	-	
10	Air Dryer	1	Prag	2230-06-20	
11	Three way magnet valve(Parking)	2	Rotex	-	
12	Three way magnet valve(Horn)	2	Rotex	-	
13	Three way magnet valve(MR)	1	Rotex	-	
14	Three way magnet valve(Compressor)	1	Rotex	-	
15	Pantograph assembly	1	Contransys		
16	Servo Motor	1	Contransys		


 SSE/ABS


 SSE/ABS

DIESEL LOCO MODERNISATION WORKS, PATIALA

DETC-200031/NER (M-83)

S.NO.	NAME OF COMPONENTS	COMPANY	MFG. DATE & SN
1	SHELL	EC BLADES PVT LTD	2020 & 75
2	HYDRAULIC PLATFORM	HYADRAULIC ACTUATOR PVT LTD	
3	LIFTING RAM	HYADRAULIC ACTUATOR PVT LTD	HAL-11-2019-1318/155
4	STARTER BATTERY CHARGER	RAMYAA ELECTRO-GEAR(P) LTD.	2003.23.578
5	RECTIFIER REGULATOR UNIT	KEL/BHEL	05/2020 & 200571C536,200571C532
6	RECTIFIER A & B	BHEL	582220225, 582220226
7	MOTOR SWITCH GROUP CUBICAL	BHEL	13/07/2020 & 200MSG027
8	AUX. ALTERNATOR-1 & 2	BHEL	05/2020 & 200571537, 200571531
9	ENGINE 1 & 2	CUMMINS INDUSTRIES	06/2020 & 25455271, 25455749
10	ALTERNATOR 1 & 2	BHEL	2020 & 4746271, 4746272
11	CONTROL CUBICAL-1	BHEL	27/07/2020 & 200CAB1030
12	CONTROL CUBICAL-2	BHEL	27/07/2020 & 200CAB2030
13	RESISTANCE PANEL	BHEL	582220307/308
14	10 KV GENERATOR SET	AMPLE COOPERATION PVT LTD/ESCORTS	12/19 & AMPL/ES/0252
15	RADIATOR		30/8/2020
16	DRILLING MACHINE	'SIDDHAPURA MACHINE TOOLS	19/2/2009
17	MOTOR WITH TROLLEY	ABB	3G3J1929153877
18	3KV DG WELDING SET	HIMALYA	SC230-1812140995
19	CONTROL PANEL FOR RAM	RAMYAA ELECTRO-GEAR(P) LTD.	2003.107.208
20	CONTROL PANEL FOR RAM	RAMYAA ELECTRO-GEAR(P) LTD.	<i>Devi Bhandari</i>

Sign

SSE/DETC

Sign

JE/DETC

DIESEL LOCO MODERNISATION WORKS

DETC No.	200031	Rly:	ER	Month:	Oct.,20
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1. BOGIE FRAME:

BOGIE	FRAME NO	Make	PL No.	PO No. & dt.	Warranty Period
Panto side	SL-489	SECPL	10992169	01194913100472	As per PO/IRS conditions
Radiator Side	SL-35	CRG		01194913100851	

2. Hydraulic Dampers (Vertical and Lateral) Make: Front: "Gaberia", Rear "IAI"

3. AXLES:

LOCATION	1	2	3	4
S.NO	N-9525	N-9510	N-9482	N-9443
Ultrasonic Testing	OK	OK	OK	OK

4. WHEEL DISCS NO. AND TYPE

LOCATION	1	2	3	4
GEAR END	20/633	20/516	CNC-597	20/879
Ultrasonic Testing	OK	OK	OK	OK
FREE END	20/643	20/932	CNC-570	20/881
Ultrasonic Testing	OK	OK	OK	OK

5. AXLE ROLLER BEARING (PL No. 31020513, Warranty: As per PO/IRS conditions)

LOCATION		1	2	3	4
Gear End	MAKE	NBC	NBC	FAG	FAG
	PO NO. & dt	566543	566543	566542	566542
Free End	MAKE	NBC	NBC	FAG	FAG
	PO NO. & dt	566543	566543	566542	566542

6. WHEEL DISC PRESSING (PRESSURE IN TONNES): SPECIFIED 77.2-115.6 T

AXLE NO	1	2	3	4
BULL GEAR END	100	109	82	97
FREE END	96	106	90	84

DETC No.	200031	Rly:	ER	Month:	Oct.,20
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7. DIAMETER AFTER PROFILE TURNING: SPECIFIED 952-955 mm

AXLE NO.	1	2	3	4
DIA IN mm GE	952	952	953	953
DIA IN mm FE				
WHEEL PROFILE GAUGE (1600±1mm)	OK	OK	OK	OK

8. SUSPENSION TUBE & ITS TAPER ROLLER BEARING:

AXLE NO.		1	2	3	4
S.T.	MAKE	BHEL	BHEL	BHEL	BHEL
G.E. BEARING	MAKE	Timken	FAG	FAG	FAG
F.E. BEARING	MAKE	Timken	FAG	FAG	FAG

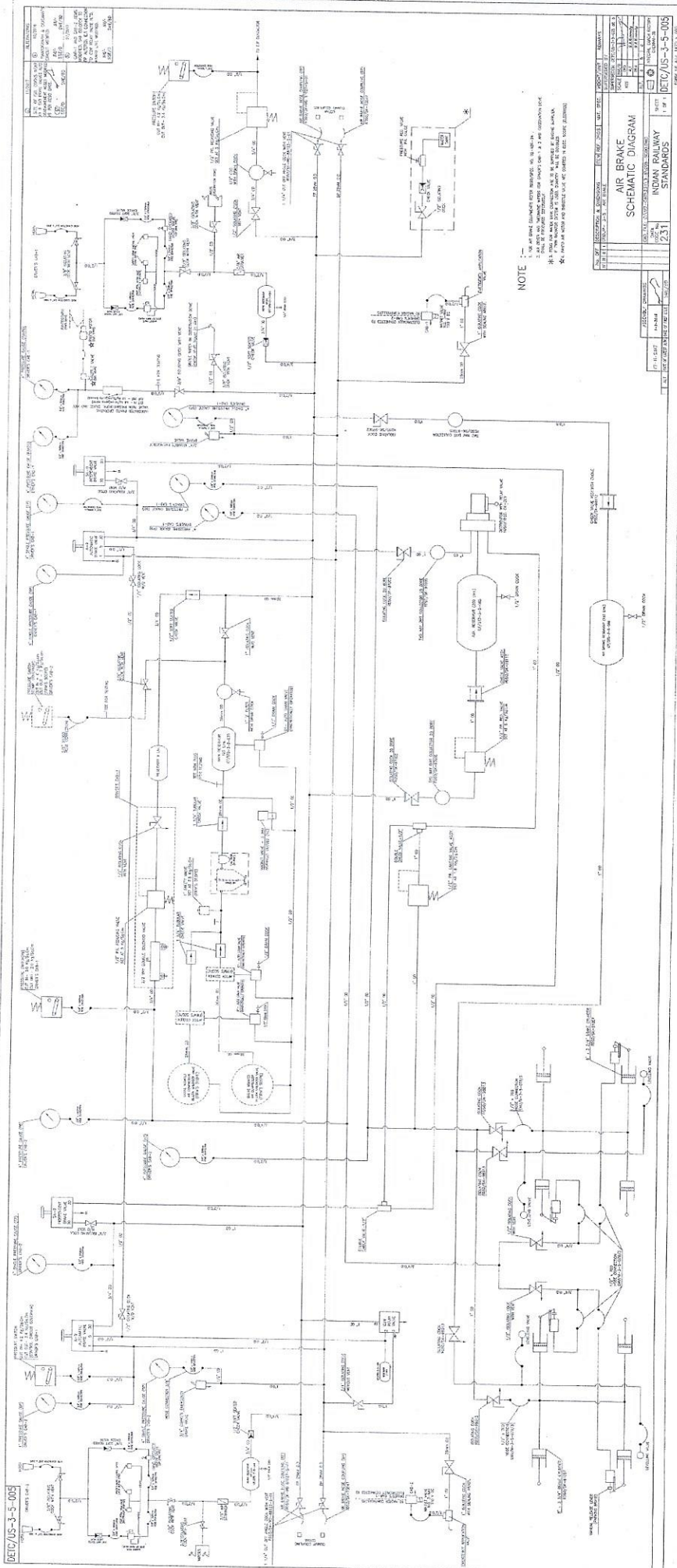
9. GEAR CASE & BACKLASH:

AXLE NO.	1	2	3	4
MAKE	BHEL	BHEL	BHEL	BHEL
BACKLASH (0.200 – 0.700mm)	0.280	0.275	0.280	0.275

10. TRACTION MOTOR : (PL No. 30906313, Warranty: As per PO/IRS conditions)

LOCATION	MAKE	PO No. & date	S. NO.
1	BHEL	566640	4920506
2	BHEL	566640	4920490
3	BHEL	566640	4920484
4	BHEL	566640	4920503


 SSE/ Bogie Shop



NOTE :-

1. All air brake components shall be tested as per the specifications given in the specifications.
2. The air brake system shall be tested as per the specifications given in the specifications.
3. The air brake system shall be tested as per the specifications given in the specifications.
4. The air brake system shall be tested as per the specifications given in the specifications.

REV.	DESCRIPTION	DATE	BY	CHKD.	APPD.
1	ISSUED	10/10/2011
2
3
4
5
6
7
8
9
10

**AIR BRAKE
SCHEMATIC DIAGRAM**

INDIAN RAILWAY
STANDARDS

231

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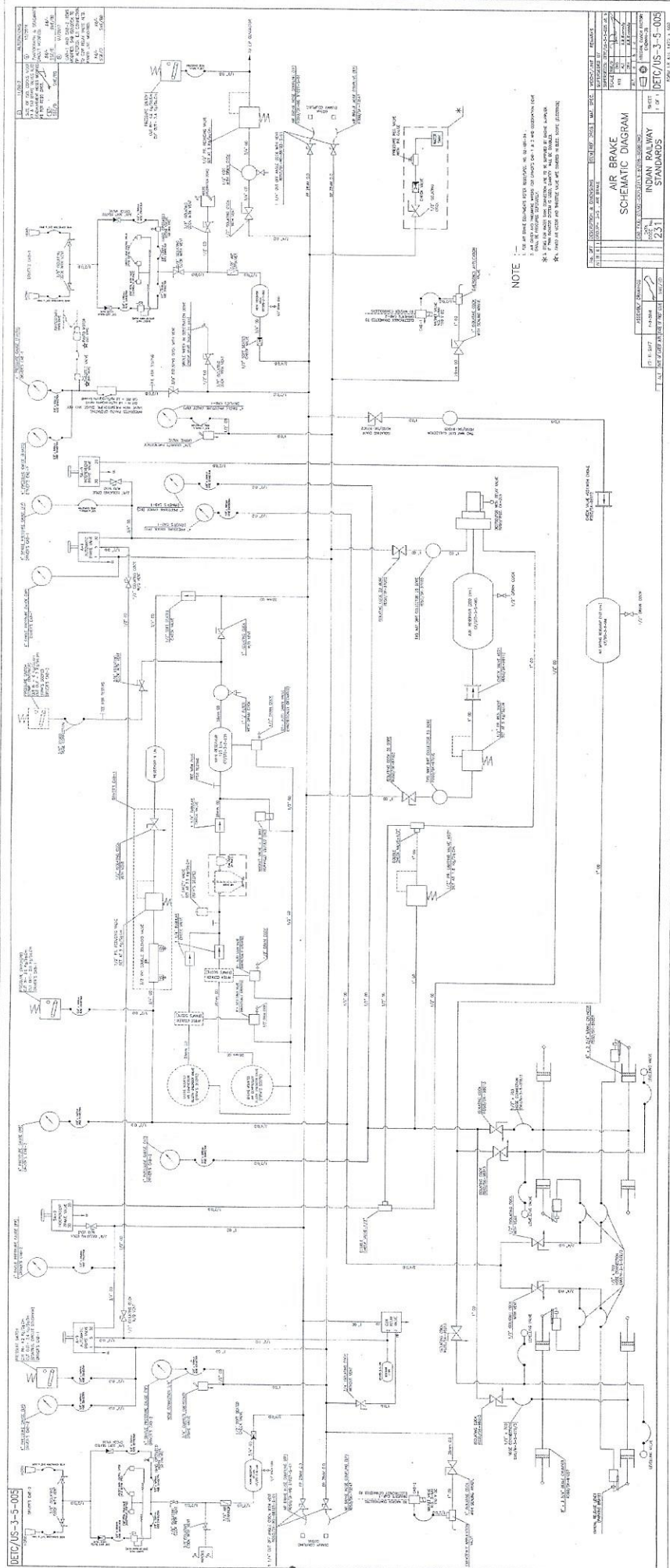
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NOTE: -
 1. For air brake equipment, refer to the following: -
 a. For air brake equipment, refer to the following: -
 b. For air brake equipment, refer to the following: -
 c. For air brake equipment, refer to the following: -
 d. For air brake equipment, refer to the following: -
 e. For air brake equipment, refer to the following: -
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 v. For air brake equipment, refer to the following: -
 w. For air brake equipment, refer to the following: -
 x. For air brake equipment, refer to the following: -
 y. For air brake equipment, refer to the following: -
 z. For air brake equipment, refer to the following: -

REVISIONS		DATE	BY	CHKD	APP'D
1	AS PER	10/10/00	10/10/00	10/10/00	10/10/00
AIR BRAKE SCHEMATIC DIAGRAM INDIAN RAILWAY STANDARDS					
1. For air brake equipment, refer to the following: - a. For air brake equipment, refer to the following: - b. For air brake equipment, refer to the following: - c. For air brake equipment, refer to the following: - d. For air brake equipment, refer to the following: - e. For air brake equipment, refer to the following: - f. For air brake equipment, refer to the following: - g. For air brake equipment, refer to the following: - h. For air brake equipment, refer to the following: - i. For air brake equipment, refer to the following: - j. For air brake equipment, refer to the following: - k. For air brake equipment, refer to the following: - l. For air brake equipment, refer to the following: - m. For air brake equipment, refer to the following: - n. For air brake equipment, refer to the following: - o. For air brake equipment, refer to the following: - p. For air brake equipment, refer to the following: - q. For air brake equipment, refer to the following: - r. For air brake equipment, refer to the following: - s. For air brake equipment, refer to the following: - t. For air brake equipment, refer to the following: - u. For air brake equipment, refer to the following: - v. For air brake equipment, refer to the following: - w. For air brake equipment, refer to the following: - x. For air brake equipment, refer to the following: - y. For air brake equipment, refer to the following: - z. For air brake equipment, refer to the following: -		1. For air brake equipment, refer to the following: - a. For air brake equipment, refer to the following: - b. For air brake equipment, refer to the following: - c. For air brake equipment, refer to the following: - d. For air brake equipment, refer to the following: - e. For air brake equipment, refer to the following: - f. For air brake equipment, refer to the following: - g. For air brake equipment, refer to the following: - h. For air brake equipment, refer to the following: - i. For air brake equipment, refer to the following: - j. For air brake equipment, refer to the following: - k. For air brake equipment, refer to the following: - l. For air brake equipment, refer to the following: - m. For air brake equipment, refer to the following: - n. For air brake equipment, refer to the following: - o. For air brake equipment, refer to the following: - p. For air brake equipment, refer to the following: - q. For air brake equipment, refer to the following: - r. For air brake equipment, refer to the following: - s. For air brake equipment, refer to the following: - t. For air brake equipment, refer to the following: - u. For air brake equipment, refer to the following: - v. For air brake equipment, refer to the following: - w. For air brake equipment, refer to the following: - x. For air brake equipment, refer to the following: - y. For air brake equipment, refer to the following: - z. For air brake equipment, refer to the following: -			