Item Name: Microprocessor based control system with automatic flasher light control, multi-setting vigilance control & event recorder for Diesel Electric locomotives (ALCO)

Specification No: MP-0-2400-26

1. RDSO is reviewing the specification/STR to cater to the latest technological developments in the field, modify clauses not relevant in the present context and making them more enabling with focus on functional requirements.

2. It is requested that your comments / suggestions with regard to improvements / modifications in specification / STR of the abovementioned item may be submitted in the following format along with the justification for the changes required.

Part A: Basic Information

<table>
<thead>
<tr>
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<th>Particulars</th>
<th>Information</th>
</tr>
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<td>1.</td>
<td>Name</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Designation</td>
<td></td>
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<td>3.</td>
<td>Professional Qualification</td>
<td></td>
</tr>
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<td>4.</td>
<td>Organization / Firm’s Name</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Address for Correspondence</td>
<td></td>
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<td>6.</td>
<td>Contact No.</td>
<td></td>
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<td>7.</td>
<td>Email ID</td>
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<tr>
<td>8.</td>
<td>Whether firm is registered with RDSO for the subject item. If yes, details like date of registration, current status etc. If no, firm’s experience in manufacturing of subject item or similar item</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Whether any technical document/Report/Study to support suggested changes is available / enclosed for better appreciation</td>
<td></td>
</tr>
</tbody>
</table>

Part B: Comments / suggestions on the specification

<table>
<thead>
<tr>
<th>SN</th>
<th>Clause No.</th>
<th>Clause, as it exists in RDSO STR/ Spec</th>
<th>Clause, as it should read after incorporation of comments / suggestions in the RDSO Spec / STR</th>
<th>Justification for changes</th>
</tr>
</thead>
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Comments may be sent to following address within one month from the date of publication on rdso.indianrailways.gov.in

B P S Bhadoria, Joint Director/MP (EC), Mobile No.-9794863120, E-mail ID: dmpec@rdso.railnet.gov.in, adeecmp@rdso.railnet.gov.in Phone no.: 0522-2450020 Fax No. 0522-2453916
Brief Description
This document describes the requirements for the development of Microprocessor based control system with automatic flasher light control, multi-setting vigilance control & event recorder for Diesel Electric locomotives (ALCO). The complete specification details the functional requirement of the unit, scope of supply and testing of the equipment ensuring reliability and fail-safe operation.
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<th>Revision</th>
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<td>1.</td>
<td>February 2003</td>
<td>0</td>
<td>First issue</td>
</tr>
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<td>2.</td>
<td>October 2003</td>
<td>1</td>
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</tr>
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<td>August 2004</td>
<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>May 2008</td>
<td>5</td>
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<td>March 2010</td>
<td>6</td>
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<td>8.</td>
<td>February 2018</td>
<td>7</td>
<td>1. Addition of new clause 6.0 Title: Vendor Changes in approved status. 2. Incorporation of Corrigendum of Rev.6 issued vide RDSO letter no. SD.DEV.MCS dt. 18.06.10</td>
</tr>
<tr>
<td>S. No.</td>
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<td>Revision</td>
<td>Details</td>
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| 9.     | October 2020   | 8        | • Review of Clause 4(Optional item) and updated with latest standard.  
  • Environment standards are updated at Clause 5.42.  
  • Test Protocol format for prototype test and Acceptance test are incorporated as Annexure-1&1(A) of the specification.  
  • Clause no. 6, reference of ISO document no. updated.  
  • Clause 7 & 8 for IPR and Confidentiality has been incorporated.  
  • ‘Make in India Policy’ has been incorporated at Clause no. 9.  
  • Addition of Document no.MP-M-8.1-1(latest) at Clause 5.43  
  • Field Trial Performance Format is incorporated at Clause no.5.43 |
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<td>2.</td>
<td>RDSO Document no. MP-M-8.1-1 (Master List of Qualifying Quantity for up-gradation to approved vendors and Qualifying Quantity &amp; Qualifying Periods for Approval for RDSO vendor for developmental order of items controlled by MP Directorate)</td>
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<td>• Event Recorder</td>
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1 Introduction

This specification is for Microprocessor based AC-DC Locomotive Control System for ALCO type Diesel Electric Locomotives/ retro fitment of locomotive with “E” type controls. As far as possible required details have been provided however vendor may deputes engineer to RDSO for obtaining further information. The development of MBCS shall be as per latest RDSO guidelines No. MP.GD.12.

The details of some of the type of locomotives are as under:

<table>
<thead>
<tr>
<th>Loco type</th>
<th>WDM3F(GE)</th>
<th>WDM3D</th>
<th>WDG3A</th>
<th>WDM3A</th>
<th>WDS6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross HP under UIC condition</td>
<td>3600</td>
<td>3300</td>
<td>3100</td>
<td>3100</td>
<td>1400</td>
</tr>
<tr>
<td>Traction Alternator / Generator</td>
<td>GTA24H / GTA11H</td>
<td>TA10102</td>
<td>TA10102</td>
<td>TA10102</td>
<td>TA 10106</td>
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<tr>
<td>Traction Motor</td>
<td>TM752AH</td>
<td>TM4907</td>
<td>TM7362A</td>
<td>TM4907, TMC1001</td>
<td>TM4907</td>
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<tr>
<td>Exciter</td>
<td>5GY27M2</td>
<td>AG3101</td>
<td>AG3101</td>
<td>AG3101</td>
<td>AG2210</td>
</tr>
<tr>
<td>Aux Gen</td>
<td>5GY27L2</td>
<td>AG3101AY</td>
<td>AG3101AY</td>
<td>AG3101</td>
<td>AG2513</td>
</tr>
<tr>
<td>Transition</td>
<td>Alternator transition</td>
<td>2S3PFF-2S3PFS, 6PFF</td>
<td>2S3PFF-2S3PFS</td>
<td>2S3PFF-2S3PFS</td>
<td>2S3PFF</td>
</tr>
<tr>
<td>Gear Ratio</td>
<td>18:65</td>
<td>18.65</td>
<td>18.74</td>
<td>18.65</td>
<td>18.65</td>
</tr>
<tr>
<td>Max Speed, Kph</td>
<td>120</td>
<td>120</td>
<td>100</td>
<td>100</td>
<td>71</td>
</tr>
</tbody>
</table>

2 Performance & other requirements

2.1. The system hardware and software shall be of proven design having trouble free service performance on diesel electric locomotives on established Railway systems. The vendor shall furnish a list of the offered equipment supplied by them to other Railways, giving relevant details and evidence of its satisfactory performance.

2.2. The prototype system shall require only minimal changes in the physical layout and operating function of existing equipment in the driver’s cab, controls, switches, indication lamps, and such changes shall be made by mutual agreement. Internally, however all such equipment shall be interfaced directly with the microprocessor system, circuits for E-Type excitation System, previously used with Alco Loco being discarded completely, except for lighting circuits, to enable all control actions to be routed through the microprocessor control system.

2.3. All issues of system integration and interfacing with third party system shall be the responsibility of approved vendor of this system. The vendor will provide complete details.

2.4. Change in performance, functionality and deviation for scope if any with the proposed system, shall be brought out by the vendor and approval of RDSO should be obtained.

3 Scope of supply

3.1. The complete microprocessor control system as per this specification.
3.2. The complete control panel fully wired and equipped with control gears (integrated with power and control items) as per vendor requirement (Optional).
3.3. Suitable sensors for engine & Traction Motor speed including speed sensing gear kit (not applicable for DLW), pressure sensors for Water Pump, lube oil, MR, BP, BC & atmospheric, temperature sensors for engine water, lube oil, Ambient, voltage/current sensors etc. required to cover the specification’s functional requirements. All the sensors to be supplied with mounting brackets/ fittings/ weld nuts with suitable inside threading for sensor fixation to outer diameter as per hose size decided by IR along with suitable mounting lead and the protective
flexible (PVC coated) conduits as per requirement. The temperature/pressure sensors to have 
⅛” NPT threading (piping interface). All the units shall be metric standard.

4 Optional features
Interfacing/Provision for these features if required at a later date should be provided without any 
additional cost for interfacing with their system and update of software. However, additional equipment 
required shall be provided by Railways as per the details/or may be part of the system under scope of 
supply, if specifically mentioned by the purchaser.

<table>
<thead>
<tr>
<th>Features</th>
<th>Applicable for New/Rebuilt Locos</th>
<th>Applicable for zonal Railways</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributed power Control</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fire alerter</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Auto Creep Control</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DIALS (TFT display)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CCB with Blended Brake</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>ACES (Auto Control of Engine Stop)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>EOTT</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>High-speed cruise control</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Micro driven Speed indicator-</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Extended Range Dynamic Braking feature</td>
<td>Yes</td>
<td>Yes</td>
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<td>Remote Monitoring &amp; Management of</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Locomotives and Trains(REMMLOT)</td>
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<td></td>
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<tr>
<td>DIGITAL AIR FLOW Meter</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fuel Oil Level measurement</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

If there is any requirement of sensor(s) for above optional features over and above those already 
provided for the main microprocessor system, the same shall be spelt out clearly by vendor.

5 Functional requirements:
The microprocessor control system shall have following features:

5.1 Alternator excitation control during traction and braking
The system shall control the exciter field strength to obtain required GHP and ensure Volt and current 
limit of alternator. Correction factor for GHP shall be as per RDSO publication. no. MP.MI.10 (latest). 
Unused auxiliary power, whenever unloaded or partially loaded shall be utilized for traction such that the 
GHP does not exceed the max. value.

Restricts excitation in the event various parameters water temp, grid current, power ground, TM Temp 
(based on thermal modeling) going beyond limit.

5.2 Tractive limit to 30.5 tonne (user settable)
Through A switch / input through display unit.

5.3 Wheel slip control during motoring and dynamic braking & Adhesion improvement
System shall have wheel creep – based slip and slide control and automatic sanding to maximize 
adhension in all weather conditions. In case of failure/ malfunction of TM speed sensors, system shall 
employ with TM current/voltage dependent algorithm. The system shall have automatic wheel wear 
diameter compensation.
Minimum improvement of adhesion over the conventional loco by 10% and 15% on dry rail with sanding, in unsanded and 3% in wet condition (starting, running, braking) to be validated during trial.
TE shall be reduced in steps with the experience of wheel slip and slide beyond the regular creep range for minimum time and shall have adequate protection for locked axle/excessive slipping/Pinion Slip/TM Over speed.
Manual sanding for front and rear sanders shall be provided.

5.4 Fail safe feature & protection to the equipment
The equipment shall have failsafe feature where, in case of a system failure the system goes to SAFE MODE so as not to cause any damage to any equipment controlled by it. Protective actions shall include automatic action to isolate defective assembly, request to driver for manual corrective action, shutting down or idling engine in emergency situations. The system shall have fault tolerance feature to keep locomotive in operation or downgraded till it completes trip safely.

5.5 Loco Over Speed Alarm & Protection
System shall be able to give audio-visual warning at pre- desired maximum permitted speed & protection

5.6 Aux gen excitation control
A 64 V battery is available for meeting the power requirement of the system. During cranking, the battery voltage may drop to around 22V for about 0.8 sec. Shall regulate the AG voltage within 72+1V, 160 Amp (user settable) Shall monitor battery charging and protection be provided against deep discharge and over voltage of battery.

5.7 Propulsion control
Operate the locomotive i.e. starting, stopping, traction, braking, field weakening and motor transition etc. including implementation of safety features and protection of all traction equipment.

5.8 Engine control
The Engine RPM and load control shall be through MCBG to RDSO specification no. MP.0.17.00.01. The notch, LCP, engine rpm, Lube oil, fuel oil and booster air pressure signals signal shall also be communicated through RS 485 port with MCBG. RDSO shall facilitate in exchange of data between two systems. However, Lube oil pressure sensing shall be at both ends to have redundancy.
If required 72V notch and LCP signal reference signals for Woodward PGEV-8 governor and shall be made available in conventional manner.

5.9 Power setter (MU operation)
In this mode, when selected by the driver, all rear locomotives shall run in idle. Dynamic brake shall work normally in both the locos at all times.

5.10 Extended range dynamic braking i.e. Higher breaking effort at lower speed system
The system shall have software and input/output capability to implement this feature if the locomotive is equipped requisite additional contactors as RDSO modification sheet no. MP.MOD.EC.05.26.09.

5.11 Low idling feature on locomotives fitted with MCBG
The system shall bring the engine to 350 rpm, if engine is running at idle at 400 rpm continuously for 5 minutes and Lube Oil Pressure is more than 1.7 kg/cm². If LOP reduces below 1.2 kg/cm² RPM shall revert to normal 400 rpm. Refer RDSO Instruction Bulletin No. MP.IB.EN.08.43.08

5.12 Control of auxiliaries
1. System shall control Unloading/ loading of Air Compressor when MR Pressure is 10/8- kg/cm².
2. System control Radiator Fan based on temp of cooling water by means energizing R1 & R2 Contactors. RPM measuring may be displayed for radiator fan speed (control system to have direct feedback of radiator fan speed). However this feature is not mandatory.

5.13 Pre and post lubrication:
System would control same 72V-1.5 hp lube pump (if provided) Carry out pre-lubrication for 60 second If the locomotive is started after half an hour from the last shut down. A counter shall display the time left for
completion of pre lubrication before cranking. Post lubrication shall be done after every shut down for 5 minutes and Display of message showing post lubrication is in process.

5.14 Automatic emergency brake system
System should automatically operate to apply the brake at a pre-determined speed through user variable parameter option.
Provision for manual switch with resetting of the system from the lead locomotive shall be kept.
Norms for AEB Penalty Brake Application confirm to RDSO Instruction bulletin no. MP.IB.EC.01.02.08.

5.15 Multi-resetting vigilance control
The system shall have Vigilance Control feature, functionally conforming to RDSO latest spec. no. MP.0.3400.04. Pressure sensor for Brake Cylinder pressure sensing will be taken from delivery pipeline of brake cylinder charging C2W relay valve.
However, VCD shall not be active during cranking, speed is≤ 3 Kph, BC ≥ 1.3 kg/cm².
If locomotive is provided with CCB, system shall give a command to CCB for penalty brakes application during VCD & AEB operation.

5.16 Flasher light control
Flasher Light shall be driven by the system directly and replace the existing control unit may be considered as deleted. (Ref: Corrigendum of Rev.6 issued vide RDSO letter no. SD.DEV.MCS dt. 18.06.10)

5.17 Automatic flasher light control
Flasher light shall glow automatically even if flasher light switch is in OFF position along with audio visual indication to the drive whenever, BP is less than < 4.4 kg/cm² (reset at 4.7) and A-9 pilot air pressure > 4.8 kg/cm² (this condition shall only be effective for 60 sec after that only first condition is valid) however, audio signal can be reset by a separate switch.

5.18 Display screen and facility of fault data analysis through display
All the message and information to the drivers and maintainers shall be given through a suitable alphanumeric display of minimum 4 lines and 40 characters, preferably 256X64 pixels graphical display. Display Screen shall be configurable.
System shall have provision to see the logged fault history on Display Unit. This fault history shall have all faults with frequency (code wise), Faults since date and all faults in chronologically recorded with the real date and time of the occurrence.
Display shall have provision for customising the display screens with selectable parameters as User programmable display screens. Display of various parameter on DID including messages, User Inputs. LED indication and audio buzzer.

5.19 User settable parameters
The system shall have user settable parameters with password protection. It shall be possible to enable / disable the user programmable feature based on type of loco and its configuration.
Parameters shall be as per RDSO Mod sheet No.MP.MOD.EC.05.27.10.

5.20 Data logging, fault management & diagnostics
The system shall have built in data logging, diagnostics features and trouble shooting, including indication of fault status, information pack, analysis of the fault data, Classification of faults, fault data pack and provision of necessary information to drivers/maintainers shall be as per Mod sheet No.MP.MOD.EC.05.27.10. However, supplier may propose alternatives for approval of RDSO.
Two USB ports shall be provided for downloading through laptop/ Pen drive. The contractor vendor shall supply software for configuring Microprocessor based control system, downloading, and analysis of data. It should be possible to on line monitor and record the various excitation and propulsion parameters through a lap top computer. Analysis software should also support the graphical analysis.
5.21 Event recorder
Industrial rugged design separate (take out type) Flash EEPROM based Memory Card under lock and key shall be provided. To download the data the portable memory card shall be removed from the locked cassette compartment of the control unit connected to USB port of IBM compatible PC, equipped with required software for downloading short and long term to be supplied by the vendor.
Short term memory shall be one sec interval for the last 72 hours. Long Term Memory data for 90 days with resolution of 20 secs.

5.22 Memory freeze of the Event recorder
A switch for freezing the data under a sealed glass cover shall be provided. A LED freeze indication shall also be provided.
The glass shall be broken, when required, for operating the switch

5.23 Self-test
The system shall be able to run a self-test at user request to verify satisfactory functioning of all component system including Input/ output.

5.24 Analog meters interface
System shall be provided with analog output interface for Load Ammeter (FSD 90 mV) and Speed indicator with calibration facility.

5.25 Test Modes
System shall be able to test following (through DID): Radiator Fan, Load meter, speedometer, motor transition, Auto Emergency Braking, Relays, PWM drive, etc.

System in password protected test mode and locomotive in standstill and reverser in neutral position shall be able to test engine GHP and control system by connections of alternator output at rectifier terminals with external load box as well as self-load test with dynamic braking grids (up to the grid current limit).

5.26 Fuel oil level recording and display (Optional)
System shall have provision for acquiring fuel Tank level data on Locomotive fitted with fuel oil level sensor to RDSO specification No.MP.0.24.00.63 latest. Calculation of sfc/consumption would done by the system. Calibration of Fuel Tank shall be done through pre-defined function from micro display Unit/lap top.

5.27 Auto control of engine stop (ACES) (Optional)
The functionality shall be in accordance with RDSO specification no. MP.0.2400.61 (Latest). However, the system shall be finalized by successful vendor in consultation with RDSO. Limits of the parameters shall be set through user settable parameters.

5.28 Distributed power (Optional)
The functionality shall be in accordance with RDSO specification no. MP.0.400.02 (Latest).

5.29 High-speed cruise control (Optional)
System shall have capability to run the train at predetermined speed entered though DID. However system can be automatically interrupted by the loco pilot.

5.30 Integration with digital air flow meter (Optional)
The system shall be suitable for interfaced with Digital airflow gauge to RDSO Specification No. MP.0.01.00.18. Digital flow sensor can be offered and it may be suitably integrated with the Microprocessor Controlled air brake system.

5.31 Integration with Fire Alerter (Optional)
Fire Alert alarm shall be Interfacing (relay output) with the system to Shutdown the Engine of locomotive with suitable message on Display unit
a. Apply Penalty Brake through VCD Magnet valve
Train line 11 shall be energised for MU operation. The system shall interface with Fire sensor through Digital input from Fire sensor (Where provided).

5.32 Integration with REMMLOT (Optional)
System shall be interfaced with REMMLOT. Remote Monitoring & Management of Locomotives and Trains (REMMLOT) shall be as per RDSO specification no. MP.0.04.02.04. (latest)

5.33 DIALS TFT display (Optional)
Analog dials and LED indications on the control stand shall be replaced by a pre-configured TFT LCD display screen/s and interfaced with the system for displaying important parameters required for driver. Display screen shall conform to RDSO latest specification no. MP.0.04.00.10.

5.34 Microprocessor controlled Air Brake System with versatile software (Optional)
System shall be integrated with Microprocessor controlled Air Brake System with versatile software (Specification No. MP.0.01.00.23 Rev 0 or latest)

5.35 END-OF-TRAIN TELEMETRY (Optional)
System shall be integrated with END - OF - TRAIN TELEMETRY confirming to RDSO functional requirement specification no..RDSO/2019/EL/FRS/0025 Rev.0 dated 25.06.2019 or latest.

5.36 Auto Creep Control (optional)
System shall have capability to run the train at predetermined low speed entered though DID. However system can be automatically interrupted by the loco pilot.

5.37 Speed Indicator (Optional)
System shall be integrated with speed indicator conforming to EMD Part no. 40087769 /40071195. Alternatively, digital speed indicator may also be integrated with MBCS as per Instruction Bulletin no.MP.IB.EC.01.01.20, Rev.0 or Latest.

5.38 Multiple Unit operation
The system shall be capable of multiple unit operation in consist of up to four diesel electric locomotives fitted with either the conventional "E" type excitation and control system or the microprocessor system.

5.39 Meggering
It shall be possible to megger by opening two or three connectors only.

5.40 Design of the system
The vendor shall associate Indian Railway in System engineering, Control Cubicle including cooling arrangement, wiring diagram / wire cutting charts of the locomotive fitted with their system. Prior approval of the RDSO shall take drawings & electrical schematic diagram and of the system. The design shall be far as common with existing systems.

5.41 Identification Plate
ID plate Name of Component, Make, Sl. No, Date of Manufacture, Ratings shall be provided on All assemblies /sub assemblies.

5.42 Climatic, Environmental Condition & Testing
One no. complete prototype system shall be tested to ensure compliances for climatic and environmental condition as per latest edition of IEC 60571 on any other equivalent IS Standard(Railway applications - Electronic equipment used on rolling stock). Verified Test certificates and reports submitted from internationally accredited/NABL accredited lab for environmental test compliances may be accepted. The Test Plan for prototype is attached as Annexure-1. Such tests are required only on initial approval, change of design and change of manufacturing processes.
These tests shall be done as pre-requisite for design approval.

5.43 Field trials

After successful prototype test and validation on locomotive, the Systems shall be subjected to field trials before clearance is given for bulk supply. The Qualifying period and Qualifying Quantity for field trials is governed by RDSO Doc.no.MP-M-8.1-1 (Latest). Feedback shall be furnished by User Railways as per prescribed format as follows:

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Loco No./Type</th>
<th>MBCS make</th>
<th>Date of commissioning of MBCS</th>
<th>Date of failure (if failed)</th>
<th>Date of rectification (if failed)</th>
<th>Feedback/Remark incl. comments on issues related to MBCS and its associated electronics if any.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Performance shall be closely monitored and evaluated by Vendor controlling authority for:
- Reliability under actual operating conditions
- Advantages for locomotive operation and maintenance
- Maintainability of the system

Notwithstanding anything that may be specified in this specification, the final responsibility for the suitability of the design shall lie with the vendor and shall carry out all modifications for satisfactory functioning during the period of field trials. Any safety related modifications issued by IR are to be carried out by the vendor.

5.44 Warranty, Support for Preventive & Breakdown Maintenance

The vendor shall guarantee the equipment against design and manufacturing defects for a period of two years from the date of commissioning. The reliability locomotives fitted with the microprocessor equipment should be available for a minimum of 95%.

The proposal shall be given for service support to be provided to diesel shed at the shortest notice. IR Staff shall also be associated with the supplier’s engineer for maintenance and operation. If the tenderer vendor does not have adequate service support, his offer will be liable for rejection.

AMC beyond warranty period shall be as per DLW’s Spec no. DLW/ALCo/AMC(micro)/01.

5.45 System integration

The vendor shall be primarily responsible for the system integration of the system offered by them with the other systems on the prototype locomotives. The tenderer vendor on the prototype (at least two different types of locomotives) shall demonstrate the system integration.

5.46 Training

The vendor shall arrange, free of cost training to the personnel of IR in India or abroad to make them proficient in operation and maintenance of the system and associated equipment. The to and fro fare and living expenses shall be borne by Indian Railways. Details of the training requirements shall be indicated by the tenderer vendor in its offer.

5.47 Documentation

1. Documents to be furnished with their offer
   - Schedule of supply with part number, Outline and general arrangement drawings, Printed product catalogue and standard data sheet of offered system.

2. Data and documents to be furnished before type testing
   - Detailed specifications (technical catalogue and data sheet) for the equipment offered.
   - Maintenance schedules for the major equipment
• Maintenance manual, Loco operational manuals and List of spares for maintenance.
• Commissioning test procedure for the locos.
• Driver's operating instructions and trouble shooting handbook.
• Schematics for the control and power circuit of the locomotive. Locomotive Circuit descriptions and sequence of operation where necessary.
• Detailed trouble shooting directory.
• Such design data as may be required by RDSO to establish the adequacy of the design.

5.48 Annexures
• Locomotive and E-Type Control Description.
• Typical power circuit for WDG3A and WDM3D class of locomotives.
• Characteristic curves for traction alternators, traction motors, exciters, auxiliary generators.
• Performance curve of the locomotives during Powering and Braking.
• List of high priority faults.
• Schematic of Vigilance Control system.
• Event recorder.
• Graphical (expanded) data of speedometer.
• User settable parameters.
• Type test and Acceptance test Plan.

6 Vendor changes in Approved status
All the provisions contained in RDSO’s ISO procedures laid down in document no. QO-D-8.1-11, dated 01.07.2020 (Titled “Vendor - changes in approved status) and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.

7 Undertaking by equipment manufacturer
Vendor shall provide a signed copy of the undertaking on “INFRINGEMENT OF PATENT RIGHTS”. The undertaking shall be as under:

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components in the design & development of this item and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such disputes/matters lies with the manufacturer/supplier.

Details / design/documents given by them are not infringing any IPR and they are responsible in absolute and full measure instead of railways for any such violations. Data, specifications and other IP as generated out of interaction with railways shall not be unilaterally used without the consent of RDSO and right of Railways / RDSO on such IP is acceptable to them.

8 Declaration of confidentiality of submitted documents by manufacturers
While submitting a new proposal/design, manufacturer must classify their documents confidentiality declaration, such as:

This document and its contents are the property of M/s XYZ (Name of the vendor) or its subsidiaries. This document contains confidential proprietary information. The reproduction, distribution, utilization or the communication of this document or any part thereof, without express authorization is strictly prohibited. Offenders will be held liable for the payment of damages. Indian Railways/RDSO is granted right to use, copy and distribute this document for the use of inspection, operation, maintenance and repair etc.

9 Preference to Make in India
The Government of India policy on “Make in India” shall apply.
## A. Type Test Plan for Microprocessor Based Control System

### (i) Environmental Test & Test on Simulator/Test Bed

Following table summarizes the type test of the equipment/system as per IEC 60571(Latest) or its equivalent to BIS:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Standard</th>
<th>Test Name</th>
<th>Test Location</th>
<th>Test Result/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>IEC 60571 - 12.2.2 or its equivalent to BIS</td>
<td>Visual Inspection</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>2.</td>
<td>IEC 60571 - 12.2.10.2 or its equivalent to BIS</td>
<td>Insulation Measurement Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>3.</td>
<td>IEC 60571 - 12.2.10.3 or its equivalent to BIS</td>
<td>Voltage Withstand Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>4.</td>
<td>IEC 60571 - 7.2.6 or its equivalent to BIS</td>
<td>Reverse Polarity Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>5.</td>
<td>IEC 60571 - 5.1.1.2 or its equivalent to BIS</td>
<td>Voltage Variation Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>6.</td>
<td>IEC 60571 - 12.2.3 or its equivalent to BIS</td>
<td>Performance Test with Simulator</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>7.</td>
<td>IEC 60571 - 12.2.6 or its equivalent to BIS</td>
<td>Damp Heat Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>8.</td>
<td>IEC 60571 - 12.2.4 or its equivalent to BIS</td>
<td>Cooling Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>9.</td>
<td>IEC 60571 - 12.2.5 or its equivalent to BIS</td>
<td>Dry Heat Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>10.</td>
<td>IEC 60571 - 12.2.8.1 or its equivalent to BIS</td>
<td>Surge Voltage Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>11.</td>
<td>IEC 60571 – 12.2.12 &amp; IEC61373-Cat.1-Class-B or its equivalent to BIS</td>
<td>Vibration and Shock Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>12.</td>
<td>IEC 60571 - 12.2.8.3 or its equivalent to BIS</td>
<td>Transient Susceptibility Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>13.</td>
<td>IEC 60571 - 12.2.9.1 or its equivalent to BIS</td>
<td>Radio Frequency Susceptibility Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>14.</td>
<td>IEC 60571 - 12.2.9.2 or its equivalent to BIS</td>
<td>Radio Frequency Emission Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>15.</td>
<td>IEC 60571-12.2.11 or its equivalent to BIS</td>
<td>Salt Mist Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>16.</td>
<td>IEC 60571-12.2.13 or its equivalent to BIS</td>
<td>Water Tightness Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>17.</td>
<td>IEC 60571-12.2.14 or its equivalent to BIS</td>
<td>Equipment Stress Screening Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>18.</td>
<td>IEC 60571-12.2.15 or its equivalent to BIS</td>
<td>Low temperature storage test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
</tbody>
</table>
1. **Visual Inspection as per clause 12.2.2 of IEC 60571**
   a. **Physical Dimensional Check**
      The Physical dimensions are to be measured and recorded as per the RDSO approved drawing.
   b. **Equipment Number plate verification:**
      Equipment number plate is to be verified.
   c. **Power ON check:**
      This check is to ensure that the system is working normal when the rated input voltage is connected to the system.

2. **Insulation Measurement test as per clause 12.2.10.2 of IEC 60571**
   - All the Input / Output pins of the unit are to be shorted together. All the Cards are to be removed from the respective enclosures.
   - The Insulation Resistance is to be measured through a 500V DC Megger between the body of unit and above pins.
   - The value should be >100 Meg Ohms.

3. **Voltage Withstand (Di-Electric) Test as per clause 12.2.10.3 of IEC 60571**
   - All the Input / Output pins of the unit are to be shorted together.
   - A test voltage of 1000V AC is to be applied by gradually increasing the voltage amplitude to set limit and maintained at that level for 1 min.
   - No disruptive discharge or flash over should occur. The system should work satisfactorily.

4. **IR Test after Dielectric Test**
   Repeat the “Insulation Resistance Test” after the Dielectric test once again and record the Insulation Resistance Values. Values of insulation resistance should not deteriorate much.

5. **Reversal of Polarity as per clause 7.2.6 of IEC 60571**
   - The equipment is to be connected with 72V DC in Reverse Polarity at the Power Supply input terminals and kept in that condition for one minute.
   - The equipment is then to be connected with normal polarity of 72V DC and status LEDs are to be verified
   - No damage should occur to the equipment because of reverse polarity.
   - The equipment should work normally after reverse polarity test.

6. **Effect of Voltage Variation Test as per clause 5.1.1.2 of IEC 60571**
   - The equipment is to be connected to a variable DC source with normal polarity and the voltage is set to 50V DC, (0.7 times of the rated voltage 72V DC).
   - Status LEDs are to be verified
   - Then the voltage is to be slowly increased and to be set at 90V DC (1.25 times of the rated voltage 72V DC).
   - Status LEDs are again to be verified
   - Finally the voltage is set to rated voltage of 72V DC.
   - Status LEDs are to be verified.
   - There should be no damage to the equipment or malfunctioning because of voltage variations.
   - The equipment should work satisfactorily in all above conditions.

7. **Performance Test as per clause 12.2.3 of IEC 60571**
   - Performance test or functionality of the system as per clause no.5.0-“Functional Requirements” is to be checked by RDSO on Simulator/test bed at the firm’s premises. Annexure-1(A) for functional test is given for guidance.

8. **Damp Heat test as per clause 12.2.6 of IEC 60571**
• Test is to be carried out as per IEC 60068-2-30, Test db. With +55°C as upper temperature limit and 2 cycles of 24 hours.
• The equipment is to be placed in the test chamber without powering ON.
• A functional performance test is to be carried out at the beginning of second cycle.
• After completion of test, equipment is to be allowed to recover to ambient conditions.
• An Insulation Measurement and Di-electric Test is to be carried out.
• No damage should occur to the equipment or malfunctioning should not occur because of Damp Heat.
• The equipment should work satisfactorily during Damp Heat Test.
• The Insulation Resistance is to be measured value should be >100 M Ohms.
• No disruptive discharge or flash over should occur in the Di-electric test.

9. Cooling start Test as per clause 12.2.4 of IEC 60571
• This test is to be carried out in accordance with IEC 60068-2-1
• The equipment is to be placed in a cold chamber without any voltage applied condition.
• The temperature is to be lowered from ambient to -0±2°C gradually.
• Once the the temperature in the chamber is stabilized at -0±2°C , the equipment is to be retained in the chamber about 2 hours at that temperature.
• The equipment is to be then powered up after approx 5 to 10 minutes.
• There should not be any damage to the equipment.
• Status LEDs are to be verified.
• No damage should occur to the equipment because of Cooling start test.
• The equipment should work satisfactorily.

10. Dry Heat test as per clause 12.2.5 of IEC 60571
• This test is to be carried out in accordance with IEC60068-2-2,
• The equipment is to be connected with 72V DC in normal polarity and placed in a hot chamber.
• The temperature is to be raised from ambient to 70±2°C.
• Equipment is to be kept in this condition for 6 hours, after stabilization of temperature.
• Status LEDs are to be verified at the end of 6 hours period.
• There should not be any damages to the equipment after the test.
• No damage should occur to the equipment because of Dry Heat Test.
• The equipment should work satisfactorily after the test.

11. Surge Voltage test as per clause 12.2.8.1 of IEC 60571
• The surge waveform is to be generated and tested using the generator and waveform as specified in IEC 62236-3-2:2008
• Surge Voltage is to be applied at BP and BN pins of working equipment.
• Status LEDs are to be verified after the test.
• There should not be any damage to the equipment.
• No damage should occur to the equipment because of Surge Voltage Test.
• The equipment should work satisfactorily after the test.
12. Vibration, Shock and bump test as per clause 12.2.12 of IEC 60571

- The complete cubicle with its mounting arrangements is to be subjected to the tests indicated in IEC 61373.
- There should not be any damages to the equipment after the test.
- No damage should occur to the equipment because of test.
- The equipment should work satisfactorily after the test.

13. Transient Burst Susceptibility test as per 12.2.8.3 of IEC 60571

- Test voltage of 2KV, 5/50 nS, 5KHz as per IEC 62236-3-2:2008 is to be used for testing.
- The test is to be carried out in working condition of equipment as per procedure of IEC 61000-4-4.
- No damage should occur to the equipment because of test.
- The equipment should work satisfactorily after the test.

14. Radio Frequency Interference Immunity test as per 12.2.9.1 of IEC 60571

- Radiated Radio Frequency Interference test is to be performed with 10V/m (r.m.s) severity as per IEC IEC61000-4-6
- The equipments is to be kept energized during the test.
- For conducted disturbances induced by radio frequencies fields, refer to IEC 62236-3-2:2008 (Table 7 and Table 8).
- For radiated disturbances induced by radio frequencies fields, refer to IEC 62236-3-2:2008 (Table 9).

15. Radio Frequency Interference Emission test as per 12.2.9.2 of IEC 60571

- Radio Frequency Interference emission test is to performed as per IEC 62236-3-2:2008
- The equipments is to be kept energized during the test.
- The equipment is to be tested to the requirements as specified in IEC 62236-3-2:2008 (Table 3,Table 4, Table 5, and Table 6).

16. Salt Mist Test as per IEC 60571-12.2.11

a. Salt solution

- The solution for producing the salt mist is to be prepared by dissolving (50 ± 1) g Sodium Chloride (NaCl) analytical reagent quality, in distilled or demineralised water to make up(1 ± 0,02) l of final solution at 20 °C; if the pH does not lie between 6,5 and 7,2, the solution is to be rejected.

b. Test procedure

- During the test, the temperature in the test chamber is to be maintained at (35 ± 2) °C.
- The solution and the air used to produce the salt mist should have a temperature equal to that of the test chamber.
- The equipment is to be tested in the manner in which they are expected to be used, i.e. protective covers should be in position and the equipment arranged, as nearly as possible, in the position it will occupy in actual use.
- The test chamber is to be kept closed and spraying of the salt solution is to be continued without interruption during the whole conditioning period.
- The period shall be:
  - for class ST2: 16 h;
  - At the end of the test, the equipment is to be washed in running tap water for 5 min, rinsed in distilled or demineralised water, then dried to remove droplets of water and stored under standard atmospheric conditions of the testing area for not less than 1 h, no more than 2 h.
- After that, the equipment is to be subjected to a visual examination.
- No major damage shall occur.
- A performance check shall not show any failure or damage nor any results which are beyond the specified tolerances.

17. Water tightness test as per IEC 60571-12.2.13
- As electronic equipment is generally mounted either inside the body of the vehicle or in boxes outside, there is no need to carry out water tightness tests, apart from exceptional cases to be defined between user and manufacturer.

18. Equipment stress screening test as per IEC 60571-12.2.14
- A screening procedure to be applied to completed equipment or a part of it, for the purpose of eliminating dormant manufacturing or component defects.
- Burn-in test

After mounting of components, the populated PCB cards are to be kept in proper chassis in energized condition is to be burnt in for minimum 45 hrs at +70 deg. C and -25 deg C as per the cycle at figure above, wherever specified in the main specification. The PCBs is to be tested for functionality to the extent possible during the burn-in test. This will be mutually decided.

19. Low temperature storage test as per IEC 60571-12.2.15
- This test is to be in accordance with IEC 60068-2-1.
- The temperature value for the test shall be –40 °C and the time period shall be 16 h minimum.
- After recovery, a performance check shall be carried out at ambient temperature.
- No damage should occur,
- The functional check should not show any failure nor any results beyond the specified tolerances.

(ii) Loco Validation test

After successful prototype test as given above, the prototype shall be subjected to loco validation test which includes load box test, checking of functional test, RRT, etc. Functional test of the MBCS should be
carried out to verify the functional requirements of the specification stated at Clause 5. The detailed functional test plan may vary from vendor to vendor based on their design. Hence, vendor shall submit the detailed functional test plan as per their design meeting the functional requirement of the specification for approval by RDSO before prototype test. For guidance, the functional test plan is given at Annexure-1(A).

B. Acceptance Test Plan

This test is to be conducted for the system other than prototype for purchase inspection. This is the subset of type test mentioned above. Following test is required to be conducted for Acceptance test plan. The sampling plan as per IS: 2500, Pt.I, General Inspection Level-II should be adopted for selecting the samples against the lot and determining the acceptance/rejection of lot based on test result.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Standard</th>
<th>Test Name</th>
<th>Test Location</th>
<th>Test Result/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>IEC 60571 - 12.2.2 or its equivalent to BIS</td>
<td>Visual Inspection</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>2.</td>
<td>IEC 60571 - 12.2.10.2 or its equivalent to BIS</td>
<td>Insulation Measurement Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>3.</td>
<td>IEC 60571 - 12.2.10.3 or its equivalent to BIS</td>
<td>Voltage Withstand Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>4.</td>
<td>IEC 60571 - 7.2.6 or its equivalent to BIS</td>
<td>Reverse Polarity Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>5.</td>
<td>IEC 60571 - 5.1.1.2 or its equivalent to BIS</td>
<td>Voltage Variation Test</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>6.</td>
<td>IEC 60571 - 12.2.3 or its equivalent to BIS</td>
<td>Performance Test with Simulator</td>
<td>At firm’s premises/NABL Labs</td>
<td>Pass/Fail</td>
</tr>
</tbody>
</table>

Note: The Test plan given above is the minimum requirement and strictly governed by IEC 60571. The latest edition of IEC 60571 shall apply mutatis mutandis to this Test plan. The test other than above as specified may also be considered with mutual agreement between vendor and Vendor approving authority, if desired so.
1. Excitation Control:

Excitation Control of Traction Alternator:
The test consists of operating the Diesel engine at different Notches from 1 to 8 & at the same time varying the load on the traction motors to operate the Loco simulator in the different modes of Constant V limit mode, constant HP Limit mode and Constant I limit. mode. Using software send Excitation parameters , auxiliary parameters and wheel slip parameters to the control unit before starting the test.

Set up : Connect the Control unit and Display unit in the Loco simulator and switch on the breakers and after cranking GF1 and GF2.

A) Traction Alternator Voltage Limit Test
With Low load on the Traction alternator , change the notches one after the other & note down the TA volts after RPM for the Notch has stabilized. Observe TA volts at V-Limit as per acceptable design limits.

B) Traction Alternator Current Limit Test
With high load on the Traction alternator , change the notches one after the other & note down the TA current after RPM for the Notch has stabilized. Observe TA Current at I-Limit as per acceptable design limits.

C) Traction Alternator GHP Limit Test
With medium load on the Traction alternator , change the notches one after the other & note down the GHP after RPM for the Notch has stabilized. Observe TA GHP limit as per acceptable design limits.

D) Power De-ration due to Engine water temperature
Power De-ration due to engine water temperature condition can be tested by simulating the increased engine water temperature from as per design temperature limits and note down the TA O/P HP DE-ration (Power De-Ration as per design duration percentage). Unit displays suitable messages. Selected Notch for Experiment: 8th Notch

E) Power De-ration due to Lube oil temperature
Power De-ration due to lube oil temperature condition can be tested by simulating the increased lube oil temperature for design temperature values. and note down the TA O/P HP DE-ration (Power De-Ration as per design duration percentage values). Unit displays suitable messages. Selected Notch For Experiment: 8th Notch

2. Auxiliary Generator Control and Battery Charging:
The test consists of loading the auxiliary generator and checking for the AG control and battery charging functionality. By changing the AG control parameters(Using System software)- Aux. Gen. O/P Volts , AG Armature Current Limit , BAT Charge Current Limit ,Battery Voltage at Min. Battery Temp. to values less than actual values in any Notch we can test Voltage-Control , Current-Limit , Battery Temp. Limit and Battery charging current Limit.

3. Performance test of Control Unit : Propulsion Control

A) Sensing and implementation of Master Control Settings:

<table>
<thead>
<tr>
<th>Sn.</th>
<th>Test Details</th>
<th>Acceptance Criteria</th>
<th>Observations</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Set the Master Control as below: Selector Handle – Motoring Reverser Handle - Forward Master Handle – Notch 1 to 8</td>
<td>The System Software should control the traction motors in the simulator setup in such a way that they move in Reverse direction and pick up speed based on Notch elected. Also the display will show the Engine RPM corresponding to selected Notch , Engine Speed and notch number.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Set the Master Control as below: Selector Handle – Motoring</td>
<td>The system software should control the traction motors in the simulator setup in such a way that they move</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Reverser Handle - Reverse
Master Handle – Notch 1 to 8

in Reverse direction and pick up speed based on
Notch selected. Also the display will show the
Engine RPM corresponding to selected Notch ,
Engine Speed and notch number.

3. Set the Master Control as below:
Master Handle - Ideal
Selector Handle – Braking
Reverser handle – Forward or Reverse
Master Handle – ‘B’ (Braking Side)
The system software should control the traction motors in
the simulator setup to bring them to halt condition by reducing the Loco speed based on
Braking Control Potentiometer position that is selected on the MH .On the display we can see
Loco speed , along with with % of Brake applied Values.

### B Engine Speed Control Test:
This test involves to check whether Engine speed increases with increase in Notch & decreased with decrease in Notch. Hence Select different notches & note corresponding Engine RPM.

<table>
<thead>
<tr>
<th>Notch</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td>350±3</td>
</tr>
<tr>
<td>1</td>
<td>400±3</td>
</tr>
<tr>
<td>2</td>
<td>450±3</td>
</tr>
<tr>
<td>3</td>
<td>550±3</td>
</tr>
<tr>
<td>4</td>
<td>650±3</td>
</tr>
<tr>
<td>5</td>
<td>750±3</td>
</tr>
<tr>
<td>6</td>
<td>850±3</td>
</tr>
<tr>
<td>7</td>
<td>950±3</td>
</tr>
<tr>
<td>8</td>
<td>1050±3</td>
</tr>
</tbody>
</table>

### C Motor Transitions Control and Field Weakening Test:
This test involves to check whether the Microprocessor based control system is able to configure the Traction motors in 2S-3P formation-(3 parallel paths consisting of 2 traction motors in each path) to achieve high initial Torque and when speed picks up it should be able to configure the Traction motors in

<table>
<thead>
<tr>
<th>Speed</th>
<th>Traction Motor Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;45</td>
<td>2S-3P Series Full Field to Series Weak field</td>
</tr>
<tr>
<td>&gt;80</td>
<td>2S-3P Weak field to 6P</td>
</tr>
</tbody>
</table>

Configuration of traction motors should change as described below:

#### Up Transition

<table>
<thead>
<tr>
<th>Speed</th>
<th>Traction Motor Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>6P to 2S-3P</td>
</tr>
<tr>
<td>&lt;30</td>
<td>2S-3P weak field to 2S-3P</td>
</tr>
<tr>
<td>6P formation (6 parallel paths consisting in one traction motor in each path) to achieve higher speeds. Note: 2S-3P to 6P is called Up transition and 6P to 2S-3P is called Down transition. <strong>Note:</strong> Transition configurations settings for 2S-3P and 6P are subject to change as per requirement and type of locomotives.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

- When seen on the display unit in the HP status screen, the SITE HP should be equal to Sum of following.

  
  SITE HP =
  
  TA Input HP + TMBLR HP + RFC HP + EXP HP + EXC HP + AG HP

---

**D Control of Auxiliaries & Radiator Fan:** This test is to check whether power to auxiliaries including radiator fan is controlled by control unit.

- In 8th notch, simulate the following conditions:
  - Compressor in ON condition.
  - Radiator in ON condition.

---

**E Low idle feature**

- a) Engine should run at idle with 400 rpm continuously for 5 minutes and Lube oil Pressure is more than or equal to 1.7 Kg/cm².

---

**F MCBG Interface Test**

- System Software should have provision for interface with MCBG and collect the Eng RPM, LOP, BAP & FOP signals for loco operation.
  - a) Disconnect the Eng RPM cable of system software at RDB Unit.
  - b) Disconnect the following pressure sensors from MCBG

  **Applicable only when MCBG is interfaced with MBCS.**

- The microprocessor through Governor shall bring the engine to low idle at 350 rpm.

---

System software should show Eng RPM signal by taking from MCBG
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System software. BAP Sensor LOP Sensor FOP Sensor</td>
<td>System software should show LOP, BAP &amp; FOP values</td>
</tr>
</tbody>
</table>
| G | **T**ractive **E**ffect **L**imit Test:  
This test is to check whether control unit is able to limit the TA current to a predetermined value through user settable parameter. 
With TE Limit S/w in OFF condition Run the system in 8th Notch, note the TAAI then throw the TE Limit switch to ON position. | TA current should get restricted to the Pre-determined value. |
| H | **P**ower Setter Test  
This test is to check whether the rear locomotive can be brought to idle condition from lead loco whenever required to save fuel. 
Run the engine in 8th notch and put 16D to trail side & enable power setter switch. 
If Disable Power Setter Switch. | It should be possible to bring rear loco to idle or Normal condition whenever required. 
Engine should come to IDLE 
Engine will raise to 8th Notch |
| I | **C**ontrol of Pre and Post Lubrication:  
In pre lubrication arrangement, oil under pressure is supplied to the engine during the first few revolutions of cranking. 
Pre Lubrication should not take | When Start push button is pushed, A suitable message should be displayed along with a LED glowing and a counter showing the time left over to complete the Pre lubrication operation. Only after 60Sec Engine cranking should be permitted. 
Engine should crank with out Pre |
place in case Locomotive is started within half an hour from the last Shut Down.

Pre Lubrication should take place in case Locomotive is started after half an hour from the last Shut Down.

In post Lubrication arrangement, oil under pressure is supplied to engine after shut down for an interval of 5 min.

Lubrication.

Pre Lubrication will activate and engine will crank soon after complete Pre-Lubrication.

Post Lubrication should activate soon after Engine shut down & a suitable message should be displayed.

| J | **Wheel Slip**:  
1) Alter the RPM of any of the traction motors to create a Wheel slip condition.  
2) Restore back the disturbed RPM of the traction motor. |
|---|---|
|   | a) Sander should get operated and display will show this wheel slip Status.  
   | b) Also note that control unit reduces output HP to decrease the power to traction motors.  
   | Sander should stop, Output power will be restored. |

| K | **Fault diagnostics & Data Pack**:  
   | a) The system has built in Fault diagnostics, trouble shooting and necessary information to Drivers / maintainers. It should have provision for analysis of the 8 seconds fault data through display.  
   | b) Provision shall be made to enter (i) Train Number / name in 8 digits (ii) Loco pilot ID/ name in 12 digits manual by the Loco Pilot with Alpha numeric keyboard.  
   | c) The fault detection and diagnostics should be of comprehensive nature to include all possible faults like open circuit, stuck closed faults and the details of fault messages shall be displayed on display panel.  
   | d) Any occurrence of fault should be displayed. The fault displayed message |
should have Fault code, fault message, Date & Time trouble shooting advice (where ever applicable). It should log 90 seconds data pack for critical faults as per and 8 seconds data pack remaining faults.

### Example: Some Faults Simulation to check action taken by the system

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td>In running condition simulate the condition Of Low water Level.</td>
<td>Engine Should Shut Down. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>2.</strong></td>
<td>In running condition simulate the condition Of Engine Over Speed</td>
<td>Engine Should Shut Down. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>3.</strong></td>
<td>Simulate the condition of Control Circuit Ground Fault and then try to crank the Engine.</td>
<td>Cranking Should get Prohibited. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>4.</strong></td>
<td>In running condition simulate the condition of Power Circuit Ground Fault</td>
<td>Motoring and Dynamic Braking Should get Prohibited and Engine should be brought to Idle. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>5.</strong></td>
<td>In running condition simulate the condition of Loco over speed.</td>
<td>Engine should return to Idle condition. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>6.</strong></td>
<td>In running condition and above 4th Notch simulate the condition of Rectifier Diode Hot.</td>
<td>Engine power should limited to 4th notch. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>7.</strong></td>
<td>Simulate the condition of Stuck Closed Fault for S31 contactor.</td>
<td>Loco should not take change from 2S-3P to 6P up transition. A Suitable message should display.</td>
</tr>
<tr>
<td><strong>L</strong></td>
<td>Real Time I/P, O/P &amp; Derived data:</td>
<td>System should display real time Input (TAV, TAAI), Output (LA/Max TMAI), calculated parameters (GHP), during Locomotive operation Motoring.</td>
</tr>
</tbody>
</table>

### M Information Pack:

1. In addition to fault archive, following parameters shall get recorded at every 10Min interval and keep record of around 45 days data:

   - TA VOLTAGE
   - TA CURRENT
   - Lube Oil Pressure_LOP
   - Fuel Oil Pressure_FOP
   - Booster Air Pressure_BAP
   - Eng. Water Temp._EWT
<table>
<thead>
<tr>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lube Oil Temp. _ LOT</td>
</tr>
<tr>
<td>- BAT charging/dis charge A</td>
</tr>
<tr>
<td>- NOTCH</td>
</tr>
<tr>
<td>- GHP</td>
</tr>
<tr>
<td>b) The information archive shall also provide following cumulative information,</td>
</tr>
<tr>
<td>- Engine Run Hours</td>
</tr>
<tr>
<td>- Distance Traveled</td>
</tr>
<tr>
<td>- Traction Energy Consumed in KWH</td>
</tr>
<tr>
<td>- GHP Hours</td>
</tr>
<tr>
<td>This information shall be viewed Notch wise, Trip wise, monthly wise or cumulative.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Engine Run Hours</td>
</tr>
<tr>
<td>- Distance Traveled</td>
</tr>
<tr>
<td>- Traction Energy Consumed in KWH</td>
</tr>
<tr>
<td>- GHP Hours</td>
</tr>
<tr>
<td>c) In addition to information pack, a steady state pack gets recorded. When ever the Loco works on 7th / 8th Notch for more than 3 Mins, the following data stored in this pack after expiry of 3 Mins.</td>
</tr>
<tr>
<td>After recording one reading during steady state the next reading should be recorded after 30 Mins.</td>
</tr>
<tr>
<td>- Loco Number</td>
</tr>
<tr>
<td>- Date &amp; Time</td>
</tr>
<tr>
<td>- NOTCH</td>
</tr>
<tr>
<td>- GHP</td>
</tr>
<tr>
<td>- ENGINE SPEED</td>
</tr>
<tr>
<td>- FOP</td>
</tr>
<tr>
<td>- LOP</td>
</tr>
<tr>
<td>- BAP</td>
</tr>
<tr>
<td>- EWT</td>
</tr>
<tr>
<td>- LOT</td>
</tr>
<tr>
<td>- TA VOLTAGE</td>
</tr>
<tr>
<td>- TA CURRENT</td>
</tr>
<tr>
<td>- BAT Charge/Discharge Amps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Data Downloading</td>
</tr>
<tr>
<td>a) It should be possible to download the data from system to PEN DRIVE / LAPTOP through USB port.</td>
</tr>
<tr>
<td>b) It should be possible to On line monitor &amp; record the various excitation and propulsion parameters through a Lap top computer. Analysis software should support in both tabular &amp; graphical for analysis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Event Recorder</td>
</tr>
<tr>
<td>The system shall recorded following events in a separate(take out) memory unit or filter mode to separate these data from the continuously recorded other data of the Locomotive.</td>
</tr>
<tr>
<td>- TRAIN BRAKE PIPE PRESSURE_BPP</td>
</tr>
<tr>
<td>- LOCO BRAKE CYLINDER</td>
</tr>
</tbody>
</table>
### PRES._BCP
- VCD T2 Cycle Operation Status
- VCD T3 Cycle Operation Status
- VCD Acknowledgment/RESETS/w
- VCD Fail
- VCD Isolated
- NOTCH
- Power Application_ MOT / DB Status
- Loco direction_ FOR / REV
- LOCO SPEED
- HEAD LIGHT_ ON/OFF & BRIGHT / DIM
  - FLASHER LIGHT _ ON / OFF
  - TE LIMIT S/W _ ON/OFF
  - SHED NAME
  - LOCO NUMBER
  - DISTANCE IN KM
  - DATE & TIME
  - TE LIMIT CURRENT

### Q Internal Memory
Events shall get recorded electronically every second in circular form for last 24hrs.

In stand still Loco, the events shall get recorded only if one of the parameters changes.

b) And shall be accessible through a USB port with proper sealing arrangement.

Separate Password provided (other than one provided for down loading Data Pack & Information Pack) for down loading the Event Recorder data through PEN DRIVE / LAPTOP.

### R External Memory
A portable flash memory card confirming to industrial standard ruggedly designed to work at 70 Deg C. The card shall be interchangeable from one Loco to other and also from one unit to other unit and should record one second data for the last 24 hrs of loco travel in loop form.

This Memory card shall be removed from the locked cassette compartment and can be inserted in to Memory Reader unit or connected to LAPTOP directly for Down Loading the data.

After the Data downloaded the Memory Card shall be erased through Analysis Software for re-use.
<table>
<thead>
<tr>
<th></th>
<th>Graphical &amp; Tabular Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>A graphical &amp; tabular analysis of the recorded data should be supported by the analysis software.</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Memory Freeze</td>
<td></td>
</tr>
<tr>
<td></td>
<td>System should have Memory freeze facility to allow the locomotive to be moved after an incident without over writing the last 8 hrs data.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The switch for freezing the data shall be under a sealed glass cover and when this switch is enabled an LED indication should be provided to indicate the Memory Freeze Status.</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>Multi Setting Vigilance Control:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) Perform any of the following operations in Vigilance cycle T0.(60 Sec).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) VCD reset button pressed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Change the throttle handle Position.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Application of dynamic brakes &amp; Change in brake level.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Operation of Horns.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Operation of sanders.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) Application of brakes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If none of the above operations are performed in 60 Sec.</td>
<td>VCD should get reset.</td>
</tr>
<tr>
<td></td>
<td>2) If any of the above operation are performed in Level 1 Warning cycle T1.(8 + 2 sec.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If none of the above operations are performed in T1 cycle.</td>
<td>Level 1 warning cycle T1 should start.</td>
</tr>
<tr>
<td></td>
<td>3) If any of the above operation are performed in Level 2 warning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VCD should get reset.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 2 warning cycle T2 Should start.</td>
<td>VCD should get reset.</td>
</tr>
</tbody>
</table>
### V suppression of VCD

- **a)** Increase the Brake cylinder pressure (BCP) to greater than 1.5 Kg/cm² and reduce loco speed to zero.

- **b)** With BCP > 1.5 Kg/cm² and simulate a speed greater than 3 Kmph.

### W VCD during MU operation

Switch OFF the MCB1 & MCB2 circuit breakers to simulate the condition of loco in trailing position during multiple unit operation.

### X Automatic Flash Light Control:

Pressure Switch 1 for Auto Flasher Light (AFL P1) will remain Open as long as required control air pressure is available.

Pressure Switch 2 for Auto Flasher Light (AFL P2) will remain Open as long as required control air pressure is available.

Penalty brake cycle T3 should start.

VCD should not get reset.

VCD should be able to reset only after bringing MH to Idle & after pressing VCD reset button.

Penalty brake cycle T3 should start.

VCD should start functioning.

VCD functionality should get suppressed.

VCD should start functioning.

VCD functionality should get disabled.
Light (AFL P2) will remain Open as long as Brake Pipe Pressure is > 4.5 Kg/cm².

a) **Simulating Train Parting:**

With AFL P1 still in open condition, Close AFL P2.

b) Since in normal service brake application condition, the control air pressure drops faster than the brake pressure, simulate the same by closing first the switch- AFL P1 followed by closing the switch- AFL P2

<p>| | |</p>
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Since in normal service brake release involves in building control air pressure first &amp; then within 60 Sec, the brake pressure also should build, simulate this condition by opening the AFL P1 followed by opening the switch- AFL P2 within 60 Sec.</td>
</tr>
<tr>
<td>Z</td>
<td>Simulate a condition of control air pressure building up but failing of brake pressure building up by opening the switch AFL P1 followed by opening the switch- AFL P2 but with a delay greater than 60 sec.</td>
</tr>
<tr>
<td>AA</td>
<td>Engine Speed</td>
</tr>
</tbody>
</table>

DMR should De-energize & engine should be brought to Idle.

DMR should remain energized.

FLASHER LED, AFLR buzzer should ON.

DMR should remain energized.
Sensor Test:
The purpose of this test is to check whether engine will continue to work in the event of failure of one of the two engine speed sensors.

a) When engine is in running condition Simulate the condition of making one of the engine speed sensors faulty.

Engine should not fail & should start working on other speed sensor.

AB Loco Testing:(Load Box Test) Facility should be available to conduct Load box test & this test mode should be password protected.

AC Self Load Box Test: The system shall be able to run a self-Load test for confirming availability of power to traction systems. The power generated during Self Load test should get dissipated in DB grid Resistors.

AD Self Test The system shall be able to run a self test at Power ON at drivers request to verify functioning of system including Input & out Put.

AE Automatic Emergency Brake System:
This test is to check whether control unit can apply a automatic penalty brake at a Pre-determined user settable speed.

a) Simulate to set the speed limit at which AEB should be applied and simulate the condition of AEB enabled and Try to increase the Loco speed.

Penalty Brake should get applied at predetermined Loco speed irrespective of Motoring mode or Dynamic mode.

AF Fire Alerter:
This test is to Fire Alarm ON in Self Loco. A suitable
check whether control unit can shut down engine.

| a) Keep the engine running and. Fire Alerter toggle switch in On position. | message will be appeared on the display. System will apply the penalty brake and shutdown the engine. |
| b) Keep the engine running. MU fire alarm rotary switch is in ON position, 16D is Low and Fire Alerter toggle switch in On position. | Fire Alarm ON in MU Loco. A suitable message will be appeared on the display. System will apply the penalty brake and shutdown the engine. |