PART- 1
(On-Board Remote Monitoring System)
of
Technical Specification
of
Data Retrieval and Analytics System
for
Three Phase Electric Locomotives

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Brief Description

This is a part of a four-part specification numbered 0 to 3 describing the requirements for setting up systems for Data retrieval and Analytics system for Three Phase Electric locomotives (DRAS).

FOREWORD

DRAS Enables remote monitoring of Electrical Locomotives. It creates a complete IT enabled ecosystem which provides a platform for remotely monitoring health and operational characteristics of electric locomotives.

It also enables monitoring of performance of crew and helps in identifying lapses. This will enable focused counselling and training of such crew, who are prone to unsafe working.

DRAS also monitors condition of locomotive and makes preventive and predictive maintenance of locomotives more effective. DRAS monitors shutting down of locomotives when idle for a long time and generates management information to ensure this.

The complete specification for DRAS is split over four parts numbered from 0 to 3. Together these parts specify the requirements for setting up the complete system.

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1. Introduction

This document is part of set of documents specifying equipment and services for the deployment of DRAS. Kindly see the list of referenced documents for locating other documents of the set.

2. Scope &Objective:

This document describes the requirements of locomotive remote monitoring system consisting of on-board equipment i.e. Onboard Remote Monitoring System (ORMS) required for the implementation of DRAS.

3. Abbreviations & Keywords used throughout the document:

Kindly refer common list in part 0 of the specification

4. Keywords:

Kindly refer common list in part 0 of the specification..

5. Brief description of the system/equipment/components

The locomotive On-board Remote Monitoring System (ORMS) consists of hardware components and associated modification and integration of software for making the equipment functional and interfaced to the locomotive central computer. The following shall be considered as part of this equipment:

- Interface card for locomotive VCU providing full functionality required for ORMS.
- Antennae suitable for mounting on the locomotive inclusive of mounts and shrouds / covers protecting the antennae from environmental and physical damage.
- Connectors / cables and wiring accessories required for making the equipment functional.
- Software for enabling all equipment features on the locomotive computer.
- Service support required for fitment, integration, software modification for making the features fully operational.
- Communication system with required communication link for transfer data. This provision shall include connectivity (including subscription cost) for the specified warrantee period.
- Training for operations and maintenance of the equipment.
- A utility for download and convert the data logfile of the VCU to NI TDMS format.
- ORMS shall have 32 number of Analog and 32 number of Digital channel configurable through software for acquisition of additional parameters of locomotives such as current, voltage, pressure, temperature, switch position, etc. The sensors are not under scope of supply of this specification. IR will procure and

provide sensors as and when required. The sensors shall be of standard sensor used in rolling stock. The type and details of sensor shall be finalized in consultation with ORMS vendor. The details of such sensor would be provided to vendor for necessary calibration and recording and relaying of parameters through ORMS.

6. General requirements

6.1. Equipment Requirements The equipment specified in this document is expected to meet the following general requirements:

- The equipment shall be designed for installation on three phase electric locomotives. The equipment manufacturer shall get the equipment design approved by CLW before fitment on locomotives.
- The computer interface cards of the equipment shall be interfaced with the locomotive computer, preferably be an integral part of the system and shall plug into the system bus.
- The antennae for GPS and communication link shall be fitted on the locomotive exterior and shall be located for best possible reception / transmission. These antennae shall not violate the MMD of Indian Railways.
- The equipment, cabling and connectors shall be designed to handle the harsh environmental conditions of the locomotive.
- The equipment shall be capable of working in all types of electrified as well as non electrified territories.

7. Training

The equipment manufacturers shall arrange, training this shall be a part of the equipment supply. Personnel of Indian Railways shall be nominated to attend. The to and fro fare and living expenses shall be borne by Indian Railways.

8. Functional Requirements

The expected functional requirements of the system components are provided briefly as under.

8.1. Provision for Locomotive Remote Monitoring through DRAS web portal.

8.2. Real time data can be viewed in Electric Loco Sheds and Traction Loco Controllers through internet. The same can be accessed by any authorized person by logging into ORMS's web portal.

8.3. The supplier, supplying the system, shall create facilities such as memory space, communication devices and support for a minimum period of five years from the date of commissioning.

8.4. All the data shall be available with GPS location, date and time stampings. In addition to geographical location, location on rail network indicating line and section should also be shown. Stations within a division can be mapped in look

up table of RMS server to indicate division along with location of locomotive also.

8.5. In case of problem with GPS signals, the system shall display last GPS location. On availability of signals, it will update automatically.

8.6. Facility of configuration of SMS and/or e-mail alerts in case of any major fault and/or isolation of any safety equipment in locomotives should be available.

8.7. Provision for downloading of fault data or DDS and stored data of any safety equipment for report generation, analysis, remedial action etc. shall be provided in web server. The format of the uploaded data shall be decided by Indian Railways.

8.8. ORMS system shall be able to record long and short-term event recorder and fault data packs. Data is stored in the ORMS system data logger. ORMS shall have the required non-volatile memory for recording of 72 hours of short term data with a sampling rate of 1 sample per second. Approximately 100 signals shall be required to store. Final list shall be decided during the design finalization stage. Long term data to approximately 90 days with a sampling rate of 1 sample per 10 second shall be recorded. Approximately 100 signals shall be required to store. Final list shall be decided during the design finalization stage. There shall be provision to download the above data in laptop and visualize it thought proper applications.

8.9. The complete system should be accommodated in the existing locomotive without much alterations/shifting of equipments.

8.10. The ORMS, which shall house the GPS, antenna & associated modems and intelligent processor unit shall be mounted on the locomotive (preferably on the roof of the locomotive for better network and GPS connectivity).

8.11. The ORMS, if mounted on the roof, shall be at least IP 67 class ingress protected, after it is mounted with mounting stool on the loco. The system shall have its own power supply unit, which shall work from locomotive battery at 110V DC nominal, with variations defined in IEC-60571. There shall be hot redundancy of power supply unit so that if one power supply unit fails system should work on second power supply until with any deterioration in performance. The power supply shall be routed to the unit by 3 pin bayonet locking connectors conforming to MIL-C-26482 suitable for outdoor use.

8.12. The remote monitoring unit shall communicate with the web application server through commercially available communication link. Network modems or better high frequency network should be used in the system. GPS module and the selection of commercial network service provider (such as Airtel, Vodafone, JIO, BSNL, etc.) shall be decided by the supplier depending on their

design and network availability at different geographical locations across India. But, the supplier should ensure high rate of data availability at all the times.

8.13. The contractor shall supply SIM as a part of the system and should bear all the expenses including SIM registration charges, and monthly rent for the data connection for the first five years from the date of commissioning. Contractor should also offer the rates for the Annual Maintenance Charges (AMC) for the operational expenses of cellular data connection and ORMS device for next three years after the warranty period of five years.

8.14. Minor deviations from the specification if any, can be mutually sorted out with CLW during development stage if supported by justification on ground of cost and/or technical superiority.

8.15. The complete system shall be capable of working with MICAS and TCN based VCU, which is as per latest CLW/RDSO specification.

8.16. The On-Board Remote Monitoring System (ORMS) shall continuously monitor the heath of the vehicle over the MVB and in case of any new fault generated, the corresponding DDS and the background data are to be extracted and sent to the remote monitoring unit for transmission to the web application server through Two number of redundant network modems or better high frequency network. For integration with MVB system, ORMS vendor shall be ready to closely work with Propulsion vendors of three phase locomotive for software and hardware integration.

8.17. Real time data is required to be captured and transmitted to the web application server in every 1 (one) second.

8.18. All types of data shall be stored and maintained in the web application server. The web portal/web application server, hosted by IR and/or CRIS, shall be connected properly with the ORMS through specific static IP address so that no error/cross communication takes place.

8.19. Data pack transmitted to the web application server by remote monitoring unit shall be stored as an accumulated database for further filtering and viewing, whenever required. The database shall be in one of the standard packages like ACCESS. Contractors shall associate themselves with IR and/or CRIS in developing a system for creating the above database.

8.20. Modification of software shall be the responsibility of the contractors and CLW will give details of the telegram address & process variables list to the contractor. Accordingly, the contractor can generate the frame of ORMS data, with the help of supplied telegram address & process variables list, which will be read from the locomotive and sent to the web application servers. The changed software along with the source code and comprehensive details of changes shall be submitted to CLW for approval.

8.21. Provision is to be made in RMS system to upload data of other third-party equipment in RMS server by maintenance personnel of sheds for further mapping.

8.22. Provision is also to be made for giving alerts (pop-up/scroll) for important data/signal by changing colour of blinking. Scheme will be similar to MICAS system where Pop up messages come first as alert and P1 message comes on occurrence of major fault/isolation of subsystem.

9. Technical Requirements

9.1. For the electronic equipments to be supplied against this specification, the supplier shall make use of components and systems of high reliability, suitable for rolling stock applications. In this regard, the supplier is advised to refer to "Rules for Electronic Equipments used on Rail Vehicles IEC Publication 60571".

9.2. Adequate provisions should be made in the design for suppression of internal transients, spikes and to withstand external transients, spikes and surges as per limits laid down in IEC-60571 edition-3 or latest.

9.3. All electronic components and ICs used shall be selected after proper burn in and screening tests and shall be adequately rated to withstand the service requirements. A quality assurance scheme should be submitted by the supplier for approval of CLW.

9.4. All the components on PCBs shall preferably be wave soldered. The surface mounted devices should be mounted using SMT workstation.

9.5. All the connecting wires, cables used on PCB in the subunits should be properly laid out with suitable connector. The cable used inside the subunit should be properly supported with stiffeners. No soldering should be done on the PCB for inter connection.

9.6. Polarized bayonet type circular connector with crimped pins will be used for all external connections. These should be confirming to JSS no. 50815 design to meet the specification.

9.7. The equipment should function satisfactorily under 25 kV A.C. electric traction. It should not be susceptible to malfunction due to interference from overhead traction power supply lines or under abnormal conditions such as overloads and faults in the electrical traction circuits of the locomotives.

9.8. The tracks over which the Locomotive shall work may be equipped with AF (Audio Frequency)/ DC track circuits and AC track circuits at 83.33 Hz and at higher frequencies. Similarly, other devices like axle counters, block instruments, point machines, etc., may also be used. On the communication network, control circuits and tele-printer circuits, VHF/UHF and microwave circuits are used. ORMS shall not affect the performance of the above equipments.

9.9. On-Board Remote Monitoring System:

9.9.1. The equipment shall house its own power supply modules (including hot redundant power supply), which will work from the locomotive battery. The nominal battery voltage is 110V DC, which is subjected to variation from 77V to 137.7V as per IEC-60571. In addition to this a self battery pack for giving power to ORMS for at least 24 hours with inbuilt charging facility is to be accommodated. The manufacturer shall provide the life and periodicity of change of battery during design approval stage to CLW.

9.9.2. MVB connection at the equipment side shall be provided through a 9 or 15 pin Sub-D connector with a coding frame. The equipment side receptacle shall use male contacts, while cable side plug shall use socket contacts. The connector pins shall be of crimp type, gold plated. The system should access MVB variables by direct access through a signal converter connected to a separate MVB multiplier card. The MVB multiplier card shall house the connector receptacle for the type of interface used and shall be arranged by the contractor. MVB connector shall be provided on the rear side of the equipment. There shall also be provision for integration of system though Ethernet for integration with propulsion system if propulsion vendor agreed to provide VCU data through ethernet to avoid dependency on MVB.

9.9.3. Option for Ethernet should be available on ORMS for integration with TCMS components as TRDP/UDP protocol.

9.9.4. The 110V DC power connector to the equipment shall be provided through a 3 pin miniature circular connector of MIL-C-26482 (Series-I) standard with bayonet locking. The receptacle on the equipment side shall have pin contacts and on the cable side, socket contacts. The contacts shall be of crimp type, gold plated. The supplier shall provide power supply cable of suitable length, duly provided with connector at one end and crimped to cable lug on the other side. The power supply connector shall be provided at the rear of the equipment.

9.9.5. The mechanical housing shall be compact and robust.

9.9.6. The equipment shall have its own cooling arrangement. Natural cooling is preferred.

9.9.7. The equipment, if mounted on roof, shall be packaged to conform to IP-67 ingress protection class in accordance with IEC-60529.

9.9.8. The system should be capable to self recognize the locomotive type with the help of hard-wired detection.

9.9.9. The speed of the microprocessors, used in the remote monitoring unit, shall be adequate so that the status of all the parameters is scanned continuously and the desired real time result can be achieved.

9.9.10. In case of failure of any internal/ external equipment of remote monitoring unit or if the full remote monitoring unit goes to out of order, no effect shall occur on the normal performance of the locomotive.

9.9.11. The GPS time stamp of ORMS system shall be provided to Propulsion system through same MVB/ethernet interface so that the all the subsystem of propulsion system can be synchronized with GPS clock.

9.9.12. There should be two-way communication so that basic data entry is not required to be repeated in ORMS for each and every update, such data can be fetched from server of IR.

9.10. Details of On-Board Remote Monitoring Unit:

9.10.1. Transmitter/Receiver: The remote monitoring transmitter / receiver shall be a separate unit, preferably mounted on the roof of the locomotive, which shall house the GSM and GPS antenna, associated modems and intelligent units. Antenna used shall be suitable for working under 25kV A.C. traction system. RMU with antenna shall be within MMD of the locomotive. Mechanical dimension of the RMU will be finalized during design approval stage. GPS data should be updated in every one second. Remote monitoring transmitter/ receiver unit shall have IP-67 protection class in accordance with IEC-60529. The transmitter/ receiver shall have local intelligence to sense the availability of GSM footprint, data packet transmission and acknowledgment, packet re-transmission in case of errors; store and late transmission in case of temporary non-availability of GSM network etc. It should also be ensure that the GPS clock data shall be shared with propulsion system for synchronization / correction of RTC of propulsion system.

9.10.2. Communication with the system: The system shall communicate with the web server through commercially available communication network. The Contractor shall supply and integrate data cards with antennas (compatible with these commercial cellular networks) with the system. The Contractor shall bear the cost of setting up a new connection (like SIM card, registration etc.) and also pay for data connection for first five years from the date of commissioning. For operational expenses beyond that the Contractor shall indicate the commercial terms of the cellular network provider and indicate an appropriate data plan as is available from the network provider. The Contractor may also quote to bear the operational expenses for the data connection through commercially available cellular network as an Annual Maintenance Contract' cost for next 3 years after the expiry of warranty of five years. The

system should access MVB variables by direct access through a signal converter connected to a separate MVB multiplier card. The MVB multiplier card shall house the connector receptacle for the type of interface used and shall be arranged by the Contractor. The circuit schematic of MVB multiplier card to be submitted to CLW for approval. The communication media between remote monitoring unit and the VCU must have suitable interfacing facility and should be provided as the part of the system. The system should send the set of remote monitoring data to the Web application server at an interval of 1 second. Therefore, the system should have enough memory to store the remote monitoring data during the data connection loss. Once the data connection is established, all the stored remote monitoring data with timestamp should get transferred to the Web application server. In addition to this the data should also be captured in case of any event which may have sample below 1 secs. Thus, the controller of ORMS should have adequate speed for capturing and storing the data.

9.10.3. Web Application Server Indian Railway will host and maintain its DRAS web application portal which will have web application software, data base management and communication interface with remote monitoring unit through static IP address with standard TCP/IP protocol. During the course of development, standard TCP/IP will be provided by IR to all the prospective contractors in consultation with them. In parallel vendor may also host and maintain its remote monitoring system web portal as mentioned in Part 0 of the specification. Communication between Web application server and ORMS unit shall be in the scope of supplier.

9.10.4. Display of Data: IR and Contractor shall mutually decide the data to be transferred to the server and also formulate the format of data to be displayed in the web pages of IR web portal. It is proposed that data shall be displayed in the form of tables and graphs with proper GUI. A set of proposed data to be sent/input/viewed on web portal has been mentioned in the upcoming clauses. But the final set of data to be sent/input/viewed on web portal shall be mutually agreed and finalized during the design stage. The supplier shall also involve during its finalization and shall give the valuable inputs in this regard as per the latest practices being followed. IR also intends to develop AI and ML for monitoring the condition of locomotive and makes preventive and predictive maintenance of locomotives more effective. For this the ORMS vendor should provide technical assistance for implementation of AI and ML so that predictive maintenance can be done with accuracy.

9.10.5. Home Page Data:

The home page (i.e., first page after log in) shall display the following data of all the locomotives fitted with ORMS: -

i. Locomotive No.
ii. Type of locomotive
iii. Home shed
iv. Present active cab
v. Pantograph position
vi. VCB status
vii. Catenary Voltage (in kV)
viii. Battery voltage of locomotive (in Volt)
ix. Actual TE/BE of locomotive (in kN)
x. Speed of locomotive (in Km/h)
xi. Present situation of the brakes i.e., Loco Brake (Direct Brake), Train Brake (Auto Brake) and Parking Brake.
xii. Isolation of any sub-system
xiii. Current location of locomotive (geographical map view should also be available) with date and time
xiv. Name of the controlling vendor
xv. Single/Multi/Push Pull operation status
xvi. VCD (Vigilance Control Device) status
xvii. Earth fault status for 415V Auxiliary Converter , 415/110V Aux Circuit, 110V DC Circuit, Harmonic filter Cicuit, Power/Traction Circuit
xviii. ZBAN status for Banking operation
xix. ZTEL status for Traction limitation. Inching mode and and Push Pull operation
xx. MCB 100 status for Battery Charger.
xxi. Status of rotatory switches, MCBS, parameters like vigilance warning, emergency brake through vigilance activation.

The home page data should be updated in every one second.

9.10.6. Real Time Data:

This type of data shall comprise of the following parameters of major safety items of locomotive:

A. High-Voltage Circuit: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position

v. VCB status
vi. Present active cab
vii. Catenary Voltage (in kV)
viii. Primary Voltage of the main transformer (in kV)
ix. Primary Current of the main transformer (in Amps)
x. Input Power (in kW)
xi. Line Frequency (in Hz)
xii. Main Transformer Oil Pressure (in Bar)
xiii. Harmonic Filter Current (in Amps)
xiv. Main transformer oil temperature

B. Traction Converter: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Node progressing
vii. Input A.C. Voltage (in Volts)
viii. DC-Link Voltage of both the converters (in Volts)
ix. Status of Pre-charge Contactor
x. Status of Converter Contactor (or Main Contactor)
xi. Converter Oil Pressure (in Bar)
xii. Status of Filter Contactor (8.1,8.2 and 8.41)
xiii. Status of Main and pre-charging contactor for each converter
xiv. DC link Earth fault status
xv. Status of line side and motor side converters
xvi. Fault log messages

C. Traction Motor: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Input A.C. Voltage to Traction Motor (in Volts)
vii. Speed of locomotive (in Km/h)
viii. Speed of each Traction Motor (in rpm)
ix. Traction Motor Current (in Amp)

x. Bearing temperature of Traction Motor. (In degree C) (Sensor will be provided by Railway)

D. Auxiliary Converter: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Input A.C. Voltage (in Volts)
vii. Input A.C. Current (in Amps)
viii. DC-Link Voltage of each Auxiliary Converter (in Volts)
ix. DC-Link Current of each Auxiliary Converter (in Amps)
x. Output Voltage of each Auxiliary Converter (in Volts)
xi. Output Current of each Auxiliary Converter (in Amps)
xii. Status of the Auxiliary Contactors
xiii. Battery Charger charging current (in Amps)
xiv. Frequency of Auxiliary Converter (in Hz)
xv. Voltage of Battery (in Volts)
xvi. Status of line side and drive side converters
xvii. Auxiliary Converter fault log messages

E. Auxiliary Machines: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Status of both Compressors
vii. Status of both Oil Cooling Blowers
viii. Status of both Traction Converter Oil Pump
ix. Status of both Main Transformer Oil Pump
x. Status of both Traction Motor Blowers
xi. Status of both Machine Room Blowers
xii. Status of both Machine Room Scavenge Blowers
xiii. Status of both Traction Motor Scavenge Blowers
xiv. Status of Vibration of Oil Cooling Unit, Traction Motor Blower and Machine Room Blower (in mm/s) (Sensor will be provided by Railway)

xv. Status of Air flow of Oil Cooling Unit, Traction Motor Blower and Machine Room Blower (in CFM) (Sensor will be provided by Railway)

xvi. Alert needs to be generated if one Traction Motor Blower (TMB) is out of service and corresponding Traction Motor (TM) are drawing current for which program/logic is to be written by ORMS manufacturers.

F. Traction/Braking: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Present active cab
vii. Speed of locomotive (in Km/h)
viii. Reverser position
ix. Throttle position
x. TE/BE amount (in %) as calculated depending on the current Angle Transmitter position
xi. Demanded TE/BE of locomotive (in kN)
xii. Actual TE/BE of locomotive (in kN)
xiii. Status of Direct or Loco brake
xiv. Status of Automatic or Train brake
xv. Status of Constant Speed Push Button (BPCS)
xvi. Status of Parking Brake
xvii. Status of Vigilance Brake

G. Temperature and Ventilation: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Main Transformer Oil Temperature (in °C)
vii. Traction Converter Oil Temperature (in °C)
viii. Temperature of each Traction Motor (in °C)
ix. Ventilation level of Main Transformer
x. Ventilation level of Traction Converter
xi. Ventilation level of Traction Motor

H. Pneumatic Pressure: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Target BP Pressure (in Kg/cm^2)
vii. Actual BP pressure (in Kg/cm^2) (Sensor will be provided by Railway)
viii. Actual BC Pressure (in Kg/cm^2) (Sensor will be provided by Railway)
ix. Actual MR Pressure (in Kg/cm^2) (Sensor will be provided by Railway)
x. Actual Air Flow (Sensor will be provided by Railway)
xi. Actual FP pressure (in Kg/cm^2) (Sensor will be provided by Railway)
xii. Pressure Switch status of BC-1/2, Emergency, MR, AFI

I. Energy Consumption: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Speed of locomotive (in Km/h)
vii. Energy Consumed (in kWh)
viii. Energy Regenerated (in kWh)
ix. Regeneration percentage
x. Energy Consumption of HLC (Hotel Load Converter) by real data or calculated data of Voltage and current of HLC .

J. Subsystem Status: -

In general, a locomotive has been divided into 19 nos. of sub-systems and a brief of the sub-systems has furnished below in the table.

Subsystem No.	Name of Locomotive Part
01	Main Power
02	Traction Bogie 1
03	Traction Bogie 2
04	Harmonic Filter
05	Hotel Load
06	Auxiliary Converter 1

Subsystem No.	Name of Locomotive Part
11	Auxiliaries HB1
12	Auxiliaries HB2
13	Cab 1
14	Cab 2
15	Fire Detection
16	Speedometer

07	Auxiliary Converter 2	17	Processor FLG1
08	Auxiliary Converter 3	18	Processor FLG2
09	Battery System	19	Train-bus
10	Brake System	20	DPWCS

The following parameters should be displayed under this 'Subsystem Status' menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Speed of locomotive (in Km/h)
vii. Isolation of any Subsystem
viii. Data related to HLC (Hotel Load Converter) and DPWCS also needs to be shown

K. Software Version: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Date and Time
iv. Pantograph position
v. VCB status
vi. Speed of locomotive (in Km/h)
vii. Node progressing
viii. Versions of software for different processors like FLG1, FLG2, STB1, STB2, HBB1, HBB2, SLG1, SLG2, BUR1, BUR2, BUR3, DDU and DPWCS of the locomotive.
ix. Provision for manually entering S/W version of DDU, Auxiliary Converter, Traction Converter for which data is not available on MVB should be made

L. Minimum and Maximum Value for last 24Hrs: -

The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Home shed
iv. Minimum and Maximum value reached in last 24hrs for the following items
   (a) Catenary Voltage (in kV)
   (b) Line Frequency (in Hz)
   (c) Speed of locomotive (in Km/h)
   (d) DC-Link Voltage of Traction converters (in Volts).

(e) DC-Link Current of Traction converters (in Amps)
(f) Brake Pressure (in kg/cm^2)
(g) Main Transformer Oil Temperature (in °C)
(h) Traction Converter Oil Temperature (in °C)
(i) Temperature of each Traction Motor (in °C)
(j) Demanded TE/BE of locomotive (in kN)
(k) Actual TE/BE of locomotive (in kN)
(l) Harmonic Filter Current (in Amps)
(m) Main Transformer Oil pressure (in bar)
(n) Traction Converter Oil pressure (in bar)
(o) Battery Voltage (in Volts)
(p) Hotel Load Current (in Amps)
(q) Primary Current (in Amps)
(r) Current of Traction Motors (in Amps)

M. **43 important signals** as per following list are to be recorded per second or upon occurrence of any event in ORMS and shown in a separate menu

1. Loco speed (KMPH)	23. CAB2 DirFor (-)
2. OHE Volt (KV)	24. CAB2 DirRev (-)
3. OHE Current (Amps)	25. Panto 1 PrSw (-)
4. Energy Consumed (Kwh)	26. Panto 2 PrSw (-)
5. Battery Volt (Volts)	27. VCB Status(-)
6. BP Pressure (Kg/cm2)	28. Motoring(-)
7. TE/BE Demand (%)	29. Regenerative Brake(-)
8. TE/BE BG1 (KN)	30. Emergency Brake Applied(-)
9. TE/BE BG2 (KN)	31. Isolating Emg Exhaust(-)
10. CABI FwSand (-)	32. Start/Run Interlock(-)
11. CAB2 FwSand (-)	33. Traction Interlock(-)
12. CABI Key in D(-)	34. Node number
13. CAB2 Key in D(-)	35. Vig Warning(-)
14. Compressor ON/OFF status(-)	36. VigEmgBrk(-)
15. CABI Dirfor (-)	37. Air Flow PrSw(-)
16. CABI DirRev(-)	38. BC1 PrSw(-)
17. CAB1 MaxTELimit(-)	39. BC2 PrSw(-)
18. CAB2 MaxTELimit(-)	40. MR Low PrSw(-)
19. CAB1 EmgStop(-)	41. BrkEleHIth(-)
20. CAB2 EmgStop(-)	42. Loco number
21. CAB1 FtSwLocBrk(-)	43. LSP Status (-)
22. CAB2 FtSwLocBrk(-)	

N. The status of banking/push pull/DPWCS operation/loco in running or cut out from traffic or attached load in tonne is to be indicated. Suitable logic maybe incorporated for this.

9.10.7. Diagnostic Data Set (DDS):

This is the set of fault messages required for diagnosis of any type of fault occurred in the locomotive. Every fault message shall be stored along with a set of background data of 5 second before and 3 second after the incident with 1 second interval for a minimum period of 180 days in FIFO type ring buffer in the ORMS memory. The requirement of data retention in server are mentioned in relevant part of specification. The following parameters should be displayed in this menu:

i. Locomotive No.
ii. Type of locomotive
iii. Home shed
iv. Locomotive GPS location
v. Current Date and Time
vi. Locomotive GPS location during last recorded fault
vii. Date and Time of last recorded fault
viii. Distance travelled after last recorded fault
ix. Last recorded fault
x. Link to see all fault messages of a particular locomotive

In the page of all fault messages of a particular locomotive, a link should be provided to see the background data corresponding to a particular fault. List of background data to be recorded along with each fault is given below:

(I). Pantograph position
(II). VCB status
(III). Active cab
(IV). Throttle position
(V). Reverser position
(VI). Speed of locomotive
(VII). Catenary Voltage
(VIII). Main Transformer Oil Temperature
(IX). Traction Converter Oil Temperature
(X). Temperature of each Traction Motor
(XI). Actual TE/BE of locomotive (in kN)
(XII). DC-Link Voltage of both Traction Converters

(XIII). Line Frequency
(XIV). Harmonic Filter Current
(XV). Status of M.U. operation
(XVI). Isolation of any Subsystem (Related to fault)
(XVII). Status of Emergency Brake
(XVIII). Battery Voltage
(XIX). BP Pressure and BC Pressure
(XX). DC-Link Voltage of Auxiliary Converters
(XXI). Primary Voltage of the main transformer
(XXII). Primary Current of the main transformer
(XXIII). Status of Pre-charge Contactor
(XXIV). Status of Main Contactor
(XXV). Status of Constant Speed Push Button (BPCS)
(XXVI). Main Transformer Oil Pressure
(XXVII). Traction Converter Oil Pressure
(XXVIII). Status of the Auxiliary Contactors
(XXIX). MR Pressure

During downloading of background data, the corresponding fault message should also come in the downloaded file.

9.10.8. Recorded Data:

This is the stored data. This type of data shall be stored in the web application server. Data related to the following parameters of all the locomotives fitted with ORMS shall be stored for a minimum period as mentioned in the relevant clause of the specification with resolution of 1 second and run in FIFO type ring buffer.

1. Pantograph
2. VCB
3. Active cab
4. Throttle
5. Reverser
6. Speed of locomotive
7. Catenary Voltage
8. Main Transformer Oil Temperature
9. Traction Converter Oil Temperature
10. Temperature of each Traction Motor
11. Actual TE/BE of locomotive
12. DC-Link Voltage of both Traction Converters
13. Line Frequency

14. Harmonic Filter Current
15. Isolation of any Subsystem
16. Emergency Brake
17. Battery Voltage
18. BP Pressure and BC Pressure
19. DC-Link Voltage of Auxiliary Converters
20. Primary Voltage of the main transformer
21. Primary Current of the main transformer
22. Pre-charge Contactor of Traction Converter
23. Main Contactor of Traction Converter
24. Constant Speed Push Button (BPCS)
25. Main Transformer Oil Pressure
26. Traction Converter Oil Pressure
27. Auxiliary Contactor
28. Input Power
29. Output Voltage of each Auxiliary Converter
30. Output Current of each Auxiliary Converter
31. Software version in FLG1, FLG2, STB1, STB2, HBB1, HBB2, SLG1 and SLG2
32. Energy Consumption
33. Energy Regeneration
34. MR Pressure
35. Ventilation level of Main Transformer
36. Ventilation level of Traction Converter
37. Ventilation level of Traction Motor
38. Compressors
39. Oil Cooling Blowers
40. Traction Converter Oil Pump
41. Main Transformer Oil Pump
42. Traction Motor Blowers
43. Machine Room Blowers
44. Machine Room Scavenge Blowers
45. Traction Motor Scavenge Blowers
46. Speed of each Traction Motor (in rpm)
47. Node
48. Wheel Diameter

After selecting the parameters, home shed and locomotive no. should be selected. There shall also be a provision of date wise filtering. In addition to the selected parameters, respective date and time stamp of the corresponding data shall also be there in the final page.

9.10.9. Configurable Data:

Provision shall be kept to configure the following parameters based on operating requirements of various classes of locomotives with prior approval of CLW by using secure login and password protection. This type of data will be stored and maintained till the next login made to modify/ change the data of the parameters.

i. Date of commissioning
ii. Wheel Diameter (in mm)
iii. Last minor inspection done
iv. Next minor inspection due
v. Last AOH/IOH inspection done
vi. Next AOH/IOH inspection due
vii. Last POH/MTR done
viii. Next POH/MTR inspection due
ix. Total distance travelled (in Km)

9.10.10. Loco Utilization Data:

This type of data shall be stored for every individual section. This section specific data shall be maintained on FIFO type ring buffer till the next section specific data input is made. Therefore, in the server, the running details of the locomotive for the last section shall remain store till the running of current section completes. The following parameters should be displayed in this menu:

i. Section details
ii. Date and Time of entering the section
iii. Date and Time of departing the section
iv. Total distance travelled (in Km)
v. Total energy consumed (in kWh)
vi. Total energy regenerated (in kWh)
vii. Train load (in Tons)

This type of data shall be entered in such a manner that only section details and train load should be entered manually by using secure login and password protection. All the other parameters should change automatically.

9.10.11. Loco Lifetime Data:

After selecting home shed and locomotive no., the following parameters should be displayed under the selected locomotive:

i. Date of commissioning
ii. Last minor inspection done
iii. Total distance travelled (in Km) since last minor inspection
iv. Last AOH/IOH inspection done

v. Total distance travelled (in Km) since last AOH/ IOH inspection
vi. Last POH/MTR inspection done
vii. Total distance travelled (in Km) since last POH/ MTR inspection
viii. Total distance travelled (in Km) since date of commissioning
ix. Total energy consumed (in kWh) since date of commissioning
x. Total energy regenerated (in kWh) since date of commissioning

This type of data will be stored and maintained till the next modification/ change in the data of the parameters is being made.

9.10.12. Downloading of data/ record:

Provision shall be made to download all types of data/record as visualized in the different web pages of IR web portal in different formats like MS Excel, MS Word, PDF etc.

9.10.13. Data in Graphical Formats: The analog (graphical) plotting of the data shall be in following configurations:

Speed, TE/BE, BP & BC Pressure Vs Time	Plotting of Speed, Tractive Effort/ Braking Effort, BP & BC Pressure with respect to time
Speed Vs Time at constant time interval	Plotting of speed data at desired constant time intervals, the smallest intervals being same as sampling rate of recording.
TE/BE Vs Time at constant time interval	Plotting of Tractive Effort/ Braking Effort data at desired constant time intervals, the smallest intervals being same as sampling rate of recording.

It shall also be possible to have above analog (graphical) print outs for desired time intervals, on enlarged/ amplified scale for better clarity. Parameters on 'X' and 'Y' axis shall be clearly marked on the graphical print outs with major gridlines whatever the case.

9.10.14. Filtration of Data:

I. Provision to filter the display of data by Locomotive no., Type of Locomotive, Shed, Date, Vendor name etc. (where applicable) shall be given.
II. Provision shall also be made for printing of data (all pages as well as only the desired page) directly from web pages, in spite of printing after downloading.
III. Option of filtering data between desired time/ GPS locations and data above/ below a specified speed threshold shall be provided.
IV. In DDS, fault wise selection shall be provided.

Note: The requirements mentioned above for the remote monitoring system are generalized in nature and meant for monitoring and displaying the vital and important parameters based on preventive maintenance practices. However, the suppliers may offer development of a predictive analysis model demonstrating prediction of loco failure well in time. The suppliers may suggest parameters to be monitored on continuous basis for facilitating predictive analysis. The above aspect shall be discussed during design stage and agreed mutually between the supplier and the purchaser.

10. Applicable drawings There are no drawings forming a part of this specification.

11. Safety Requirements The equipment shall meet all statutory and regulatory criteria required for safety of users. All requirement as specified in the specifications of the respective propulsion/ORMS equipment shall be complied by the ORMS.

12. Environmental / climatic requirements All requirement as specified in the specifications of the respective VCU equipment shall be complied by the ORMS. The antennae and its accessories including cables and connectors shall be tested for compliance to AAR-S-9401 or IS equivalent For reference The climatic and environmental conditions prevailing in India in the area of operations are the following:

Temperature

Maximum temperature inside stabled Locomotive under sun	: 75 deg. C
Maximum temperature inside working loco	: 55 deg. C
(Temperature inside working locomotive may reach 60 deg. C)	
Minimum temperature	: -20 deg. C

The equipment shall be able to start up at the maximum specified temperature inside the locomotive without any pre-cooling requirement.

Humidity: Upto 100% during rainy season.

Altitude: Upto 1776 m above mean sea level.

Rainfall: Very heavy in certain areas. The equipment shall be designed suitably.

Atmosphere during hot weather: Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/cub. In many iron ore and coalmine areas, the dust concentration is very high affecting the filter and air ventilation system.

Coastal area: The equipment shall be designed to work in coastal area in humidity and salt laden and corrosive atmosphere. The maximum values of the condition shall be as follows:

Maximum pH value : 8.5

Sulphate	: 7 mg per litre
Max. concentration of chlorine	: 6 mg per litre
Maximum conductivity	: 130 micro siemens /CM

Vibration: The equipment shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in IEC for the electronic equipment used on rolling stock.

Electromagnetic Pollution – High degree of electromagnetic pollution is anticipated in locomotive machine room. Necessary precaution shall be taken in this regard

13. Referred standards Kindly refer common list in part 0 of the specification.

14. Maintenance and diagnostic aid As listed in the relevant part of the specification.

15. Documents to be supplied by the equipment supplier The equipment provider shall provide all documents as specified in the specifications of the respective equipment. A copy of the detailed bill of materials for the ORMS system shall be provided.

16. Approval for Design: Kindly refer common list in part 0 of the specification.

17. Accessories

17.1. Tools: The supplier shall provide all tools required for maintenance by the end user. The list of tools shall be jointly approved by CLW and the equipment provider before supply.

17.2. Spares: The supplier shall provide all spares required for maintenance by the end user. The list of spares shall be jointly approved by CLW and the equipment provider before supply

18. Training The equipment manufacturer shall provide training to maintainers operators and other users of the system where required for operations, maintenance and proper use of the system

19. Scope of Supply and Deliverables:

19.1. Scope of the specification is to Design, Development, Manufacture, Testing, Commissioning, Installation and field validation of DRAS-ORMS system.

19.2. Network modem with data cards of commercial mobile internet provider with appropriate antennas and their activation/registration are in the scope of supply for Contractor. The Contractor is required to pay the cost of an unlimited data plan

for first five years. The mobile internet provider shall be selected in consultation with Indian Railways. Installation and maintenance of this equipment (along with antennas) is also in the scope of supply of Contractor.

19.3. Following items shall be the delivered along-with each set of equipment:

SN	Item	Qty/Set
1	ORMS having Transmitter cum Receiver, which includes antenna, associated redundant modems, intelligent units for GPS and SIM and 32 Analog and 32 Digital I/O channels for current/pressure/temperature/vibration sensors.	01
2	MVB multiplier card and power supply modules for ORMS	One loco set
3	MVB Interface Cable duly crimped with connectors at both end, fitted with MVB signal Converter.	01
4	Power supply cables (110V DC) for RMU duly crimped with connector at equipment end and cable lug at loco end. Further self driven power supply for a backup of 24 hours with inbuilt battery charging facility.	01
5	Suitable MCB for 110V supply tapping (to be provided for isolating the system).	01
6	Braided protective hose for protection of fiber optic and electrical cables.	01
7	Self Battery backup for at least 24 hours with inbuilt charging facility	01

19.4. Following documents shall be submitted by the Contractor:

- Technical documentation explaining the complete scheme, characteristics protection and control.
- Procedure for parameter alteration.
- Operation manual containing detail functioning of the items of RMS.
- Trouble shooting manual explaining step by step fault finding procedure

20. Tests and verification The equipment shall be tester functional capability, ability to withstand environmental conditions and for reliable performance under field conditions..

21. Types of tests.

21.1. The prototype equipment shall be subjected to type test according to IEC-60571(latest).

21.2. Individual equipment and system/sub-systems as may be necessary shall be type and routine tested in accordance with the relevant standards/specification/ publications/details given elsewhere in this specification, which, if required, may be modified to suit local conditions.

21.3. Type tests shall be carried out by the Supplier at his own responsibility and cost.

21.4. Wherever the relevant standard test procedures do not adequately cover the requirements of arduous environmental conditions prevailing in India, CLW might lay down special tests apart from those specified that shall be required to be conducted. These may include accelerated ageing test and endurance test.

21.5. The Supplier shall formulate and submit a type test protocol/plan at design approval stage for approval of CLW before undertaking manufacturing of the product.

21.6. Modifications found necessary as a result of the tests/trials shall be incorporated in the locomotives by the Supplier at his own cost. Drawings incorporating those modifications, found necessary as a result of tests and trials, shall be submitted to CLW for final approval.

21.7. The manufacturer shall offer all the testing facilities free of charge to inspecting authority. Testing of equipment and fittings shall, as far as possible, be carried out at the works of the manufacturers. Testing of bought out components may also be carried out at sub-contractor's premises, if so required.

21.8. The test for which facilities are not available may be carried out at any approved laboratory for which the testing charges shall be payable by the supplier.

21.9. The contractor shall provide, free of charge, the materials or fittings which may be required for testing either at his own or at his sub-contractor's premises. All the equipments and fittings, required for testing, shall be selected by the inspecting officer and the tests shall be carried out in his presence.

21.10. No material shall be packed or dispatched until it has been passed by the inspecting officer. Though the contractor's responsibility for its efficiency, in every way, shall remain the same as if the work had been manufactured and tested by himself.

21.11. If any part require alteration or any defect appear during the test or trial, the contractor shall make such alteration or rectify the defects to the satisfaction of the inspecting authority without any extra charges.

21.12. Copy of characteristic properties and specification of each and every electronics & electrical items, used for manufacturing the system, shall be supplied to the inspecting authority as and when required to confirm about the quality of those items.

21.13. If there is any change in design or source of supply of any components/sub-components/assembly, units made to the changed design or from new source shall be treated as new item for the purpose of conducting type tests.

21.14. Type tests are to be repeated in case of any major change is made. In case of minor changes, i.e. change in type, rating of component etc., special test/tests as agreed by user and manufacturer are to be conducted to ensure their suitability and effectiveness of the modifications.

21.15. The type tests shall be repeated once in three years by CLW if required.

21.16. On successful completion and passing of type tests, routine tests shall be done on the rest of the equipment.

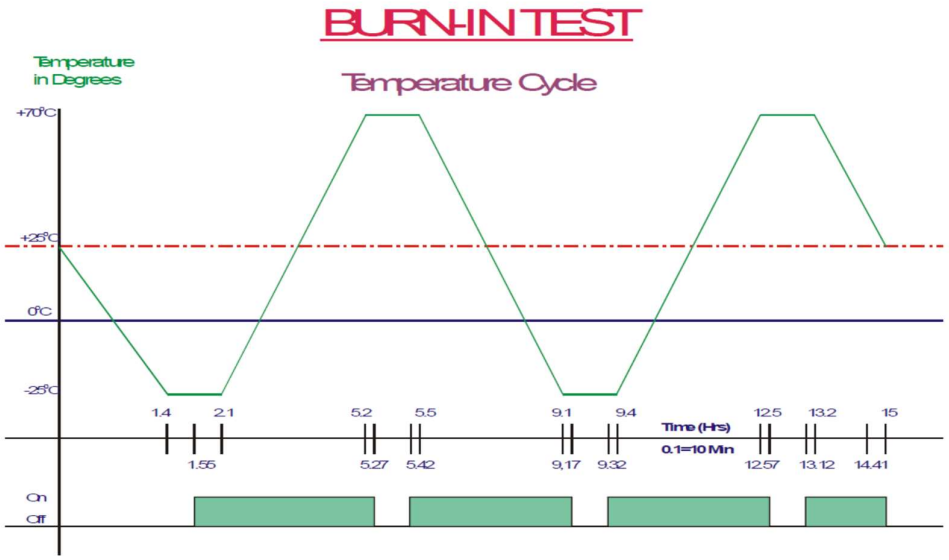
21.17. The type and routine tests to be carried out on complete unit are given in the following table with the clause number of IEC-60571

Sl. No.	Name of Test	Clause No. of IEC-60571	Type Test	Routine Test
1	Visual Inspection	12.2.2	✓	✓
2	Performance Test	12.2.3	✓	✓
3	Cooling Test	12.2.4	✓	×
4	Temperature Rise (Dry Heat) Test*	12.2.5	✓	×
5	Temperature Rise (Damp Heat Cyclic) Test	12.2.6	✓	×
6	Supply Overvoltage Test	12.2.7	✓	×
7	Surge Test	12.2.8.1	✓	×
8	Electrostatic Discharge (ESD) Test	12.2.8.2	✓	×
9	Transient Burst Susceptibility Test	12.2.8.3	✓	×
10	Radio interference test	12.2.9	✓	×
11	Insulation test	12.2.10.2	✓	✓
12	Voltage Withstand (Dielectric) Test	12.2.10.3	✓	✓
13	Salt mist test	12.2.11	✓	×
14	Vibration and Shock Test	12.2.12	✓	×
15	Water tightness Test**	12.2.13	✓	✓
16	Equipment Stress Screening***	12.2.14	✓	✓

* Dry heat test shall be carried out at elevated temperature of 85°C for 10 mins and water tightness test shall be carried out only for roof mounted portion of the equipment.

*** In addition to the above, Ingress Protection test (IP-67) for the roof mounted equipment shall be done according to the IEC-60529.*

*** Equipment stress screening test should be conducted as per cycle provided below. Further the populated PCB cards kept in proper chassis in energized condition shall be burnt in for minimum 45 hrs at +70 deg. C and - 25 deg



Note: Class T6 and above is to be followed for testing.

22. Inspection

22.1. The type test shall be witnessed by the authorized representative of CDE/CLW.

22.2. The inspecting authority may visit at any reasonable time and without previous notice, either contractor's works or his sub-contractor's works to inspect the manufacturers and the quality of the work at any stage.

22.3. The inspecting authority can reject any materials or fittings that does not conform to the relevant standard/specifications or have not been manufactured in accordance with the approved practices. The rejected materials or fittings shall be marked in a distinguishable manner and shall be disposed on in such manner as the inspecting officer may direct to avoid its inadvertent use in the product order as per this specification.

23. Painting labelling and marking: The equipment shall be appropriately painted for aesthetics and protection. The parts, connector ports, mounting points etc shall be clearly marked in a manner that these are easily readable and remain legible over the lifetime of the equipment. ID plate Name of Component, Make, Sl. No, Date of Manufacture, Ratings shall be provided on all assemblies/subassemblies.

24. **Packing and delivery:** The equipment consists of sensitive and fragile electronic systems. These should be packed with precautions required to prevent damage in transit. All requirements of IRS conditions for packaging and delivery shall be applicable..

25. **Field Trials:** Kindly refer common list in part 0 of the specification.

26. **Guarantee / Warrantee:** Kindly refer common list in part 0 of the specification. Further The subscription and the functioning of the GPRS / EDGE connectivity shall be ensured by the manufacturer for the duration of the warrantee and also during the period of extended warrantee

27. **Intellectual Property Rights;** Kindly refer common list in part 0 of the specification.

28. **Information to be supplied by supplier** The equipment manufacturer must provide to CLW, the complete details of algorithms, design and drawings required for the purpose of evaluation of the design and its functionality. All documents as required by the specification of RMS. Operations and maintenance manuals, spare parts catalog shall be supplied to all users as required in both hard and soft (PDF) copies.

29. **Information to be supplied by purchaser** Required design details and layouts of locomotives on which ORMS is required to be fitted.