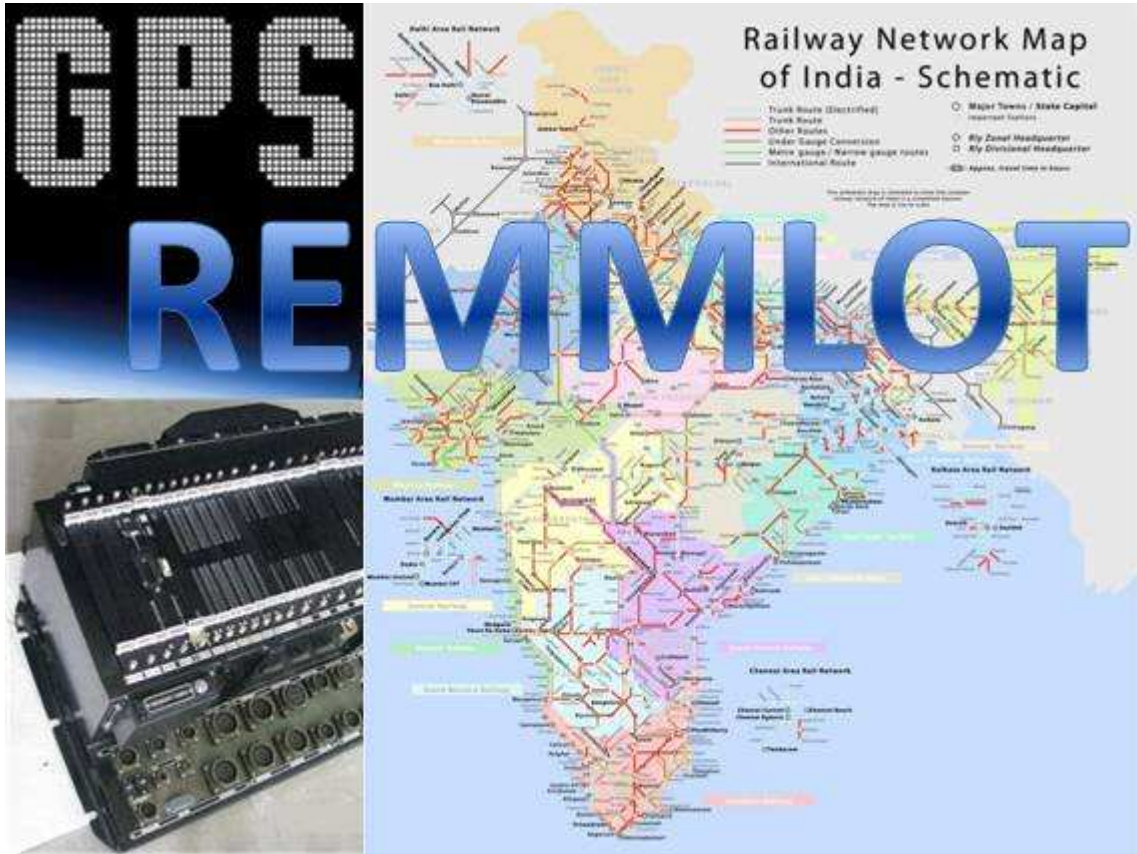


## रेमलोट: भाग-2

### REMMLOT: PART-2

### (LOCOMOTIVE & TRAIN MANAGEMENT SYSTEM)



Specification Number	MP.04.02.04	Date of Issue	[dd/mm/yyyy]
Revision	5		

#### Brief Description

This is a part of a four part specification numbered 0 through to 3 describing the requirements for setting up systems for Remote Monitoring of Locomotives and Trains (REMMLOT).

## **FOREWORD**

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

It also enables monitoring of performance of crew and helps in identifying lapses, e.g. when he passes a signal at danger. This will enable focused counselling and training of such crew, who are prone to unsafe working.

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

The complete specification for REMMLOT 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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## LIST OF AMENDMENTS

Kindly see part 0 of the specification.

DRAFT

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DRAFT

## 0 Introduction

This document is part of set of documents specifying equipment and services for the deployment of REMMLOT. This document is one of the set of 5 (five) documents that together comprise of the complete specification for REMMLOT.

## 1 Objectives and Scope of the specification

This document describes the requirements of locomotive and train management system (LTMS) consisting of backend servers, databases, analysis programmes and internet portal based data presentation using the SADS concept.

## 2 Terminology / Abbreviations

Kindly refer common list in part 0 of the specification.

## 3 Definitions (Optional)

Kindly refer common list in part 0 of the specification.

## 4 Brief description of the system/equipment/components

LTMS consists of service provision for the REMMLOT system that aims to provide services for the following: Logging, maintenance, analysis and presentation of data logged on the locomotive control computers for use by the operations and maintenance personnel of Indian Railways.

This service provision shall require internet accessible server cluster, operational 24x7. This system shall collect the data transmitted by the locomotive LRMS, compile the same in suitable databases and also convert and maintain this data in NI-TDMS files. The data in databases shall be available over the internet through dynamic web pages. The TDMS files shall be provided via a FTP interface.

This captured data shall be presented via web based applications for use by maintenance sheds and power control organization for management and maintenance planning of locomotives.

The equipment required for the setup shall not be owned or operated by the Indian Railways. Instead the service shall be purchased using the concept of performance based logistics.

LTMS is a service provision that shall provide required services for the following:

- Setting up, operation and maintenance of web portal running on servers based at an internet data centre
- Setting up, operation and maintenance (including connectivity) of SADS and DAWS at control offices.
- Setting up, operation and maintenance of scaled down system for maintenance of data, programmes and configuration of software used on the internet accessible portal. This system shall be setup at specified premises on Indian Railways.

**Application Note:** Recommended that equipment described in the parts 2 and 3 of this specification be purchased together for better integration and improved management of the service contracts.

## 5 General requirements

The following general conditions apply to all equipment that shall be supplied against this specification.

### 5.1 Quality of equipment / software

- The equipment and mounting racks, tables and chairs shall follow OSHA guidelines for office working.
- All equipment shall be from reputed manufacturers and shall be of good quality.
- All software shall be developed with proper documentation and be thoroughly tested before deployment.

- All computers workstations supplied shall have remote management features.

## 5.2 Requirement for service provider

The LTMS system and its clients (covered in part 3) shall be developed, deployed and maintained by the same service provider.

## 5.3 Duration of contract

Since a considerable effort and experience are required for developing, testing and deployment, the duration of this service contract shall be atleast three years or more preferably tallying with the life of equipment and technological obsolescence.

The duration of the contracts shall be suitably modified by the agency initiating the contract and as such the correct duration shall be mentioned in the tender documents.

## 5.4 Duration of contract

Since a considerable effort and experience are required for developing, testing and deployment, the duration of this service contract shall be atleast three years or more preferably tallying with the life of equipment and technological obsolescence.

The duration of the contracts shall be suitably modified by the agency initiating the contract and as such the correct duration shall be mentioned in the tender documents.

## 5.5 End of life / termination of contract

The equipment / service provider shall handover the following at the time of:

- Source of all equipment and ordering specifications
- All software source code and configuration files
- Details of header files, libraries and compilers used for creation of software.
- Full rights to ownership of the code and details provided.

**Note:** The developer may retain rights to re-use the code, configuration and specifications for any other application or customer. This option shall be explicitly stated while entering the supply / service agreements.

**Explanatory Note:** The applications described in this specification are unique to the Indian Railways and will be developed for use by the Indian Railways. There is no expected re-use of the entire application stack, hence the withholding of source code and other details is not desirable.

## 6 Functional requirements

The LTMS service provider shall provide services with the following features.

### 6.1 Web portal for LTMS

This web portal shall be hosted on clustered high availability servers located in an internet data centre and shall be available on the internet on a fixed IP address with a registered domain name. The web portal setup shall be compliant to **TIA 942 Tier III** or better.

The service provider shall setup operate and maintain the web portal for use by the Indian Railways.

#### 6.1.1 Duplicate setup for testing and monitoring

A scaled down but fully functional duplicate of the server setup for the web portal shall be setup at specified location on Indian Railways premises.

Document No:	MP.0.04.02.04 Part-2	Version No: 5	Date Issued: dd/mm/2011
Specification Title: REMMLLOT-LTMS			

Indian Railways shall provide a suitable room for housing the server with electricity, water and network connections. The service provider shall setup up a scaled down but otherwise identical server setup of the internet portal.

The data on this setup shall be synchronized with the main server atleast once a month or better. However whenever configuration and programmes are to be amended, this server shall be modified first. The modifications tested and only then implemented on the main server.

### 6.1.2 Ownership of data

All data collected on the internet portal servers shall be the property of the Indian Railways. The service provider shall seek written permission for using this data for any purpose other than that specified here.

### 6.1.3 Ownership of programmes and configuration files

All application packages, configuration files etc. required for operation of the internet portal shall be the property of Indian Railways.

The service provider shall provide fully documented source code for all proprietary applications developed by them for the implementation of features required on the web portals and its clients.

### 6.1.4 Selection of application packages

It is suggested as a general guideline that the application packages that also have open source licensed copies be selected over proprietary packages.

The preferred server software stack for web portal shall be based on open source technology using Linux, Apache, MySQL and PHP. Other application software for data mining, presentation, security etc. shall also be selected similarly.

The software shall be highly scalable to support growing number of locomotives and clients.

The service provider must propose with detailed justification the selection of software packages for the internet portal and obtain an approval for the same from Motive Power Directorate of RDSO.

### 6.1.5 Selection of hardware platform

The service provider shall select a suitable hardware platform for creation of web portal. It is recommended to use scalable computing clusters for fault tolerance and expandability.

The service provider must propose with detailed justification the selection of hardware for the internet portal and obtain an approval for the same from Motive Power Directorate of RDSO.

## 6.2 Access to servers and security

The following features shall be provided for securing and accessing the web portal and its servers.

### 6.2.1 Access to the servers through internet

All access to the server shall be secure. A two factor authentication system shall be used for authentication and authorization.

The server shall also have atleast three user categories i.e.

- Normal Users: Able to access all reports and data but no changes are permitted
- Power users: Able to access all reports and data and modify parameters and reporting modules.
- Administrators: All functions of power users with additional ability to add / delete users.

Super user accounts shall be retained by the service provider for the system maintenance.

### 6.2.2 Physical security of server and data

The service provider shall ensure that servers are physically protected from unauthorised access. The server shall be secured with biometric security and all physical access shall be logged.

There shall be adequate provisions to ensure that data available on the server is available only to authorised personnel and the access by all shall be logged for traceability.



### 6.3 Reception conversion, storage and management of LRMS data

The servers shall be capable of receiving the data transmitted by the locomotive LRMS. The server systems shall be capable simultaneous reception of locomotive data and meet the performance metrics for the same.

The data received from the locomotives shall be checked and then converted and stored in two different formats.

#### 6.3.1 Data on RDBMS Server

The data shall be stored on RDBMS server. The data on the RDBMS server shall be available through ODBC interface and also via predefined dynamic web pages.

#### 6.3.2 Data stored in NI TDMS format

The data shall be converted and stored as National Instruments TDMS (Technical Data Management Streaming) file format. These files shall be prepared on per locomotive per day basis i.e. for a given locomotive number; one file shall be kept for each day. A new file shall be opened when the locomotive is standstill. (Incase a locomotive is in motion at 00:00 HRS, data shall be recorded in the previous day's file till such time the locomotive comes to a stop.)

These files shall be named as per the following naming template.

File name template	NNNN-YYYYMMDD.tdms
NNNN	5 digit locomotive number
YYYY	Year in 4 digits
MM	Month of year in two digits
DD	Day of month in two digits

Table 1: TDMS file name template

The TDMS files offer three levels of hierarchy – root, group and channel as shown in the figure alongside. The file format also allows the logged data to be stored alongwith the meta-data which can contain properties and names of data channels.

These features shall used to document the captured data extensively and also to internally organize the file.

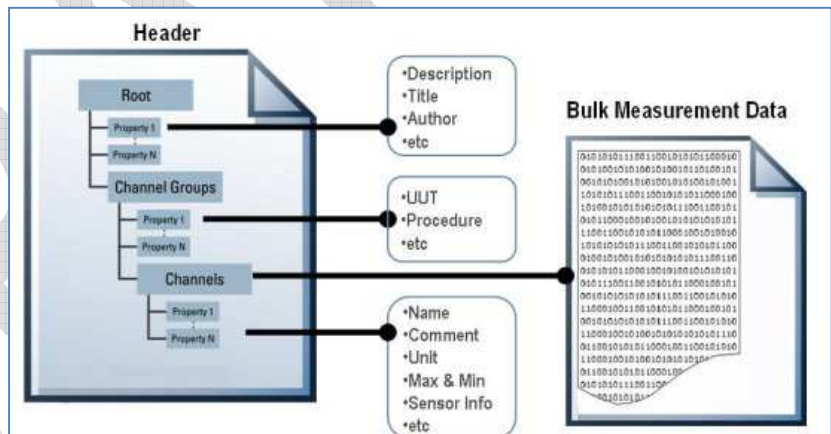


Figure 1: TDMS file hierarchy

The internal organization shall be as per the following overall plan:

- Root property fields shall be used to store information like locomotive number and date, train details as entered by the crew.
- All data channels shall be named with names / abbreviations that make the channel name unique and easy to understand.
- The following top level groups shall be used to organize data channels:
  - **Engine:** Shall contain all channels pertaining to the diesel engine and its systems.
  - **Pneumatic system:** Shall contain data related to compressors and pneumatic brake equipment.
  - **Low Voltage Electrics:** All parameters of equipment associated with low voltages on board.
  - **High Voltage Electrics:** Parameters of equipment in the high voltage equipment.
  - **Vehicle:** Parameters related to whole locomotive like speed, TM speed, vehicle speed etc.

- **General / Misc Parameters:** Parameters that could not be included under the other groupings.
- **Data Pack:** This group shall contain the data captured for the different data packs i.e. Event Recorder Data Pack, Steady State Data Pack, Cumulative Data Pack and Fault data pack.

All the TDMS format files generated shall be stored in folders by locomotive number. These files shall be available for download via FTP.

### 6.3.3 Retention period of data

Data shall be stored for a period of four years for each locomotive. Older data shall be archived for a period of six months and if no request is received this shall be automatically purged without any further confirmation.

The data shall be moved from active to archive and purging of archive shall be done once a month on fixed and mutually agreed dates.

## 6.4 Analysis and presentation of data acquired

The server shall have predefined queries for analysis of the logged data. The server shall also support user defined queries with options to save the same as pre-defined queries.

The results of the queries shall be published on the website in a tabular format, graphs and also links shall be provided to download the data into a MS Excel readable file.

The data shall be presented to the users in the form of reports and data visualization in charts and graphs.

### 6.4.1 Reports

#### 6.4.1.1 Canned reports

The portal shall have canned (predefined) reports that can be accessed by the users on demand. These reports shall be displayed in a separate new window and options for printing, emailing and exporting (to MS Excel readable file) the same shall be provided.

The following canned reports shall be provided

1. Diesel Shed MIS Report
2. Divisional Power Control MIS Report
3. Zonal Power Control MIS Report

The data and the format for presentation of these reports shall be jointly fixed by RDSO and the service provider.

#### 6.4.1.2 User defined reports

The portal shall have options for users to create their own reports. It shall be possible to save these visualizations as canned reports in the user's login.

### 6.4.2 Data visualization

The portal shall offer feature of data visualization. This feature shall provide the users with the ability to select data in a SELECT query and display the same in two different modes for visualization i.e. time trend visualization and aggregate data visualization.

The two modes of data visualization are detailed below.

#### 6.4.2.1 Time trend visualization

This feature shall allow the user to select upto six channels of data which shall be presented as a time trend graph.

It shall be possible to fix Lower Control Limit (LCL) and Upper Control Limit (UCL) on any one parameter out of six and the software shall indicate areas for where the given parameter falls out of these limits. The remaining five time trends shall also be indicated in this graph using suitable scale.

It shall be possible to download the selected data in MS Excel readable file for offline data analysis.

It shall be possible to save these visualizations as canned visualization in the user's login.

#### **6.4.2.1.1 Visualization of trends with selection of independent parameter**

The system shall also have the provision to permit users to design their own custom visualization. It shall be possible to save these custom reports as canned reports for repeated use.

The feature shall permit selecting upto six parameters together for creation of data table and graphs. It shall also have feature permitting selection of any logged parameter as the independent parameter on the X axis.

It shall be possible to download data into an MS Excel readable file.

#### **6.4.2.2 Aggregate data visualization**

This feature shall allow the user to select upto two channels of data which shall be presented as aggregate data charts like scatter plot, population distribution, Pareto chart.

It shall be possible to download the selected data in MS Excel readable file for offline data analysis.

It shall be possible to save these visualizations as canned visualization in the user's login.

#### **6.4.3 Canned visualizations**

Time trends of parameters as defined below shall be provided as canned visualization i.e. visualization that are ready to use at a press of a button.

These graphs shall contain the data table and graphs depicting the time trend.

The time period for displaying the trends shall normally be two months however the user shall have the option for changing the same.

These trends shall be displayed for the following parameters.

- Engine Parameters
  - Lube oil pressure and lube oil temperature.
  - Fuel oil pressure and fuel oil temperature.
  - Booster air pressure.
  - Coolant temperature and pressure at discharge.
  - CC vacuum
  - Peak BHP and exhaust gas temperature (EGT) recorded at the max BHP for each day.
  - EGT with throttle handle position, exciter current, and inlet air temperature.
- Electrical parameters
  - Battery voltage when not charging
  - Max differential current recorded between all traction motors. (Max of all samples aggregated to one reading per hour)
- Pneumatic parameters
  - MR pressure
  - Compressor load / unload events with time duration
- Journal of data pack occurrences alongwith the option to download the relevant data pack

#### **6.4.4 Presentation of data**

Information shall be presented by the data centre servers over the internet using the concept of Situation Aware Display System (SADS). The basic underlying concept shall be: "Overview first, zoom and filter, then details on demand."

The SADS requirements are detailed in another part of this specification. The data centre must ensure that the information is generated and presented as required by the SADS.

## 6.5 Geo-fencing

The LTMS provider shall develop suitable applications and create databases to correctly identify the location of the locomotives. These applications shall be based on the concept of geo-fencing.

The following shall be identifiable entities provided in under geo-fencing.

1. Railway Divisional boundaries
2. Railway Zonal Boundaries
3. Diesel Shed Boundaries
4. Every railway station
5. City / town limits

The geo-fencing application and its information store shall be developed in such a manner that it shall be possible to continually refine and add further details in future.

In order to kick start the system the geo-fencing application system shall be developed in the sequence given above.

## 6.6 Scalability requirement

The servers shall be designed for expandability. The following loads are expected to be serviced by the servers at different stages:

Stage	Locomotives	Diesel Shed Offices	Divisional Offices	Zonal Railway Offices
<b>Initial</b>	1000 nos	10 nos	10 nos	5 nos
<b>Full Deployment</b>	5000 nos	50 nos	70 nos	16 nos

**Table 2: Table showing scalability requirements**

## 6.7 24x7 Technical support

The service provider shall also provide 24x7 technical support for maintenance and management of REMMLOT systems including LRMS, LTMS and clients over the following media:

- Telephone via a toll free number
- Video conferencing
- Email
- Physical visits

The technical support shall have a documented and advertised issue tracking system (ITS) which shall be fully automated and shall log and issue tickets for issues reported through any of the media above.

## 6.8 Application performance measurement and management

Established third party systems for monitoring measuring and reporting performance of services provided shall be setup at the data centre or where ever required.

These reports shall be used for determination of quality of service based on which the payments to be made shall be calculated.

Further details are included in another part of this specification. Kindly see Part-0 for details of the Service Level Agreement performance parameters for REMMLOT.

## 7 Technical requirements

### 7.1 ISO 9001 Certificate

The service provider must be certified to ISO 9001.

## 7.2 ISO 27000 certificate

The service provider shall be certified as conformant to **ISMS ISO27001**. The firm providing the service shall further ensure that the new facilities setup for handling the LTMS shall be included in the scope of certification within 6 months from the date of setting up the services.

## 7.3 CMMI Level 3 qualification

Service provider for the services requirement described in this document shall be assessed to **CMMI Level 3** or better.

## 7.4 Uptime requirements for internet portal

The internet portal for LTMS shall be compliant to **TIA-942 Tier III**.

## 7.5 Guidelines for user interfaces

The user interfaces shall developed using the guidelines contained in **ISO 9421**.

## 7.6 Performance indices for service provision

A separate document lists the performance indices for the services expected to be provided in this specification and its concomitant parts. Payments shall be governed by the quality of services provided.

## 7.7 Power supply

All mains powered equipment shall be suitable to operate on Indian utility supply

## 8 Applicable Drawings

None

## 9 Safety requirements

The equipment shall meet all statutory and regulatory criteria required for safety of users.

- All mains powered equipment shall be compliant to UL 60950 for electrical safety.

## 10 Environmental/Climatic requirements

All equipment (if any) supplied by the service provider, under the requirements mentioned in this document shall be suitable for use in non-air-conditioned office spaces.

## 11 Referred standards

Kindly refer part 0 of the specification.

## 12 Maintenance and diagnostic aid

The service provider shall explicit document and requirements and function of the any special tools and diagnostic aids required.

All such tools and aids shall be provided by the service provider.

## 13 Documents required from supplier

The service provider shall initially provide documents containing concept overview of LTMS. This document shall be approved and filed at RDSO.

The following documents shall be provided and updated as required by the service provider during the duration of the contract.

- All software developed shall be documented and provided in source code in soft copies.
- All configuration files shall be documented and provided in soft copy.

## 14 Accessories

List of accessories required shall be specified by the service provider.

## 15 Training

The service provider shall arrange, training this shall be a part of the service supply.

This training shall be provided to all personnel who shall be required to operate the client programmes for REMMLOT.

Personnel of Indian Railways shall be nominated to attend. The to and fro fare and living expenses shall be borne by Indian Railways incase the training is held outside the normal place of work.

## 16 Tests & Verification

All equipment and software shall be tested for functional working before deployment. Performance tests shall be conducted using the third party APM tools.

These tests and verification shall be conducted by RDSO or by any other third party. A scheme for testing shall be jointly prepared by RDSO and service provider for conducting the tests.

## 17 Types of tests

The following different types of tests shall be conducted at different stages verifying compliance of functional requirements and meeting the performance requirements

### 17.1 Proof of concept

The proof of concept shall be tested at the initial stages to prove out the concept of LTMS. This shall be done by demonstrating the setup with limited users and simulated data. The complete details of deployment shall be documented and same approved by RDSO for further action.

### 17.2 Functional test

This test shall be conducted after deployment of LTMS servers. This test shall be conducted for checking the compliance to the functional requirements specified in the set of specifications and developed during the proof of concept tests.

### 17.3 Load test

Server load test shall be conducted by enabling data transfer from locomotives already equipped with REMMLOT LRMS and simulating additional loads of locomotives and clients on the local area network. The load test parameters shall be monitored using third part APM tools.

The parameters to be tested shall be monitored as described in another part of this specification.

These load tests shall be conducted as required for determining stability of the server systems and ability to meet the performance specification.

### 17.4 Routine tests

The routine test shall be conducted whenever a new locomotive is to be added to the list of locomotives monitored by the REMMLOT system.

This test shall consist of functional check for all features for the particular locomotive to verify the system is working and operational.

### 17.5 Makers test certificate for outsourced item

All items that are outsourced by the equipment manufacturer shall be indicated so. The type and extent of control that has been exercised shall be provided with proper documentation.

The manufacturers (of the outsourced sub-assembly) test certificates shall be provided.

## 18 Painting, labeling 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.

## 19 Packaging 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.

## 20 Guarantee / Warrantee

The equipment manufacturer shall provide warranty guarantee for performance as per the IRS conditions.

## 21 Intellectual Property Rights

### 21.1 Undertaking by equipment manufacturer

All the specifications issued by RDSO shall include a requirement of undertaking to be signed by Vendors on "INFRINGEMENT OF PATENT RIGHTS". The undertaking can 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.

### 21.2 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.

## 22 Information to be supplied by supplier

The equipment manufacturer must provide to RDSO, the complete details of algorithms, design and drawings required for the purpose of evaluation of the design and its functionality.

Operations and maintenance manuals, spare parts catalog shall be supplied to all users as required in both hard and soft (PDF) copies.

## 23 Information to be supplied by purchaser

Required design details and layouts of room to house the mockup server and other equipment shall be provided by the purchaser.