MINISTRY OF RAILWAY

TECHNICAL SPECIFICATION FOR SELF PROPELLED TRACK AND TURNOUT MONITORING CAR (Specification No. TM/IM/457 of 2019)

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Issued By:
Track Machine & Monitoring Directorate
Research Designs and Standards Organization
Manak Nagar, Lucknow-226011
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SUPPLY, INSTALLATION AND COMMISSIONING OF
SELF PROPELLED TRACK & TURNOUT MONITORING CAR

Chapter-I (System Specifications)

1.0 DEFINITIONS & ABBREVIATIONS:

IR - Indian Railway
RDSO - Research, Designs and Standards Organisation, Lucknow, India.
Purchaser - RDSO, Ministry of Railways, India
System - Integrated Track Monitoring System
UPS - Uninterrupted Power Supply System
VDU - Video Display Unit
ALD - Automatic Location Device
LVDT - Linear Variable Differential Transformer
SD - Standard Deviation
STTMC - Self-Propelled Track & Turnout Monitoring Car
TRC - Track Recording Car
TTMS - Track and Turnout Measurement System
RWVRS - Rear Window Video Recording System
TMS - Track Management System (A web enabled IT application)

2.0 SCOPE:

2.1 The specifications given below are meant to broadly bring out the functional and technical requirements of self-propelled Track & Turnout Monitoring Car (STTMC). The tenderer shall furnish compliance or deviations, if any, for each clause and sub-clause of the specification along with technical explanations/details. In case of any ambiguity in any clause or sub clause, bidder is free to seek clarification before submitting the bid. The clarifications may be sought from Director Track Machine - IV, TMM Directorate, RDSO, Manak Nagar, Lucknow – 226011, Fax – 91-522-2465682 or through email at dtm4rdso@gmail.com

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2.2 The design, manufacture, lab validation and supply of the system along with vehicle shall be completed within the time period specified in the contract. Subsequently, the installation, field validation and commissioning of the system shall be completed as per the time schedule given in the tender document.

3.0 GENERAL:

3.1 The TTMS with all related instrumentation / electronic sub systems shall be installed in a Broad Gauge (1676 mm) self-propelled vehicle which is to be supplied along with the TTMS. The technical specifications of the vehicle to be supplied have been detailed in Chapter-II of these specifications.

3.2 The TTMS, shall Consist of following sub – systems and shall be capable of recording the parameters mentioned under each sub systems in para 5.0.

i) Track parameters recording system

ii) Full rail profile and wear measurement system

iii) System for Rear Window Video Recording of IR track

iv) System for video inspection of track components and analysis for reporting condition of track components

v) System for measurement of various parameters on turnouts (Switch & Crossing)

3.3 All Transducers/Sensors, Sensor beam and their mounting arrangements shall be installed within the Maximum Moving Dimension (MMD) envelope of IR as per Schedule of Dimension (SOD)-2004 and latest correction slips. The same is available at http://www.indianrailways.gov.in.

3.4 SERVICE CONDITIONS

System should be able to work under following service conditions:

i. Ambient temperature - 0°C to 55°C

ii. Rail temperature - (-) 10°C to (+) 65°C

iii. Humidity - Up to 100%

iv. Rain fall - Fairly heavy

v. Atmospheric condition - Very dusty, Heavy fog

3.5 On IR network the electrified traction consists of overhead electric system of 25000 V AC or 2*25000 V AC with residual return current passing through one of the rails in the track. System and accessories having part of electronic...
train running safety system such as Train protection warning system (TPWS), Audio frequency track circuit (AFTC), Digital axle counter, DC track circuiting shall not affect the accuracy of track recording results in any manner due to the induction effect of the above stated electric traction and signaling systems.

3.6 The recording of parameters by TTMS should not be affected by direct sunlight, dust and rains.

3.7 TTMS should have in-built protection to absorb voltage fluctuation and should work on 220 V ± 10%, 50Hz±5% AC supply to be given from diesel generating set / AC main line.

3.8 The TTMS shall be capable of recording the parameters of various sub systems given in para 5.0 in the speed band of 5-8 kmph to 110 kmph.

3.9 TTMS shall have the facility for wheel wear compensation to enable accurate measurement and recording of speed & distance and also ensure constant sampling distance with new as well as worn wheel.

3.10 The TTMS shall be capable of monitoring all parameters of various sub systems in both forward and reverse directions accurately.

3.11 The TTMS shall be capable of measuring all track and turnout parameters on all types of track structure prevalent on IR viz continuous welded / long welded panels / short welded panels / fish plated track comprising of concrete / steel trough / CST-9, wooden sleepers and 60 kg / 52 kg rails. The System shall be capable of identifying the type of rail automatically.

3.12 The TTMS should be capable of measuring on various track features e.g SEJ, Curves, Bridges and Level crossings etc.

3.13 All the transducers/sensors and measuring frame/sensor beam/mounting arrangement for sensors and system including sub systems shall be supplied and installed in the self-propelled coach to be supplied along with system. However, prior approval for the design & drawing of system including sub systems, measuring frame/sensor beam and its mounting arrangement shall be taken from the purchaser. All holes drilled for connection of sensors to system shall be properly closed sealed to prevent entry of rats and insects.

3.14 Suitable metallic / wooden racks, panels etc. for installation of hardware, computers, monitors, power supplies and printers etc. in the inspection room of STTMC shall be provided and installed by the supplier.

3.15 The furnishing of the instrumentation room will be done by providing and fixing required furniture for operators and inspecting officials along with 01
working bench and chair for carrying out minor repair. The furniture shall be
got approved from purchaser before supply.

3.16 The layout of TTMS shall be such that adequate space is available for
maintenance of system and movement of IR officials. Prior approval from the
purchaser shall be taken for the layout. The finish and workmanship shall be to
the best international standards and shall give a decent appearance with
durability and serviceability. All surfaces liable to frequent handling shall be
finished with materials suitable for periodical cleaning and shall be of colour
matching with the interior of the coach.

3.17 The facility shall be provided for processed data transfer from STTMC to
R.D.S.O and headquarters of Zonal Railways. This facility shall be provided
through GPRS or any other suitable network.

4.0 SALIENT TECHNICAL FEATURES:

4.1 Track Parameter Recording System
   i) Inertial principle of measurement with laser contact-less sensors shall be
      used for measurement of vertical and lateral profiles of both left & right
      rails with appropriate correction for roll and yaw. Gauge shall be
      measured with laser based contact-less sensors.
   ii) System shall have the ability to record track irregularities having
      wavelengths in the range of 3.0 m to 100 m. Speed independent band
      pass filters shall be used for the same.
   iii) Sampling distance for recording shall be user selectable from 0.25 to
      0.50 meter. The least count of the tachometer shall not be more than 1.0
      mm.
   iv) The system shall be capable of storing raw data (Transducer/Sensor
      signals), profile/chord in ASCII/Binary format and processed data in
      ASCII/Database format in separate files for 10,000 km of track
      recording. An additional mirror image disk of the same capacity shall
      also be provided to guard against possible loss of data in case of hard
      disk crash. Option to record or not to record various types of data shall
      be selectable by the operator through user interface. The system shall
      also be capable of uninterrupted recording and storage of above-
      mentioned data for 1,000 km.
   v) System shall have the capability for on line reporting of track parameter
      peaks above predefined threshold value with location to nominated P.
      Way official of the concerned section through GPRS based cellular

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communication network. Facility to change the limits shall also be available.

vi) System shall be capable of recording track features and their location along with track geometry parameters, accurately using previously prepared route feature location file (wherever available) and STTMC’s navigation system, in data files and marking of same in graphical and digital exception reports.

vii) System shall have facility to automatically pause the recording in case of STTMC’s movement in reverse direction. The system shall also be able to correctly measure the reverse movement and compensate for the same on forward movement of STTMC, so as to restart the recording from the point where recording was paused.

viii) The System shall be capable of real time (during recording) processing, analysis, storage, reporting and printing of the recorded data/reports. During recording the digital reports and analogue chart shall be displayed on separate VDUs and printed on separate printers. Three copies of exception report and one copy of analogue report shall be printed during recording. Option to take or not to take the print of exception report and analogue report shall be available to user.

ix) Adequate number of minimum, 17 inch LCD based VDUs for operator interface, display of digital exception reports and analogue chart shall also be provided near operator console.

4.2 Full rail profile and wear measurement system

i) The same LASER contact less sensors being used for recording of track geometry parameters shall be used in this sub system for measurement of rail profile and wear.

ii) The LASER sensors used shall be protected from all health hazards & comply with the relevant regulations in this regards.

iii) Sampling distance for recording shall be user selectable from 0.25 to 0.50 meter. The least count of the tachometer shall not be more than 1.0 mm.

iv) The system should have the facility for measurement of both rail profiles with an accuracy of 0.15 mm or better and storage of same in a format compatible with ORIAN 8GP rail profile measurement system of KLD installed in 72 stone LORAM Rain grinding machine of RGI series at user selectable interval in the range of 0.25m to 5.0m.
v) The rail wear and other parameters should be measured/calculated on selected sampling interval and stored in a separate file in ASCII/Binary file.

vi) The system shall be capable of Storing both rail profile, vertical & lateral wear, other parameters data and exception report on the basis of predefined limits in separate files for 10,000 kilometers of track monitoring. An additional mirror image disk of the same capacity shall also be provided to guard against possible loss of data in case of hard disk crash. Option to record or not to record various types of data shall be selectable by the operator through user interface. The system shall also be capable of uninterrupted recording and storage of above-mentioned data for 1,000 kms.

vii) System shall be capable of recording track features and their location along with rail wear and other parameters accurately using previously prepared route feature location file (wherever available) and STTMC’s navigation system in data files and marking of same in graphical and digital exception reports.

viii) The System shall be capable of on line (during recording) processing, analysis, storage, reporting and printing of the recorded data/reports. During recording the digital reports and analogue chart shall be displayed on separate VDUs and printed on separate printers. Exception report and analogue report shall be printed during recording. Option to take or not to take the print of exception report and analogue report shall be available to user.

ix) Adequate number of minimum, 17 inch LCD based VDU’s for operator interface, display of super imposed rail profiles, digital exception reports and analogue charts shall be provided in instrumentation hall near operator console.

4.3 System for Rear Window and Driver’s view Video Recording of IR track

i) The system shall have the facility for measurement in both forward and reverse direction.

ii) The system shall be capable to capture good image of front and rear view of the track. Resolution of the captured view shall not be less than 1280x720 pixels.

iii) The video of rear window driver’s view video recording shall be displayed on the VDU and stored on magnetic media. The system shall
be capable of storing video, image at track features with location for at least 10,000 kilometer of track. An additional mirror image disk of the same capacity shall also be provided to guard against possible loss of data in case of hard disk crash. Option to record or not to record various types of data shall be selectable by the operator through user interface. The system shall also be capable of uninterrupted recording and storage of above-mentioned data for 500 km.

iv) The system shall be capable to acquire, store, display and print the image of track features with Section, Line, Date, Time and location of track feature with GPS coordinates, Level Crossing, Curve Start, Curve End, Bridge Start, Bridge End, Station etc. using preloaded track feature location file. A line on the location of track feature shall be printed on image along with track parameter peak value on short chord. Option to print the image at track features shall be user selectable.

v) System shall have the capability for storage of images with location at least at every 4.0 meter at maximum recording speed of 110 Kmph.

4.4 System for video recording of track components for reporting their status

i) System shall be capable to identify, store and print image and description of the defects in both left and right Rail, Fastenings, Sleepers and Ballast.

ii) System shall be capable to store image and description of defect with location in separate files for each component of track i.e Rails, Fastenings, Sleepers and Ballast.

iii) Defect information shall be printed and stored in ASCII or database format. The images shall be stored in JPEG format.

iv) The format and limiting values for exception reports will be finalized and provided after award of contract.

v) The video of track component monitoring shall be displayed on the VDU and stored on magnetic media. The system shall be capable of storing video, defect images and defect information for at least 10,000 kilometer of track. An additional mirror image disk of the same capacity shall also be provided to guard against possible loss of data in case of hard disk crash. Option to record or not to record various types of data shall be selectable by the operator through user interface. The system shall also be capable of uninterrupted recording and storage of above-mentioned data for 500 km.
4.5 System for measurement of various parameters of Turnouts

i) System shall be capable of recording turnout parameters on following types of turnouts prevalent on IR:
   - 1 in 16 turnout on concrete sleepers
   - 1 in 12 turnout on concrete sleepers
   - 1 in 8.5 turnout on concrete sleepers

ii) System shall be capable of recording all parameters of different turnouts given in para 5.5.

iii) A complete turnout inspection report shall be generated on the basis of measured values of different turnout parameters for each turnout.

iv) Facility to compare with previous reports of same turn out shall be available in offline.

v) The turnout inspection report shall be printed and the measured values of various parameters shall be stored in ASCII/database format. It shall be feasible to upload the data in IR track management system to generate the inspection report in TMS.

vi) The limiting values for turnout inspection report are given in Annexure-V. The Formats for reports will be finalized after award of contract with mutual discussion with the firm.

vii) The system shall be capable of storing the measured values of various turnout parameters at least for 1000 turnouts. An additional mirror image disk of the same capacity shall also be provided to guard against possible loss of data in case of hard disk crash.

5.0 PARAMETERS TO BE RECORDED:

5.1 Track Parameter Recording System:

A. The System shall be capable of measuring / recording the following parameters.

i) Absolute vertical profile of left and right rail on two user selectable band pass filters in the range of 3 m to 100 m in steps of 1m.

ii) Unevenness of left and right rail on two user selectable chords in a range of 2 m to 20 m simultaneously with actual chord length being an even multiple of sampling distance. While recording on chord, only one band pass filter is to be selected for acquiring the vertical profile in the range of 3 m to 100 m in steps of 1m.
iii) Absolute lateral profile of left and right rail on two user selectable band pass filters in the range of 3 m to 100 m in steps of 1m.

iv) Alignment of left and right rail on two user selectable chords in a range of 2 m to 20 m, simultaneously with actual chord length being an even multiple of sampling distance. While recording on chord, only one band pass filter is to be selected for acquiring the lateral profile in the range of 3 m to 100 m in steps of 1m.

v) Gauge (measured 14mm below rail table) at every sampling point.

vi) Super elevation or Cant at every sampling point.

vii) Twist on two user selectable bases in a range from 2 m to 20 m from cross level and from dynamic cross level (difference of left and right rail absolute profiles). Option to select the method of calculation of twist from cross level/dynamic cross level shall be available. Individual defect will be represented as the amplitude from the zero line to the peak value.

viii) Curvature at every sampling point. (To be measured in degrees. Degree is defined as 1750/R, where R is the radius of the curve).

ix) Marking of 36 route features through route feature information file and 24 route features using dedicated key pad by punching single key assigned for each feature during recording along with distance.

x) Speed of recording

xi) Distances for relevant features

B. The accuracy of measured track parameters in terms of repeatability and reproducibility shall be in accordance with the limits laid down in European code EN 13848-2. The reproducibility shall be tested and confirmed in the speed band of 20 to 110 Kmph as per the limits laid down in European code EN 13848-2.

5.2 Full rail profile and wear measurement system

i) Complete Rail Profile of both rails (left & right) for different type of rails being used on Indian Railways.

ii) Vertical and lateral rail wear of both rails (Left & right) for different type of rails being used on Indian Railways.

iii) Horizontal rail wear of both rails (Left & right) for different type of rails being used on Indian Railways
iv) Angular rail wear of both rails (Left & right) for different type of rails being used on Indian Railways.

v) Rail roll over \textit{i.e.} inclination of rail.

vi) Lip flow \textit{i.e.} burring on rail head.

vii) Marking of route features through route feature information file and dedicated key pad by punching single key assigned for each feature during recording along with distance.

viii) Speed of recording

ix) Distances for relevant features

x) The accuracy of wear in terms of repeatability and reproducibility shall be measured in terms of SD of sample to sample variation for a block of 200 m and the 95 percentile values shall be within the limits given below.

\begin{itemize}
  \item[a.] Lateral wear (Horizontal gauge side wear) \quad 0.2 \text{ mm}
  \item[b.] Vertical wear \quad 0.2 \text{ mm}
  \item[c.] $45^\circ$ internal rail profile wear \quad 0.2 \text{ mm}
  \item[d.] Rail roll over \quad \pm \, 0.25^\circ
  \item[e.] Lip flow \quad 0.3 \text{ mm}
\end{itemize}

5.3 \textbf{System for Rear Window and Driver’s view Video Recording of IR track}

i) Image of track feature with Date, Time, Section, Line, description, location and speed at track feature.

ii) Track parameter value in peak form on short chord at track feature location.

5.4 \textbf{System for video recording of track components for reporting their status}

System shall be capable of identifying and reporting defects in rails, sleepers, fastenings and ballast. Following defects shall be identified in each track component.

i) Rails

\begin{itemize}
  \item[a.] Linear Defect
  \item[b.] Area Defect
  \item[c.] Joint Gap Measurement
  \item[d.] Weld detection
\end{itemize}
ii) Sleepers
   a. Crack Detection
   b. Sleeper misalignment
   c. Sleeper level check
   d. Concrete sleeper spalling

iii) Fastenings
   a. Missing Clip
   b. Shifted rail pads
   c. Missing Bolts and Rail anchors

iv) Ballast
   a. Excess or lack of ballast
   b. Detection of axle counters, Dancing sleepers, Foreign objects, SEJ, Switches & Crossings and Level Crossings
   c. Base plate crack check and vegetation check
   d. Excess of Mud/Dry mud

Note: The accuracy values for above parameters are given in Annexure-IV.

5.5 System for measurement of Turnout parameters

The system shall be capable of measuring following parameters of turnouts

A. Parameters to be measured on complete turnout
   i) Condition of sleepers similar to straight track given in para 5.4 (ii)
   ii) Excess/Deficiency of ballast similar to straight track given in para 5.4 (iv)

B. Parameters to be measured at Switch assembly and lead Portion
   i) Condition of switch assembly as per details given in table of Annexure-V (4,5,6 of II)
   ii) Throw of switch at ATS
   iii) Divergence at heel block
   iv) Distance between web to web of tongue rails as per details given in Annexure-V (18 of II)
v) Gap between top edge of stretcher bar and bottom of rail foot as per details given in Annexure-V (19 of II).
vi) Distance between gauge faces of stock rail at JOH.

vii) Clearance at JOH as per details given in annexure-V (20 of II).

viii) Gauge and Cross level in switch and lead portion at locations given in Annexure-V (7 of II).

ix) Versine in switch and lead portion as per details given in Annexure-V (12 of II)

x) Straightness of track at stock and tongue rail as per details given in Annexure-V (15 &16 of II)

xi) Housing of stock and tongue rails as per details given in Annexure-V (13 of II)

xii) Seating of tongue rail on slide chairs as per details given in Annexure-V (14 of II)

C. Parameters to be measured on Crossing Portion

i) Gap at heel and toe of crossing on main line and turnout

ii) Wear of different types of crossings as per details given in Annexure-V (23 of III)

iii) Condition of crossing as per details given in Annexure-V (21 of III)

iv) Clearance of wing rail opposite nose of crossing and up to 450 mm towards heel end

v) Gauge and cross level on crossing as per details given in Annexure-V (25 of III)

vi) Condition of check rail fitting as per details given in Annexure-V (26 of III)

vii) Inner and outer check rail clearance as per details given in Annexure-V (27 of III)

D. Turn in Curve as per details given in Annexure-V (28 & 29 of IV)

5.6 Route Feature Information and Synchronization:

A. Route Feature location file is a data file for each route of IR (annexure-IA). This file is in ASCII format containing the location of various route features viz. turnout, level crossing, bridges, station etc. in terms of

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distance from the previous km post and length of previous kilometer along with latitude and longitude of the route feature. The data file of some routes may also be without latitude and longitude. Thus system should have the capability to read both type of files. This data file will be supplied by the purchaser.

B. The ITMS should also have the capability of identifying the RFID tags of open protocol which are proposed to be placed on IR track and make relevant location corrections. RFID tag reader compatible to read RFID tag of open protocol is to be installed on the STTMC car along with ITMS by the firm. RFID based Automatic Location Detector (ALD) system for location synchronization shall be supplied as per technical details given below:

RFID based Automatic Location Detector (ALD) comprises of two parts, one passive ground transponder installed in track and one active unit installed in STTMC to detect the ground transponder. The active unit (Reader) of ALD sensors shall be suitable to be fitted underneath the coach body & shall be rugged enough to withstand field conditions. Reader is to be supplied by the supplier. The passive unit (Tags) of ALD shall be installed on track by IR. The supplier will install the RFID reader compatible with RFID tag of open protocol as per specification details given below:

(a) The ground/track installed tags are used with all types of Sleepers of the Indian Railways. These are typically placed in the center (+300 mm) of the sleeper in-between the two rails.

(b) The tags on sleepers are mounted at sleeper top level. The base metal is steel, stainless steel or aluminum as per relevant Indian Railways standards.

(c) The tag specifications are, in general, as per GS1 standards and broadly aligned with the ‘European Guideline for the Identification of Railway Assets using GS1 Standards’. The basic encoding standard applicable is SGLN195 of GS1.

(d) For understanding the data formats for use on the tags please read the associated document ‘Guidelines for Data onboard RFID Tags of the Indian Railways Track’ attached as Annexure -III.

(e) The tag reader should work in conditions of EMI/ RFI as 25kV AC or 2x25 kV AC is used in overhead lines on tracks.

(f) Base standard of Tag being used will be: EPC Gen2 V1.2 or higher.

(g) Generic information on Tag:
   - Concrete / metal mount type of tags.
• All standards as applicable for use of UHF RFID tags in India are applicable.
(h) The RFID Tags have a user memory of 3 kb or higher.
(i) Dynamic Performance of Tag used by IR: Minimum read rate based on circularly polarized reader antennas with 110º or more azimuth angle at a minimum distance of 1.0m and maximum distance of 2.0 m up to a speed of 110 kmph.
(j) Sensitivity of tags is as under:
• The best case sensitivity is equal or better than 17 dBm
• The worst case values are more than 25.5 dBm, i.e., the variation between the worst case and the best case should 50% or less, keeping in mind that the scale is negative.
(k) Tags used by IR are as per IP68 housing standards. STTMC will run under the most severe climatic conditions. This includes sandstorms, pelting rain, snow, heat, vibrations etc. Therefore, there should be no concern in reading the data from the tag under such conditions.

5.7.1 System shall be capable to capture route features with its distance from previous kilometer post accurately using previously prepared route feature location file & manually entered route features by event marker key pad using STTMC’s navigation system and incorporate the same in the exception and analogue reports of various sub systems mentioned in para 3.2 along with storing the same in data files of various sub systems. The STTMC’s navigation system comprises of tachometer, ALD, event marker keypad and associated processing hardware and software. The method of incorporation and combining of these shall be got approved in advance from the purchaser.

5.7.2 In addition to Route feature location file, system shall also provide for manual entry of various route features by the operator using a dedicated event marker keypad having one key for each of the features given in Annexure-II. It should be possible to mark & print track features from keypad while recording with route tape in analog and exception reports and store the same in data files. The list of route features available in route feature location file and to be made available on dedicated key pad is attached as annexure- I and II.

5.7.3 The location of RFID tags installed in the track will be made available in the route feature location file. While recording, when the reader detects a RFID tag on the track, its current location should be updated/corrected as per the location stored in the route feature location file. The design and mounting of the automatic location detector should be such that it can sense the ground target without infringing the IR Maximum Moving Dimension envelope. The

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method of incorporation and combining of these shall be got approved in advance from purchaser.

5.7.4 The system shall have the facility to detect RFID tag location installed on track and synchronize the distance with respect to the actual location of the RFID tag stored in the route feature location file. In case a RFID tag is not detected or missing, then system should give a message “RFID tag not found” and synchronization should take place on next RFID tag. In addition, facility for manual synchronization by punching the kilometer switch of keypad shall also be provided.

5.7.5 The successful tenderer will be required to provide the user manuals of RFID Tag Reader.

5.7.6 The speed shall be accurately recorded using a digital optical encoder connected to one of the axles of the STTMC. The speed shall be displayed in digital form inside the STTMC at two suitable locations. A spare tachometer shall be provided duly connected with another axle as standby.

6.0 HARDWARE:

The digital and analogue hardware shall meet all requirements of the specification, keeping the following in view.

6.1 The system shall be so designed that the same is capable of up-gradation in future.

6.2 All data acquisition and amplifier cards used in the system shall be properly secured from all sides in such a way that these do not get loose in their sockets due to vibration of the coach during recording and idle movement of coach.

6.3 The latest and new industrial quality digital and analogue hardware, capable of withstanding the service conditions stipulated in clause no. 3.4 and vertical & lateral accelerations of up to \( \pm 2.0 \) g at coach floor level and upto \( \pm 50.0 \) g at axle box shall be provided. Transducers/Sensors used shall be of rugged quality and well protected against flying objects, debris, shocks, vibrations etc. and shall be properly secured.

6.4 Flexible good quality shielded cables and connectors capable of working reliably in dynamic condition prevailing on IR System shall be used.

6.5 System shall be such that results are not affected by electronic noise, spikes, surges of the generator, power line and EMI generated by over-head electric traction lines, return current & track circuiting currents in the rails etc. Adequate shielding, line filters with surge suppressors etc. shall be provided.
6.6 The system shall be compact with minimum loose links, so that during recording runs the problem of loose connection & loose link shall not be encountered.

6.7 The system shall be modular in design so that in the event any unit / card / transducer going defective, it can be replaced with ease during run.

6.8 Facility and equipment for monitoring of individual transducer output, conditioned output of the signal and the frequency/voltage/wave pattern of the power supply by the operator, shall be provided.

6.9 A system of indicating the functioning of transducers/sensors during recording shall be provided.

6.10 The system shall be provided with good quality UPS of proper rating and reputed make. The entire system will be powered via this UPS, with back up time of at least 30 minutes.

6.11 Adequate number of Laser/Dot Matrix Printers shall be supplied to print various on-line reports being generated by various sub systems for recorded parameters as mentioned in para 5.0.

6.12 The system shall be provided with DVD/Blue ray device for down loading of all data being stored in various sub systems.

6.13 The supplier shall take prior approval of the hardware / software design from the purchaser before actual adoption.

7.0 SOFTWARE:

7.1 DATA PROCESSING AND REPORTING BY VARIOUS SUB SYSTEMS DURING RECORDING:

7.1.1 The software shall be user friendly and menu driven and it shall be so designed that it should be compatible for upgradation with newer versions of operating systems and PCs.

7.1.2 Track Parameter Recording system

i) Software shall be able to print on line exception reports and analogue charts after every kilometer.

ii) Software shall have the facility to select parameters for analog / graphical output for display on VDU and print the same on laser printer. Analog output of each kilometer shall be printed on one page. The system shall also have the capability to store the analog output in suitable format for
it’s future viewing, processing and printing. The graphical / analog output shall include following for each kilometer.

a) Two level lines for each parameter as per predefined limits.

b) Vertical lines at every 100 or 200 meter distance.

c) Average speed for every 100 or 200 m section.

d) Route Features

e) Header details e.g. Railway, Section, Section speed, Kilometer, Date of recording, file name in which analog data has been stored etc.

iii) The software shall have option to select either profile or chord mode. In case of profile mode, the software shall be capable of recording the profiles on two user selectable bands of wavelengths in the range of 3m to 100m. In case of chord mode there shall be a single band of wave length in the range of 3m to 100m with processing of data on two user selectable chords in the range of 2 m to 20 m.

iv) Facility for entering threshold values initially for various parameters for generation of exception report and same shall editable subsequently.

v) Software shall be able to calculate the following from the profile and chord data and print the same as exception report on line after each kilometer. The format of exception report will be finalized and provided by the purchaser.

a) Evaluation of Standard Deviation (SD) for all track parameters for each block of 200m length in a kilometer, except for the last block, length of which may be less or more depending upon the length of the kilometer. However, if the distance in the last block is more than 250m, the SD of excess length above 200m shall be calculated and reported in next block. A kilometer can have variable number of blocks depending on the length of the kilometer.

b) Evaluation of average gauge (for blocks of 200 meter), calculated from absolute gauge and measured w.r.t nominal gauge entered at the start of run.

c) Evaluation of 01 SD based indices separately for all track parameters for each block, as per the formula supplied by RDSO.

d) Evaluation of 03 SD based composite indices for each block as well as for the whole km, as per the formula supplied by RDSO.
e) Recording & printing of route features along with distance from km post in exception reports and analogue charts being printed during recording and offline.

f) Evaluation and reporting of peak distribution for both profile and chord modes according to various user selectable predefined limits / bands.

g) Evaluation and reporting of maintenance instructions as per user selectable predefined limits of SD values for various parameters.

h) Determination and storage of one highest value peak for all parameters for every 50 meter length of track and reporting of 10 worst peaks out of the determined total no of peaks in decreasing order of magnitude along with distance from the last km post. The logic of zero crossing shall be used for determination of peaks.

i) Determination and storage of all peaks in a kilometer with location. The logic of zero crossing shall be used for determination of peaks.

j) For evaluation of SD and peak information/distribution, variation of gauge over moving average (with specified length of moving window) shall be taken. In addition absolute value of gauge w.r.t nominal gauge shall also be recorded and reported under peak information and peak distribution.

k) Evaluation of block wise and km wise average speed.

l) Generation and printing of curvature report in the format given by RDSO.

### 7.1.3 Full Rail Profile and Wear Measurement System

i) Software shall be able to print on line exception reports and analogue charts after every kilometer

ii) Software shall have the facility to select parameters for analog / graphical output for display on VDU and print the same on laser printer. Analog output of each kilometer shall be printed on one page. The system shall also have the capability to store the analog output in suitable format for it’s future viewing, processing and printing. The graphical / analog output shall include following for each kilometer.

- a) Two level lines for each parameter as per predefined limits.
- b) Vertical lines at every 100 or 200 meter distance.
- c) Average speed for every 100 or 200 m section.
d) Route Features

e) Header details e.g. Railway, Section, Section speed, Kilometer, Date of recording, file name in which analog data has been stored etc.

iii) Software shall be able to calculate the following from the recorded data and print the same as exception report on line after each kilometer. The format of exception report will be finalized and provided by the purchaser.

a) Vertical and lateral wear of both left and right rail

b) Angular wear of both left and right rail.

c) Rail roll over of both left and right rail

d) Lip flow of both left and right rail

iv) Facility for entering threshold values initially for various parameters for generation of exception report and same shall editable subsequently.

v) Software shall be capable to display and print on laser printers the superimposed measured and new rail profile of both rails at sampling interval. Option to print or not to print shall be available along with facility to print superimposed profiles of selected length of track.

### 7.1.4 System for Rear Window and Driver’s view Video Recording of IR track

i) The software shall be capable to acquire, display, store and print the image at track features with Date, Time, location of track feature with Kilometer, Meter and GPS Coordinates (Latitude and longitude) e.g. Level Crossing, Curve Start, Curve End, Bridge Start, Bridge End, station etc. using preloaded track feature location file.

ii) Software shall have the facility to print the image at track features. The facility to print or not to print shall be user selectable.

iii) The software shall have capability to store and print track parameter value in peak form on short chord at track feature location

iv) The software shall be capable for storage of images with localization index at least at every 4.0 meter at maximum recording speed of 110 Kmph.

### 7.1.5 System for video recording of track components for reporting their status

i) The software shall be capable to identify and print the defect for each component of track with location i.e. Rails, Fastenings, Sleepers and
Ballast and store the same in separate files in ASCII or database format. The images shall be stored in JPEG format.

ii) Following defects in various track components shall be identified and printed in report format. Format of report will be provided by purchaser after award of contract.
   a) Rails
      • Linear Defect
      • Area Defect
      • Joint Gap Measurement
      • Weld detection
   b) Sleepers
      • Crack Detection
      • Sleeper misalignment
      • Sleeper level check
      • Concrete sleeper spalling
   c) Fastenings
      • Missing Clip
      • Shifted rail pads
      • Marking Detection
      • Missing Bolts and Rail anchors
   d) Ballast
      • Excess or deficiency of ballast
      • Detection of axle counters, Dancing sleepers, Foreign objects, SEJ, Switches & Crossings and Level Crossings
      • Base plate crack check and vegetation check
      • Excess of Mud/Dry mud

7.1.6 System for measurement of turnout parameters

Following reports shall be generated separately with facility to combine all the 03 reports in 01 report of a particular turnout

i) Detail inspection report for switch Assembly

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7.2 POST PROCESSING OF DATA:

7.2.1 The post processing of the various data recorded by the various sub systems are to be carried out in office environment. PCs, printers and any additional hardware required for post processing of data shall be supplied with the system.

7.2.2 The post processing software modules for various systems shall be capable for regeneration of various online graphical chart and exception reports being generated during recording from the stored data along with display on PC’s VDU.

7.2.3 The post processing software modules for various systems shall be capable for generation of various offline reports for track parameters in chord and profile mode and rail wear parameters. The detail of these reports are furnished below:

7.2.4 Track Parameter Reports

i. Recording run summary, Section wise summary and various other reports using different peak based, SD based and indices based exception limits.

ii. Reports for comparison of two recording results as per formats provided by the purchaser after award of the contract. The comparison software shall also indicate the improvement or deterioration among various recordings.

The purchaser (RDSO) will provide the formats of reports after award of contract. The data of all reports shall also be stored in comma separated ASCII files.

iii. Data of section wise summary of various repeat runs shall be stored in same ASCII data file or in some standard database in the format provided by purchaser (RDSO). The purchaser will provide the data file/data base format after award of contract.

iv. Generation of analogue/graphical output of raw data (transducer signal).

7.2.5 Rail wear reports

i. Software module shall be capable for regeneration of on line analog/Graphical and exception reports for parameters given in para 5.2
by selecting the correct rail type where wrong rail type has been identified.

ii. The software shall be capable to analyse the measured rail profile with respect to number of predefined rail profiles and find out the linear difference and area difference between two superimposed profiles. The format for report and storage of data will be provided by purchaser after award of contract.

iii. Facility to input predefined profile in the system shall be available.

iv. Various exception reports for vertical, lateral and angular rail wear by changing the threshold values through user interface.

v. The purchaser (RDSO) will provide the formats of reports after award of contract. The data of all reports shall also be stored in comma separated ASCII files.

7.2.6 Turnout parameter reports

i) Comparative report of two/three successive measurements

ii) Separate exception report above threshold values for switch, crossing and lead portion

iii) Section wise summary of all crossings and switch assembly w.r.t selected parameter

7.2.7 All data required by TMS from STTMC shall be stored in database or ASCII file in a format compatible with Indian Railway TMS data format for generation of various reports. Format of TMS data will be provided after award of Contract.

8.0 CALIBRATION, DIAGNOSTICS AND SIMULATION RUN:

8.1 Detailed procedures and periodicities of different types of calibrations required to be done viz. lab, field, quick, detailed etc. shall be given for various components, cards, transducers, sub-systems etc. The daily calibration before start of recording should be possible in minimum possible time, preferably within 15 minutes.

8.2 The calibration procedure shall be easy and should require minimum adjustments.

8.3 System shall be designed with diagnostic features. It shall have facility to check various transducers, modules etc. and communication between various sub-systems and peripherals etc.
8.4 The system shall be provided with features to facilitate trouble shooting at module/card level. Status of various parameters of modules/transducers shall be displayed on system VDU with reference and limiting values for identification of faulty modules/Transducers/sensors.

8.5 System shall have facility / modules for generation of simulated signals and speed required for testing of system in stationary condition.

9.0 ACCEPTANCE TESTS:

9.1 The system shall be subjected to both laboratory and field validation tests, before acceptance. Supplier shall submit detailed lab and field validation schemes within 03 months after award of contract for approval. The decision of the purchaser regarding validation and testing of the system shall be final and binding on the supplier. Inspection, validation and acceptance of the system (laboratory & field) will be done by the nominated officials of TMM Directorate of RDSO.

9.2 LABORATORY VALIDATION TESTS:

9.2.1 The laboratory validation tests shall include detailed testing of various components, transducers, sub-systems, assemblies etc. of the system as per the approved lab validation scheme.

9.2.2 During laboratory validation various system will be tested using simulated signal at 4 simulated speeds in the range of 20 to 110 kmph.

9.2.3 The laboratory validation tests shall be carried out, prior to shipment at firm’s premises. Firm shall make available all facilities required for laboratory validation tests. The firm will inform the purchaser at least 10 weeks prior to the date when system will be ready for laboratory validation tests.

9.2.4 If laboratory validation/tests show any deficiency in the system from the specifications, the supplier shall rectify the deficiencies within a reasonable period. The travel, Boarding and other expenses to be incurred for subsequent inspection should be borne by the supplier.

9.3 FIELD VALIDATION TESTS:

9.3.1 Field validation shall be done on short stretches of up to 10 km as well as on long stretches of 500 to 1000 km consisting of any type of track (CWR, SWR, fish plated or mixed) in well maintained and/or run down track including straight, curves, bridges and station yards.

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9.3.2 In case of short stretches, the system will be tested for repeatability and reproducibility as per the provisions mentioned in para 5.1, 5.2 and 5.5 in the speed band of 20 to 110 Kmph at 04 speeds.

9.3.3 The magnitude of the defect peaks/exceedences recorded at various speeds will be compared with that measured by IR’s existing contact less sensor based TRC and actual field measurements/measurments taken by portable system. The variation in results shall be within a reasonable accuracy to the satisfaction of the inspecting engineers of the purchaser.

9.4 If field validation/tests show any deficiency in the system from the specifications, the supplier shall rectify the deficiencies within a reasonable time to complete the commissioning in the specified period.

9.5 The supplier shall be required to supply and install free of cost all the equipment, components, PCB cards, ICs, cables, transducers, connectors, spares and consumables which may fail, malfunction, become defective or required for uninterrupted working of testing car during field trial and commissioning of system.

10.0 DOCUMENTATION:

10.1 Installation, Calibration, operation, maintenance, service, and troubleshooting manuals shall be prepared in sufficient detail to the satisfaction of purchaser and supplied in three copies each.

10.2 Formats of all data files generated in various sub systems with explanatory note including detail table structure with explanatory note of database for the data to be stored in database.

10.3 Detail documentation (Manuals) for the third party sub systems/sensors/transducers/equipment used in the system design to the extant supplied by the manufacturer.

10.4 Documentation of system hardware including transducers/sensors shall be supplied in sufficient detail to enable diagnosis, repair and maintenance of system up to card/module level comprising of details of circuit diagrams.

10.5 Source code of processing and exception report generation part of online software and post processing software shall be supplied along with flow charts and algorithms. Source code and executable files of the software shall also be supplied on CD/DVD as well as in hard copy.
10.6 Installable version of system software along with procedure to install the same from scratch in case of failure of hard disk shall be provided on CD/DVD & portable hard disk.

10.7 Transfer function plots of digital filters used for recording of various parameters in different sub systems and procedure for testing of these filters.

10.8 Licensed copy of operating systems, compilers or assemblers for the language used in writing the software shall be supplied.

11.0 **TOOLS:**

All tools including measuring equipment required for calibration/diagnostics/fault finding and normal maintenance/repair shall be supplied as a complete kit. The list of such tools and equipment proposed to be supplied with system shall be furnished as part of technical details of offer.

12.0 **TRAINING**

12.1 Supplier shall provide the training to four RDSO officials for four weeks in calibration, operation, fault diagnosis, card/module level repair and maintenance of the system at his premises. In case of indigenous supplier, if certain parts/sub-assemblies is imported the required training shall also be provided at the premises of such foreign manufacturer/supplier. The following shall be included in the training schedule.

a) Hardware: This training shall include calibration, operation, fault diagnosis, repair and maintenance of hardware supplied upto card/module level. The interconnectivity of the modules/subsystems shall be explained in detail.

b) Software: The training should be so imparted that any subsequent minor changes in post processing software and online processing software for indices calculation and reporting as desired by IR in future can be incorporated. This training shall include the explanation of, flow charts, algorithms and source code of the online processing software and post processing software.

12.2 The theoretical part of the training regarding fault diagnosis, repair and maintenance including explanation of algorithms, flow charts and source codes of the processing and reporting online software and post processing software shall be completed before commencement of lab validation. The training shall be given on the system to be supplied.

12.3 During commissioning of the system, four RDSO officials shall be trained in operation, maintenance and repair of the system and installation of system software from scratch for a period of six weeks by the supplier.
12.4 Training notes and suitable reading material shall be provided to each trainee official before commencement of each spell of training.

12.5 The charges for providing the training per official shall be separately quoted by the tenderer and payment for training shall be based on the number of officials actually trained. However, the cost of traveling, boarding and lodging for IR officials will be borne by the purchaser.
Chapter-II

Vehicular specifications for Self-Propelled Track and Turnout Measurement Car (STTMC)

1 General
1.1 The Vehicle shall be called as Track and Turnout Measurement Car (TTMC). A General demarcation for allotment of area for various functions i.e. Sleeping Cabin, Driver’s cabin, Instrumentation hall, WC & pantry Car are shown in Fig.1 for general guidance. However, firm should submit a final layout of STTMC for approval before start of manufacture of STTMC.

1.2 The specification covers the requirement for design and manufacture of the vehicle as per this technical specification. RDSO specification for self-propelled OHE recording cum test car (NETRA) No. TI/SPEC/OHE/NERTA/0140 is attached as Annexure-VI, which is for guidance only and the Contractor shall develop its own design adopting the latest International standards and shall be finalized during design approval stage. In this regard, the Contractor shall be submitting the approved drawings of the said manufacturing, if required, and developing the Specification to be approved during design approval stage.

1.3 The vehicle shall be suitable to comply with the SOD, MMD, track structure, OHE parameters and climatic conditions prevalent on IR network. The climatic conditions and track structure are given in para 3.4 and para 3.11 of system specification in chapter-I. SOD and MMD envelop of IR is available on RDSO website http://www.indianrailways.gov.in

1.4 The vehicle is 4 axle/8wheeler, self-driven, air conditioned, both end left hand driving with the following features
a) Two numbers under-slung mounted, Diesel Engine, one per bogie
b) Either of Hydrostatic/Hydrodynamic/Diesel-Electric transmission. In case of DETC, Driving both axles of each bogie and one axle of each bogie with hydrostatic/hydrodynamic/combination of both

1.5 The vehicle shall be designed to work at a maximum speed of 100 Kmph, however the performance/oscillation test shall be conducted for working over IR at 110 kmph.
   a) The Bidder shall submit the simulation test for riding and oscillation of the vehicle at 110 Kmph as per the track structure of IR for oscillation analysis. The Bidder shall also submit the hauling capability characteristics of the vehicle with both bogies and one bogie in service.
   b) The Bidder shall submit the capacity calculation of each of the Diesel Engine and Traction System which shall have the capacity such that when working together, it shall be able to deliver the following output
      • On level
        Self-Driven – 110 Kmph
when connected additional one number coach with a gross weight of 65T – 100 Kmph

- The Bidder shall submit the speed potential of self-driven vehicle at 1:150 and 1:100 gradients based on the speed-tractive effort characteristics.

  c) The period for continuous running shall be taken as 20 Hrs. at 100 kmph to design the thermal rating of the traction equipment.

d) The payload shall be 5 Tonne.

1.6 The radiator shall either be mounted under frame or if it is not possible to accommodate, the same shall be mounted on the roof with strengthened structure and load not coming directly on the roof and following the MMD.

1.7 The layout of facility inside the vehicle shall be as per the particular specification. The attached sketch with each of the section is only for guidance and the Bidder is at liberty to develop its own design and submit preliminary design during the Bid stage but without any compromise on the facilities as specified. However, the Employer may ask for modification changes during design approval.

2 Design features of the Vehicle

a. Good aesthetics

b. High comfort levels

c. High standard of quality for staff amenities such as lounge, office, sleeping and resting berths, washroom, kitchen, air conditioning, low noise, good illumination, etc.

d. Maintenance free or minimum maintenance

e. Low life cycle cost

f. Low weight

g. Flush level/smooth exteriors and interiors.

h. Use of interchangeable, modular components

i. Labeling of parts, danger boards, do’s and don’ts if any

j. High reliability

k. Fire and smoke detection

l. Use of fire retardant and environment friendly materials and in case the design warrants for use of other category of material, the same shall be indicated in the Bid document.

m. Maximum possible commonality of structure, components, equipment and sub-systems in the different types of cars

The Bidder shall submit compliance on each of the above parameters giving how its design achieves the above features.
3  Recording car body

3.1 The Bidder shall submit the International Standard or Specification to which the car body is proposed to be manufactured. The Recording Car structure shall be designed so as to withstand the load specified for the material used in accordance with the stated specification.

3.2 The structure of the Recording Car body, including shell shall be suitable for severe testing and recording of parameters with services under 150% overload conditions with no fatigue or permanent deformation or failure.

3.3 Cabs at both the ends of the Recording Car shall have streamlined design to give an aesthetically appearance and minimize air drag.

3.4 The body shell shall be of integral lightweight construction consisting of separate assembly groups for under frame, sidewalls, roof and end walls; joined together to form a tubular structure.

3.5 These assembly groups shall be made from the rolled sections or pressed plates and plain sheets, which are suitable for welding. The car body shall be made by spot / resistance welding or as suitable and internationally acceptable welding procedure for quality and standard of steel to be used in the manufacture of the car.

3.6 The car body structure shall be designed to make effective use of metal in providing the required strength and stiffness. Portions of the roof, side frame, and under-frame shall be designed to form a girder to carry the longitudinal and vertical shear, and bending loads resulting from the specified vertical loads. In selecting the type and thickness of material to be used, the Contractor's design shall optimize strength, durability, and weight.

3.7 The Body Bolster shall be fabricated from pressed sections and shall have suitable pads on which lifting slings may be placed. The material of body bolster should be decided by the manufacturer based upon design and strength considerations.

3.8 Materials

a. All materials used in the construction of the coach shall be of the specified quality and shall comply with the most recent issue of the relevant International Standards specification. The list of standards followed shall be submitted during design approval stage.

b. All the materials to be used for interiors, paneling, furnishing, lighting, ventilation, etc. must comply with requirement for fire prevention, protection of passengers in case of fire and from fire -side effect and shall comply with the international standards. The design philosophy in this regard shall be submitted at the design approval stage.

c. At the same time, no materials are permitted within passenger compartments, which contain asbestos, toxic material or that may splinter or will create sharp edges when broken.
3.9 High Tensile and Corrosion Resistant Car Body

a. The Car body structure, including sheathing shall be constructed of lightweight, high tensile corrosion resistance steel similar to IRS M-41 or as per any other international standard and proven design (12/8) with thickness chosen to avoid any wavy/undulating/bulges in the external paneling and giving a smooth finish.

b. Side wall and pillars: The material of body pillar shall IRS M-41 or as per any other International Standards to the Car body is generally manufactured. Pillars shall be continuous from sole bar to cant-rail, except below window openings, and shall be braced by longitudinal members between adjacent pillars. Bracing being designed to act as integral part of the exterior sheeting.

c. The weight of the Recording Car shall be kept as low as possible consistent with adequate strength to meet the loading without exceeding stresses and deflections specified values for the structure.

3.10 Water drainage

Adequate drainage shall be provided in all body-structure members, and elsewhere as necessary to preclude water entrapment. Enclosed structural cavities shall be vented to prevent accumulation of condensate. In areas where water might be ingested, corrosion-resistant drain pans and drain lines shall be provided and shall be arranged to divert the discharge clear of all equipment and structure. Means shall be provided to prevent clogging of drain lines and drain holes. Any enclosed structural cavities of the steel members shall be treated with a rust-inhibiting coating. Interior floor should be capable of being washed with a hosepipe. There should be no location where water may stagnate.

3.11 Surface finish and flatness

All exterior non-corrugated surfaces shall be free of ripples and buckling. The surfaces of flanges and webs of all structural members shall be straight and flat, and free of ripples, buckling, dents, gashes and other surface imperfections.

3.12 Requirements for strength of recording car body

a. The mechanical strength of the Recording Car body structure shall comply with the requirements of UIC 566 or any other acceptable international standards.
b. The Car body, and any equipment mounted on, beneath, or within shall be designed to withstand the fatigue loads that the car body structure will encounter in service during its design life. The fatigue life assessment of body structure shall be carried out using proven standard techniques and shall be submitted during a design approval stage. However, manufactures who are supplying self-propelled STTMC on a regular basis during the last 5 years with records showing supply to minimum 02 world railways and submission of static stress calculation in accordance with EN 14033/EN12633 is also acceptable.

3.13 Jacking pads

a. There shall be a minimum of two jack pads on each side sill to facilitate the safe lifting of the Car. It should be possible to roll the bogies under the car without removing any equipment or structure. The bottom of all jack pads shall have a non-skid surface to provide frictional resistance against incidental horizontal loading between the jack pad and jack head.

b. Suitable carjacking pads should also be provided at the front end for lifting the car with the bogie during re-railment.

3.14 Corrosion Protection

The exterior of the Recording Car body shall be painted. Painting scheme is important for the life cycle of the Recording Cars and shall be minimum as specified in sub-clause 4.5 Section 8 Vol II.

3.15 Roof and floor Construction.

a. Roof Structure: Equipment mounted under the roof suspended from the roof structure shall be bolted to the framing members. The framing members shall reinforce in sub-assembly to accept the equipment load.

b. The Contractor shall ensure adequate water drainage from the roof such that no water is discharged into the vicinity of passenger doorways. Rain gutters shall be provided over windows and doors. The Roof equipment arrangement design shall not permit accumulation of water at all in standing or running condition.

c. Floor construction: The floating floor shall be constructed so that all applicable noise, vibration, strength and fire endurance-rating requirement are met. A multiplayer hard wearing, non-slip, fire retardant floor covering having high abrasion resistance, waterproof and sealed, resistant to staining and easily cleanable using conventional floor cleaning methods and suitable cleaning agent should be provided.

d. The floor construction shall be such that it does not permit water to seep through the floor and cause corrosion to floor / underframe component. The non-skid floor structure shall be designed so as to minimize the life cycle cost of the floor over its designed value.
e. The openings in the flooring for the passage to pipes and cables shall be constructed as to prevent any seepage of the oil/water/dust and in addition give effective protection against the spread of any fire originating beneath the body.

f. Adequate drain holes for floor water drainage at each doorway, drain pipe at one meter apart in the whole area of the engine room and floor under the seats and at points where water is likely to accumulate should be provided. Stainless steel drain pipes having a top end of bell mouth type fitted with stainless steel mesh should be provided to prevent water from spreading on the underside of the coach structure or dripping on to the running gear.

3.16 Ventilation

Brushless DC Fans with stainless body and low noise shall be provided to ensure ventilation and for comfort during a partial failure of air conditioning.

3.17 Doors

a. Doors, steps, handrails, etc. shall comply with UIC 646

b. Recording Car shall have four body side doors, two in each of cabs. An Additional door on one of the side walls may be provided. It should be possible to remove or carry the material through these doors. The requirement of additional door in the middle is for unloading/reloading the removable equipment provided by the Contractor as per Employer’s Requirement. In case, the Contractor ensures that all items can be loaded/unloaded through the cab doors, the requirement of middle door on both or either side shall be finalized at the time of design approval. (33/1)

c. All door openings shall be true to specified dimensions and perfectly square with rounding of corners. The openings shall be tested for size and squareness with templates so that doors open and close freely and when closed shall be reasonably weather and dust proof. Single leaf inward opening hinged or sliding doors with locking arrangement shall be provided in the driver’s compartment or elsewhere and shall have a clear opening of proven dimensions followed by the Specialist Manufacture in its design and in accordance with international safety standards in this regard. The door leaves shall slide on roller bearing carriers suspended from the top rail and shall work in retaining guides on the door sills. Each leaf shall have a window opening with twin glass shutters. (6/6)

d. Latches shall be fitted on all doors so as to secure them from inside in the closed position or in accordance with international safety standards. (8/6).
e. Anti-slip of stainless body footsteps shall be provided at all body side doors. The edges shall be protected with metal threads. A wearing plate shall be provided on all top footsteps. Any other suitable arrangement can also be considered. The distance between the adjacent footsteps should approximate be 200 mm.

f. The Light shall be provided at each of the footstep for easy landing during night. The step lights shall be so provided that it illuminates nearby area as well.

g. Door hand holds:

h. Door hand holds of stainless steel tubes or chromium plated steel tube, with malleable cast iron brackets shall be provided on either side of all body sides and doors shall be fitted so as to clear the side walls sufficient to prevent injury to the knuckles. Hand holds shall also be within the car profile so that mechanized car washing is not hindered.

i. The door sill shall be constructed from or equipped with a slip proof profile with excellent wear resistance and drainage effect for rainwater.

j. Door locks: All doors shall be fitted with reliable locks to be operated from outside and inside. Hasps for external padlocking shall also be provided on all doors opening out of the car.

k. Double sealed glass windows of modular design shall be used in the air-conditioned coach. The outer glass shall be laminated and toughened safety glass, which does not fall on breakage. This should be indicated in the layout of the car for approval.

l. Windows shall preferable be of wide view and true to dimensional square and of uniform width. The window opening shall be flush mounted and in no way, shall exceed 2 mm over or under the specified dimensions and shall not be out of square by more than 2 mm.

m. Two suitable emergency openable windows, shall be provided on each side of the coach.

n. Equipment mounted under slung are having adequate clearance from the rail or provided with protection cover to prevent damage by flying ballast or other obstructions.

3.18 Roof:

a. The roof shall be designed to form a satisfactory chord to the superstructure considered as a girder, and to take a concentrated load of 4 men standing, close together at any point. The structure shall consist generally of two main longitudinal members running from end to end of the car, braced at frequent intervals along their lower flanges, and rigidly connected to the arch bars, and to the grab pillars by rigid transverse members. At partition and semi bulkheads, the sills shall be attached to vertical pillars within or forming part of the partitions or semi-bulk-heads. The construction throughout shall be absolutely watertight and shall permit easy renewal of corroded sheets.
a. Roof Ventilators: The roof ventilators of a better design shall be provided and they shall not violate the schedule of Dimensions.

3.19 Driving Cabs

a. Two driving cabs shall be provided, one at each end, with complete operating & driving control with dashboards to facilitate operation from either cab. The Driver’s seat shall be on the left side. Adequate leg space shall be provided for the driver when he is seated. The general layout and arrangement of equipment in Driver’s cab shall follow UIC CODEX 651 with respect to dimensions, safety features, furnishing, lighting, ventilation, noise level, field of view, driver's desk, seats etc. Spotlights shall be provided at suitable locations. The cab shall be ergonomically designed for better view and comfort and also the various panels/equipment meant for Driver shall be so laid that they are easily readable and Driver is not required to move physically for any operation during run.

b. Foldable cushion sheet shall be provided in each of the driving cabs for 2 persons in addition to the Driver. It is optional and to be decided at design stage.

c. The driving cab for Inspection Carriage of each end shall be designed incorporating the seating arrangement for DFCCIL officials as shown in the sketch attached to 9.3.3.

d. All controls, brake handle, hand brake, Dead Man’s device for horn and indication lamps/meters shall be within easy access and view of the Driver.

e. Two numbers, 110 V sockets for hand signals in each cab, four numbers of amber color flashing light, one at each door top, shall be provided to flash when a push button is pressed provided at the driver’s desk. This is required to, alert or exchange signal with the station staff.

f. Head Light (performance parameters as given in sub-clause 9.1 of Section 9.1), Flasher Light (performance parameters as given in sub-clause 9.4 of Section 9.1), search lights and marker lights at both ends of the cab shall be provided and shall be provided.

g. OHE voltage sensing device in both the cabs shall be provided of non-contact type. The indication LED lamp shall glow driver’s desk when OHE is live.

h. Full width single or double piece Stone proof lookout glass with Sun Screen shall be provided at the end wall of each Driver’s compartment and these shall be glazed, clear, colorless polycarbonate with operating parameters equivalent to ICF Specification No. ICF/MD/SPEC-159 (latest revision) or any other equivalent international standard. (14/8)
3.20 The facilities to be provided in the Recording Car shall be as described briefly in the following Clauses.

a. Material Cabin: Two numbers of material, cabin shall be provided suitably located having adequate space and proper locking arrangement for the storage of costly equipment and fittings in one and housekeeping items in the other. The Bidder shall identify the necessary tools and equipment necessary for the daily upkeep of the Vehicle of which few are listed below:

- One number Dry cum Wet portable vacuum cleaner of 1kW or more capacity suitable for undertaking vacuum cleaning inside of the vehicle.
- One number dry hand-held vacuum cleaner of 500 W capacity suitable for undertaking vacuum cleaning of small areas.
- Two numbers chargeable LED flood light torch.

b. Air Conditioning Equipment: The recording car including driving cabs shall be fully air-conditioned with adequate capacity with high energy efficiency standards. The design calculation shall be submitted along with the Bid. The air conditioning unit shall be roof mounted with 75% redundancy, meaning thereby that 3/4th of the compressor capacity shall be sufficient to maintain the temperature under the specified conditions. The Contractor shall also submit the layout, control, capacity, and protection system, etc. of the roof mounted air conditioning unit along with the Bid. The performance parameters shall be such that it should be able to maintain a temperature of 23-25°C with maximum relative humidity of 40-60%.

- However, the instrumentation of recording car should be capable of performing satisfactorily up to the following maximum temperatures: metallic surface temperature under Sun: 75°C max. and in shade: 55°C max. The air conditioning equipment should therefore be capable to perform satisfactorily under such a high metallic surface temperature.

c. Instrument Room: Instrument Room shall be air conditioned and well-furnished to keep on board computers, monitors, DVD, Printer & Plotter, UPS and other interface equipment, storage of Hard Copies, Reports and other such requirement. The Technical specifications of all the equipment to be provided in the instrument room shall be furnished along with the Bid. Suitable ergonomically designed good and of durable quality furniture shall be provided to meet the requirement.
d. Conference Room: Conference Room shall be air conditioned having adequate space to accommodate a cushioned sofa (minimum 5 seats) with center table and latest HD-LED 19-inch TV monitor with 02 USB ports. It shall have well illumination, including night lamps, 02 mobile/Laptop charging points and one power point.

e. Staff Cabins: One air-conditioned cabin with four cushioned berths equivalent to IA configuration shall be provided. The Cabins shall have separate entry and have windows on one side. In addition, at least two (15/8) folding berths shall be provided at a suitable location without a separate cabin.

f. Lavatory: Two number of Western Style WC, bio toilet (or any other eco-friendly proven design with no night soil dropping on to the track e.g. incinerating toilets) (16/8), with separate overhead Tank, with standard and aesthetic wash room fittings shall be provided. The WC shall be provided with an exhaust Fan and hot water geyser. The flooring in lavatories shall be provided with stainless steel or ceramic tiles.

g. Multi pin Mobile Charging points shall be provided as follows:
   - Two numbers in each driving cab
   - Two numbers in Instrumentation Room
   - Two numbers in lounge
   - Two numbers in each two and four berth cabins

h. Kitchenette: A kitchenette shall be provided with exhaust fan on one of the windows. Windows for cross ventilation shall also be provided. Kitchenette shall be provided with cooking range, with electric hob or (17/8)LPG cylinder, a refrigerator, microwave oven, cooking utensils and complete dinner set. Details shall be finalized during design stage. Cooking range with LPG cylinder need not be provided in vehicle other than Inspection carriage.

i. Communicating doors: Each driving cab shall have three independent entry, two from outside and one from inside the car. It shall be possible to isolate the cabins using sliding doors with locking arrangements.

j. The equipment fixed to the under frame shall be secured properly by providing extra metallic chains of adequate strength to safeguard the equipment from falling in any unforeseen situation and to perform efficiently.
4 Noise Parameters:

4.1 The Recording Car and measuring equipment shall be so designed and built that specified noise level is not exceeded. The equipment design and their mounting arrangement shall ensure the generation of noise and vibration to bare minimum. The design of the vehicle shall have an adequate attenuation of air-borne and structural-borne vibrations along potential paths from the sources to the passenger area and to wayside receptors.

4.2 The Contractor may propose car exterior and interior noise level standards better than those specified herein provided that this does not cause significant weight penalties.

4.3 Interior Noise Level

a. Interior noise criteria apply to measurement within an empty and stationary car with doors and windows closed.

b. Auxiliary Equipment Noise with Car Stationary

c. With all auxiliary equipment operating simultaneously at maximum capacity, the noise level in the car shall not exceed 70 dB (A) at any point along the car center-line 1600 mm above the floor and not less than 600 mm from the end of the vehicle.

d. Noise level in Driver’s cab

e. The general layout and arrangement of equipment in driver’s cab shall follow UIC CODE 651 OR (latest edition) with respect to dimensions, safety features, furnishing, lighting, ventilation, noise level, field of view, drivers desk and seats. Spotlight shall be provided at suitable locations.

4.4 Exterior Noise Levels

The exterior noise levels, as measured on a dry track shall conform to the values as under. During the tests, all windows and doors shall be closed and all propulsion and auxiliary equipment shall be running at maximum levels.

a. Train Stationary

With Recording Car stationary and all systems operating simultaneously under normal conditions, the noise level measured at a location 15m horizontally from the track centerline on a horizontal plane passing through the axle centerlines shall not exceed 65 dB (A) at any point along the length of the vehicle on either side.

b. Train Moving with Recording Car moving on grade with clean smooth rails at all speeds from 0 to 100 km/hr. and whilst accelerating or braking with all vehicle systems operating simultaneously under normal conditions, the noise level measured on either side, at 25 m from the track centerline on a horizontal plane passing through the axle centerlines, shall not exceed 85 dB (A)(18/8).
5 Fire Performance

5.1 The Recording Car stock shall be designed to minimize the risk of a fire starting and to prevent the fire propagation through the use of fire barriers in the floor and in the walls at the sides and ends and fire-resistant equipment housings.

Flammable materials shall be well contained and protected. Design features for fire mitigation shall be submitted.

5.2 All non-metallic and furnishing materials such as artificial leather seat covering, flooring material, GFRP paneling, cushioning material, etc. shall satisfy the requirements of resistance to the spread of flame and deterioration in visibility due to smoke etc. as per UIC 564-2 OR Class A or EN45545 or any other equivalent International Standards (19/8).

5.3 A reliable automatic fire/smoke detection system shall also be provided on the car. The system should not cause any discomfort or undue alarm to the travelling staff. The design of the system shall be got approved during the design stage.

a. Fire prevention in Recording Car shall be suitably provided as per latest UIC standard or EN 45545 or RDSO’s Specification No. RDSO/PE/CP/EMU/0001 Rev.0 of Aug.’2003 (Amendment No.1 of July’2006) and with the latest revision. The standard to be followed shall be finalized during design stage and shall be applicable for all P&E covered under this clause.

5.4 Interior Finish & Furnishing

a. The Contractor shall propose world-class vehicle interiors, which incorporate a modern aesthetic approach with considerations to optimize staff comfort, safety and security as well as to minimize noise in the Car.

b. All interior surfaces must be finished with good blending and good slow ageing properties to provide a pleasant, high quality interior and for ease of cleaning and maintenance. Provisions shall be made to prevent any squeaking, rattling or drumming. Items such as rubber strips and other items shall be integrated with panels as far as possible.

c. All interior panels shall be of glass fiber reinforced panels GFRP. All internal GFRP surfaces shall have solid surface top (paint less) and be smooth finished. Alternate material is acceptable subject to submission of documentary evidence of its suitability, sustainability and proven record of supply to at least two world Railways. The panels shall be resistant to water and aggressive cleaning chemicals for graffiti removal, high temperatures, UV-light and radiant heat. The panels shall be resistant against kicks, punches and scratching. No cracks shall occur.
d. Areas around fasteners shall specially be considered. Exposed materials and surfaces shall withstand the daily use of various cleaning agents (alkaline or acid detergents, petroleum solvents and mechanical action of the brushes) without losing colour or noticeable deterioration of the surface. The panel should have durability without blistering, scratch, dent, cracks, dis-colour, lose their gloss level or any form of colour deterioration.

e. The interiors should not have visible screws/allen screws. The fastening devices, fixings and securing screws shall not be visible from within the cars. All the interior fittings shall have anti injury features and should not have sharp and pointed edges. Rounded corners or coves shall be provided wherever mutually perpendicular flat plane surfaces abut. Metallic kicking strips with radiused transitions must be provided in the interiors of the car body, such that no moisture can penetrate.

f. Gaps between all interiors-lining panels, seat, shell, etc. shall be minimized. The effects of the thermal expansion shall be taken into account and all unsealed gaps shall not exceed 1mm in depth where feasible. Suitable cushioning at panel joints shall be provided to suppress noise. All the joints of interior panels and flooring shall be so sealed that there are no cavities or spaces where insects such as cockroaches etc. can hide and breed.

g. Materials used shall comply with the relevant UIC specifications. Where UIC specifications do not exist, the Contractor shall submit relevant specification of proposed material for approval. Materials and substances classified as prohibited and restricted shall not be used.

h. The berth covering should be stain resistant, easily cleanable, fire retardant material in pleasing colour and pattern. The cushioning material should also be fire retardant. Material should be as per the latest UIC standard. The berth covering should give a service life of at least 10 years.

i. Equipment cupboard for housing equipment, for which access from the Car is necessary, may be provided at the car body ends.

j. The car manufacturer before undertaking manufacture should make 3-D model drawings on Uni-graphics, CAD software version NX 4 and submit them as soft (pdf or other format) or hard copy for approval of the interior-furnishing scheme at design approval stage.

5.5 Exterior and Interior Colour Scheme

Exterior and interior colour scheme of Recording Cars shall be finalized at the time of the design approval stage.
5.6 **Cattle Guard**

Cattle guard shall be provided at the driving ends of each unit. The cattle guard shall have enough strength so as not to collapse on line in case of collision with stray animals, like cows etc. Cattle guard shall preferably be designed with tubular pipe structure and fastened to the body such that under impact the fasteners does not experience shear stress.

5.7 **Piping and Pipe Fittings**

a. Seamless stainless-steel pipe bright annealed to ASTM A 269, Gr.304, which can be bent cold, shall be used. The layout of piping shall be designed to keep all pipes, especially the brake cylinder pipes, as short and straight as possible. Bends should be used throughout, but where elbows have to be used, they shall be of round type. Where the pipes themselves are bent, their internal area shall be maintained uniformly.

b. Double ferrule pipe fitting consisting of the body, front ferrule, back ferrule and nut shall be provided. The body and nut will be of carbon steel to ASTM A- 108 Grade II with electro cobalt zinc plating with chrome passivation. The front ferrule and back ferrule will be made from Stainless Steel to ASTM A 276 TP 316 SS and performance property conforming to ICF specification no. ICF/MD/SPEC-166 with latest amendments.

c. All pipes shall be adequately clamped to the frame assembly with proper clamps. Flexible hose connections conforming to spec. SAE 100R1 only shall be used.

Note: All specifications mentioned above are for guidance purpose. The Contractor may propose other equivalent international standard ensuring proven industrial design practice. (11/6)

5.8 **Elastomers**

All elastomeric parts shall be of neoprene, unless otherwise required. The elastomer shall be compounded and cured to perform satisfactorily in the temperature range specified in this specification. The elastomers shall have high resistance to ultraviolet radiation, weather, washing fluids used, salt deposits and the longest possible life consistent with the other characteristics specified. All the elastomeric parts shall be resistant to Ozone, oxidation, heat, oil, grease, salts and acids. The resilient mounts shall be of natural rubber. Synthetic rubber compounds may be substituted for natural rubber only when approved for a specific application.

5.9

The structure shall withstand end buffing load of 102 t (divided equally between two buffers) without and permanent deformation and stresses remaining below the yield point.

The vertical load of 4t/meter runs uniformly distributed shall be taken. The weight of the various equipment mounted in the vehicle shall be considered as concentrated load and shall be simulated as such during load/stain testing.
A combination of all applicable load under 2.1 and 2.2. shall be taken

5.10 The prototype test result not be more than 3 years old and having same mechanical structure with squeeze load shall be required with strain gauze stress analysis under tare and loaded condition shall be submitted during design approval stage. However, in the case the Contractor offers the design similar to the proven supply record the requirement of squeeze load test may be dispensed with.

5.11 The vehicle shall be fit to attach with different types of rolling stock working over IR either for the purpose of hauling or attached dead.

5.12 Details offered above are for the purpose of guidance only and the manufacturer shall design the product with improved features towards easy operation, handling durability, aesthetic, availability of spare parts of India, etc.

6 Diesel Engine, Transmission & Gear Box, Brake System, Air Compressor, Buffers and Couplings, Wheel Sets, Bogie, Suspension, etc.

6.1 Fuel efficient diesel engines of adequate capacity to deliver the performance as specified of reputed and proven make shall be provided, one number for providing traction to two wheels of each of the bogie. Exhaust emission shall comply to 3.10 of Section 9.1. All technical details of the engine shall be submitted along with fuel and lubricating oil consumption at different output in litre/hours with calculation to prove the adequacy of capacity.

6.2 The Bidder may select any of the diesel hydro-static or dynamic or combination of both or diesel electric transmission best suited for delivering the performance. Details of the transmission system selected shall be submitted and shall be of proven and reputed make.

6.3 The Brake system shall consist of UIC/RDSO approved Air Brake system suitable for this application. The Bidder shall submit brake schematic diagram, working principle, brake power diagram, calculations for ED, dimensions, type of brake block shall be preferably be from India. The brake system shall also include parking brake, dead-man handle and vigilance control etc.

6.4 The center buffer transition with screw coupling shall confirm to RDSO specification No. 56-BD 07 along with side buffer arrangement to RDSO’s drawing number SK-98145.

6.5 Axle shall confirm to RDSO’s drawing No. IRS R-43/92 or equivalent International Standard.

6.6 Wheel and wheel profile shall confirm to RDSO’s Drawing No. IRS 19/93 and SK-91146 respectively or equivalent International Standard.

6.7 The Bidder shall submit the schematic of wheel, bogie, suspension, transmission, axle box arrangement during Bid stage.
7. **Electrical**

7.1 Electrical power supply is required for illumination, battery charging, search lights, control circuits, instrumentation, Information Technology, air conditioning, etc. The electrical system shall be designed integrating the sources of generation and battery capacity. The loads shall be classified as essential and others and power supply circuits designed for reliable working with redundancy for essential loads.

7.2 The color code for the selection of wiring shall be as per the Indian standard. All wiring shall be in a flexible metallic concealed conduit. All plugs and sockets shall be of fire retardant material, rugged, and robust to give desired trouble-free service during the life of the vehicle. The relevant IS in this regard is given below but the Contractor may propose any other international standard and shall follow the same on all vehicles.

Switches for use on Railway Stock: IS: 6925

Three pin plug and socket outlets: IS: 1293

However, the Contractor may propose an equivalent International Standard followed by it in its regular manufacturing process. (9/6)

7.3 During the period when the vehicle is parked in the shed, a single/three phase 230/415 V socket shall be provided with inbuilt charger for charging the battery, working of air conditioner and supply to instrumentation and IT equipment for working with the data during the parking period of the vehicle.

7.4 The battery system is required for the cranking of the Diesel engine and storage of power for supply to essential loads of the coach. The battery shall preferably be flooded type tubular battery.

7.5 The audio and call bell communication shall be provided with different compartments. The details to be finalized at the time of design approval.

7.6 All lamps provided in the vehicle shall LED base with properly designed luminaire. Lights shall be provided for illumination of foot step, flood light at both ends for illumination of trailing route, if required for inspection or recording etc.

8. The Bidder shall submit the layout of the preliminary design, 3D modelling and vehicle interior with provisions of facilities and the governing specification of the major items along with the Bid in compliance to the above specification. The design shall be finalized at the design approval stage to comply with the specification.

9. **EMI/EMC REQUIREMENTS**

9.1 The measuring instruments, processors, sensors performance shall not be affected due to EMI/EMC interference arising due to working under 25 kV or 2x25kV, 50Hz, OHE system, Electronic signals generated due to the inverters and vehicle control systems shall not affect the measurements in any way.
9.2 Equipment should be suitable to work in a 25kV ac voltage environment, EMI protection and adequate protection against accidental falling of 25 kV wire on the equipment and safety of operating personal on board should be ensured. It should meet the requirement specified in standard towards immunity and emission shall be governed as per EN

a. EN 61000,
b. EN 50121