Call for Expression of Interest (EoI)
For Calling of
GLOBAL TENDER No: 2015/DEV.CELL/ICCI/1
August 2015

For Purchase of
On Board Condition Monitoring Systems for
Indian Railway Rolling Stock
to
SCHEDULE OF TECHNICAL REQUIREMENTS
Number: OBCMS/DCM/N/1, August 2015

EoI RESPONSE DOCUMENTS WILL BE RECEIVED UPTO 14.30 HRS. ON 07 September 2015
EoI RESPONSE DOCUMENTS WILL BE OPENED AT 15.00 HRS. ON 07 September 2015

NAME OF THE FIRM (Respondent(s)) and Address:

M/s. __________________________________________,

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____________________________________________.
Important Notice to Respondents:

This current document is an Expression of Interest (EoI) published by the Government of India, Ministry of Railways to solicit and examine the response of the firms/companies/entities that are supplying or capable of supplying the Goods and Services as per the details mentioned in this document before Indian Railways finalize the specification of the equipment and services and associated conditions before entering into a contract.

The current document is therefore to explore the response from the prospective bidders.

The timelines and the quantity of units mentioned in this document are subject to change and shall be firmed up while the Technical and Commercial Bids are called for by the Indian Railways at a later date.

Final specifications and conditions of contract shall be made after going through the response and comments of the respondents, in response to this document. Invitation for Bids shall be called for after the specifications are finalized by Ministry of Railways, Government of India (Railway Board).

Some of the operational conditions of contract are briefly mentioned in this document. These are subject to change based on the examination of response received and in line with the Indian Railways Standard condition of Contract.

However, it may please be noted that the decision of Ministry of Railways, Government of India (Railway Board) shall be final while addressing the issues raised by respondents in response to this document.

Ministry of Railways, Government of India (Railway Board), may change any or all of the terms and conditions and/or technical, commercial or operating requirements in their final document from the ones, which are specified in the current Expression of Interest. The revised set of conditions and specifications that shall then be part of final Invitation for Bids document which will be published at the time of calling for Bids.

Ministry of Railways, Government of India (Railway Board) reserves the right to summarily reject any or all of the offers received in response to this Expression of Interest without assigning any reason therefor.
### DESCRIPTION OF EQUIPMENT AND SERVICES.


### SCHEDULE OF TECHNICAL REQUIREMENTS.


### QUANTITY

In various phases upon success of each preceding stage for all coaches, wagons and Locomotives running on IR

### AMOUNT OF BID GUARANTEE (WHEN BIDS ARE CALLED FOR AT A LATER DATE)

Shall be declared during calling for Request for Proposals (RFP).

### Last date for submission of Expression of Interest (EoI)

7 September, 2015

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1. Indian Railways solicits response from interested companies/entities who are technically capable and are reputed in the field of condition monitoring of railway rolling stock to submit their Expression of Interest (EoI) for supply and operation of “On Board Rolling Stock Condition Monitoring System” on coaches, wagons and locomotives and to set up Ground support systems at Divisional Control Rooms (approximately 60), at Head Quarter Control Rooms (approximately 20), at Maintenance depots of Coaches (approximately 150 depots), Wagons (approximately 140 depots) and Locomotives (approximately 50 locomotive sheds) in the field, at Railway Board (approx. 10 installations) and at RDSO (approx. 8 installations), among other places for use by Indian Railways. These above mentioned ground support systems shall primarily access the data after analysis on the “Analytics Cloud” from the on-board condition monitoring system.

1.1 To facilitate the respondents in understanding of the Indian Railways operations and rolling stock, the respondents should contact Executive Director Mechanical Engineering (Development), Room No. 333, Railway
Board, Raisina Road, New Delhi -110001, email: edmed@rb.railnet.gov.in
who will issue them authority to contact Chief Mechanical Engineer, 
Northern Railway for necessary interaction with the users to understand the 
operation condition and maintenance methods and conditions in the field.

While making this request to Executive Director Mechanical Engineering 
(Development), respondents must clearly and succinctly write down in their 
request letter - their doubts, queries and issues, which they wish to resolve 
in their field visit.

1.2 This document has been published to show the Intent of Ministry of 
Railways Government of India (Indian Railways) to explore various 
technologies available in the field On Board Rolling Stock Condition 
Monitoring System for coaches, wagons and locomotives before finalizing 
the specifications of the equipment and systems. Technical and Commercial 
Bids to purchase such system shall be called after the available technologies 
are explored and most appropriate technology is chosen by Indian Railways, 
based on the response submitted by the respondents in response to this 
document. Final specifications for on board rolling stock condition 
monitoring systems shall be frozen after examining the response received in 
response to this EoI document.

2. The respondents are required to give an undertaking to express their willingness to 
enter into a comprehensive Annual Maintenance and Operation Contract (AMOC) with 
Indian Railways during warranty and post warranty period for operation and maintenance of 
“On Board Rolling Stock Condition Monitoring System” & Control Room Support Facilities. 
AMOC will be inclusive of spares and consumables required for maintenance and operation of 
“On Board Rolling Stock Condition Monitoring System” and the ground support facilities. 
This would also include attention during periodical overhaul (POH) of the 
coaches/wagons/locomotives in the designated workshops However, Indian Railways 
reserve the right to enter into AMOC with the supplier of the ‘On Board Rolling Stock 
Condition Monitoring System or with any other contractor beyond the period of warranty. Comprehensive Warranty of the entire system shall be for a period of 3 (Three) 
years from the date of successful installation.

The initial period of AMOC shall be “5 (Five) years but The AMOC contract is likely to 
be revised upwards after it is reviewed after a period of five years and shall be renewed in 
time slabs of 5 (Five) years subsequently as per operational exigencies, technological 
change, IR’s experience and administrative requirement of Indian Railways.

3. OPERATION OF “ON BOARD ROLLING STOCK CONDITION MONITORING 
SYSTEM”:

(a) The supplier shall take full responsibility of not only maintenance but also day to day 
operation of ‘On Board Rolling Stock Condition Monitoring System supplied by him
and its functioning at the end-user premises. It will be charged under the AMOC referred to in Para 2 above.

(b) To facilitate the supplier maintaining and operating the “On Board Rolling Stock Condition Monitoring System” systems during AMOC, if awarded to him, the railways shall provide without charge to the supplier a suitable place with general working amenities like electricity etc. at a convenient/suitable place in the coach maintenance depot/workshop/Control Offices for maintenance of the system.

4. DELIVERY OF EQUIPMENT AND SYSTEMS:

For the purpose of this work, the systems as asked for by Indian Railways is assumed to consist of:

i) Sensor(s) fitted on the axle ends

ii) Data concentrator – an electronic unit that is used to collect data from the sensors and transmit it to the control room. The Sensors or the data concentrator shall have “in-built intelligence” to raise alarms on the vehicle itself in case the signals generated by the sensors indicate impending failure of the component.

For the purpose of calculation and scoping of this document, it is assumed that each axle-box shall be fitted with one sensor each, i.e. two sensors on each wheel-set. Indian Railways Locomotive is a six-axle vehicle and the coach and freight cars are four axle vehicles at present.

4.1 Within 2 (two) months of placement of the order, drawings and specifications indicating functional and technical details of the system shall be submitted by the firm to Railway Board for approval. The fitment drawings shall clearly indicate not only the dimensions and details critical to fitment of “On Board Rolling Stock Condition Monitoring System” in individual type of coaches/wagons/locomotives but also those critical to proper functioning of the system. Specifications & design of critical components shall also be approved by RDSO before they are fitted. Sensors and systems shall be as per existing standards for compliance for fitment on Railways coaches, wagons and locomotives. Notwithstanding any such approval, the respondents shall stand fully responsible in respect of design, manufacture and serviceability of the complete system.

4.2 Within 2 (two) months of the approval of the drawings and layouts, the supplier shall offer at least five “On Board Rolling Stock Condition Monitoring System” systems for prototype inspection to Indian Railways at firm’s premises as per Development Cell’s Schedule of Technical Requirements as enclosed. The arrangements for necessary facilities like test stand etc. will be done by the supplier at his works at his cost. Two units of the system, other than these five, shall be subjected to extreme limit of stress testing to the point of its failure so as to investigate the margin available in the system before failure.
4.3 **Within 1 (one) month** of prototype approval by Indian Railways, 140 numbers of *On Board Rolling Stock Condition Monitoring Systems* shall be supplied to nominated coach maintenance/production units, locomotive sheds and Freight Maintenance depot on Indian Railways as per its nomination for installation & commissioning trials for fitment clearance. Respondents must make sure that their equipment does not require any modification at this stage to undertake necessary dimensional modifications to this “On Board Rolling Stock Condition Monitoring Systems”. Respondents are encouraged to inspect and get familiar with the Indian Railways Coaches, wagons and locomotives before submitting their proposals.

4.4 After successful fitment & commissioning of “On Board Rolling Stock Condition Monitoring System” Systems on the coaches/locomotives/wagons as mentioned in para 4.3 above, the supplier will be given a clearance by Indian Railways for fitment as per the contract. The firm shall make supplies of 6800 units in the first phase to IR within 2 (two) months of fitment clearance.

4.5 Once the proving trials with 6800 units of the above is completed for a duration of six months to the satisfaction of Indian Railways as per stipulations and technical requirements spelt out in the Draft Schedule of Technical Requirement, the remaining quantity of equipment (for fitment on Approximately 10,000 locomotives, 50,000 coaches and 2,25,000 freight wagons) shall be supplied and fitted by the supplier at a rate not less than that specified by Indian Railways and at locations as per mutual agreement due to exigencies of the operations. Fitment shall be done on Locomotives and passenger coaches in the first phase of the deployment. The proving trials shall be deemed to have been concluded on the date on which the joint report of the performance of the system is accepted and jointly signed by the firm supplying and operating the systems and Indian Railways.

4.6 After the proving trials are completed in para 4.5 above, permission shall be granted to the firm for supplying, installing and operating the remaining systems of Onboard Condition Monitoring Systems. These systems shall be proliferated further and by the end of three months of the conclusion of the proving trials mentioned in para 4.5, they shall be fitted on *Passenger coach trains at a minimum rate of 45 rakes per month* and the same system shall be fitted on *Locomotives at a minimum rate of 200 locomotives per month*. Rate of fitment on Freight trains shall be notified after the successful demonstration of the system on the freight trains after the supplies are made as per Para 4.4 above, due to the rough operating conditions to which freight wagons are subjected. However the pace of fitment of this system on freight train rakes shall not be less than 50 rakes per month.

4.7 The respondents shall develop all interfaces required of the “On Board Rolling Stock Condition Monitoring System” to monitor the list of parameter on the coach, wagon and locomotive sub-assemblies and structures, as enclosed at Annexure-1, at their cost and transfer the know-how to IR upon completion of the interface development.
5. **SPECIAL NOTES:**

5.1 For the future, when specifications are finalized based on response to this document, the Bids shall be invited on “Two Packet System” Consisting of “Technical Offer” and “Commercial Offer”. The two offers shall be enclosed and sealed in individual envelopes superscribed “Technical Bid for On Board Rolling Stock Condition Monitoring System” and “Commercial Bid for On Board Rolling Stock Condition Monitoring System” respectively.

These two envelopes then should be placed in the third envelope and should be sealed and superscribed “Technical and Commercial Bid offer for On Board Rolling Stock Condition Monitoring System”

5.2 The respondents are hereby advised to study the existing coach, wagon and locomotive design thoroughly and also the Indian Railways track structure including its layout in their own interest before submitting their proposal.

5.3 The indigenization plan for the “On Board Rolling Stock Condition Monitoring System” System offered against this tender should be submitted along with the technical bid. Indian Railways would insist on indigenizing at least 30% of the cost of each unit by the end of three years from the date of first supply after obtaining the first set of equipment as stated in para 4.5. Out of the remaining equipment, 60% indigenization of cost shall be completed by the end of five years from the date of deployment as per para 4.5. Suppliers/respondents who can indigenize the production of entire 100% of the equipment in India may kindly indicate so giving their plan of action – including the timelines. Indigenization shall be done by the firm who is awarded the contract.

5.4 All electrical/ Electronic equipment used in the system shall be tropicalized for use under environmental conditions as indicated in the RDSO’s Schedule of Technical Requirements.

5.5 When Request for Proposals are called for, the bids including technical details should be submitted in triplicate and each of the bids should be complete in all respects

5.6 When Request for Proposals are called for, Bidders shall then be required to deposit Bid guarantee as per Indian Railways condition of contract when the Bids are invited. Any bid not accompanied by bid guarantee shall be summarily rejected.

5.7 The respondents should submit their comments and compliance to the specifications in all respects and not in abstract or cryptic manner. If there are any deviations to the specifications, a deviation statement indicating the clause/sub-clause, deviation proposed and justification thereof should be enclosed.

5.8 Bids against the Request for Proposals, when called for, will be entertained only from those firms who have purchased the bid documents in their own name or by their authorized representatives on payment of the specified charges. The firms should enclose the proof of the same along with their bid document when submitting their
offer. Detailed procedure shall be spelled out at the time of calling for Bids at a later date.

5.9 BIDS FROM RESPONDENTS, WHO HAVE NOT PURCHASED THE BID DOCUMENTS THEMSELVES, BIDS NOT ACCOMPANIED BY BID GUARANTEE AND BIDS FROM AGENTS WITHOUT LETTER OF AUTHORITY FROM THE MANUFACTURERS ARE LIABLE TO BE SUMMARILY REJECTED.

TELEX, FAX AND OTHER INCOMPLETE BIDS ARE LIABLE TO BE SUMMARILY REJECTED.

5.10 Indian Railways reserve the right to cancel the Expression of Interest or the tender at any stage without assigning any reason.

6.0 When Notice inviting tender is published and bids are called, the respondents must clearly indicate in the offer various costs under the following heads for commercial evaluation of the tender:

i) Unit Cost of the “On Board Rolling Stock Condition Monitoring System” for each coach, wagon and locomotive - including installation & commissioning.

ii) Cost of the recommended spares and consumables required per annum during warranty period of three years and post-warranty period of seven years thereafter.

iii) Annual operational (day to day) and maintenance cost (AMOC) of the On Board Rolling Stock Condition Monitoring Systems and Ground Support Facilities respectively during warranty and post warranty period.

iv) Any “Must-change” items to keep the system running and the periodicity of changing such must-change” items, if any.

v) The respondents must specify the “Up-time” of their system. Any non-availability of their system, below their specified “Up-time” shall incur penalty. Quantum of penalty shall be advised at the time of framing the final specifications.

7. QUANTITY VARIATION CLAUSE:

On calling the Bids and at the stage of placing Purchase Order, the purchaser reserves the right to vary the supply quantity by ±30% after the placement of the order but during the currency of the contract.

8. INSPECTION:

Inspection will be carried out by Ministry of Railways or its nominated representative but the ultimate responsibility of the compliance with various statutory and demanded clauses shall lie with the supplier.
QAP as per standard format must be submitted by the respondent for the equipment that they intend to offer for sale to Indian Railways giving all relevant details of inspection procedures, reference standards, sampling plan, testing regime, etc.

9. **WARRANTY:**

9.1 The respondent will provide warranty at the nominated depot for 39 months from the date of supply or 36 months from date of commissioning, whichever is earlier. During warranty, the respondents shall rectify the defects, if any, in the “On Board Rolling Stock Condition Monitoring System” system by replacing components as necessary at his cost. Warranty is 3 years and post warrant is 7 years thereafter.

9.2 If the warranty support is not provided within 15 (fifteen) days of notice demanding the same, Indian Railways shall levy appropriate penalties for non-functioning of the system. For this purpose, even if a sub-assembly within a complete unit (one coach/wagon/locomotive) is not working, the entire coach, wagon or locomotive system shall be deemed to be non-functional. Rate of penalty shall be calculated and notified at the time of calling for Request for Proposals. The rate of penalty shall be telescopic in nature so as to discourage non-compliance for long duration.

10. Respondent shall also undertake to ensure availability of all requisite spare parts for a minimum period of 15 years after purchase from the date of Letter of Acceptance of the offer when Technical and Commercial Bids are called for.

11. The respondent shall give an undertaking that should there be any need for modification arising out of field trials or during the currency of the contract – as per the deliverable functional capability promised by the respondent, it will be carried out by the respondent without any cost to the Indian Railways.

12. **PERFORMANCE GUARANTEE BONDS AFTER REQUEST FOR PROPOSALS ARE CALLED FOR:**

   (a) Contractor will have to give a Performance Guarantee Bond equivalent to 10% of the cost of the contract.

   (b) Contractor will also have to give a Performance Guarantee Bond equivalent to 10% of the cost of AMOC at the time of entering into AMOC.

13. **SUBMISSION OF OFFERS WHEN BIDS ARE CALLED:**

When the Bids are called for, the Bid offers shall be submitted in triplicate, as two-packet system offers. The offers should be addressed to and submitted to:

*Executive Director Mechanical Engineering (Development),*
*Room No. 333,*
*Rail Bhavan,*
*Raisina Road*
*Ministry of Railways,*
*New Delhi - 110001.*
*India*

The name and address of the Respondents should clearly appear on all the envelopes.
14. **VALIDITY OF RESPONSE TO THE EXPRESSION OF INTEREST:**

The respondents must keep their response valid for consideration and for acceptance for a minimum period of 180 days from the last date of submission of their comments as mentioned on Page 1 of this document.

The authorized representative of the firm submitting the document must sign each page of the respondent’s document. In absence of the signature, Indian Railways may assume that the firm has not authorized the response on such a page and such a response page/document is liable to be disregarded or not taken cognizance of.

15. **LAST DATE OF RECEIPT & OPENING OF EXPRESSION OF INTEREST (EoI):**

The response to EoI should reach the Executive Director Mechanical Engineering (Development), Ministry of Railways, Railway Board, Room No.333, Rail Bhavan, Raisina Road, New Delhi – 110001 not later than 14.30 hrs on 7 September 2015. The offers will be opened on the same date at 15:00 hrs. in the presence of respondent’s representatives who may like to be present in the tender opening. If in case the date of offer opening falls on a gazetted holiday or is subsequently declared as such, the offers will be opened on the next working date at the appointed time as per above procedure.

16. **THE RESPONDENTS WILL BE SUBJECT TO:**

(a) Other General Conditions and stipulations contained in the bid documents followed by Indian Railways when the Bids for purchase of the equipment are called for.

(b) If and when sales tax on order (if placed) becomes payable under law, such payments when made will not be on contractor’s account. The Ministry of Railways (Railway Board) will not, however, be responsible for the payment of sales tax paid by the contractor under misapprehension of law.

(c) Firms may indicate the rate at which they are capable of supplying the equipment to Indian Railways. If the progress of manufacture and supply or performance of the material and/or stores during inspection and tests is not considered satisfactory, the Purchaser may at his option and without any claim for compensation by the contractor, either cancel the order altogether or modify the quantity ordered.
17. The user interface for using the “On Board Rolling Stock Condition Monitoring System” should be developed by the supplier to the satisfaction of Indian Railways. The supplier shall do necessary customization in the front-end interface as per the requirements of Indian Railways at the cost of supplier. This exercise shall be done to mutually acceptable demands from users.

Yours sincerely,

(Nitin Chowdhary)
Exe. Director Mech. Engg. (Dev.)
Railway Board.
for & on behalf of the President of India.

Enc: i) Copy of the Schedule of Technical Requirements
No. OBCMS/DCM/N/1, August 2015 for
Development Cell Tender No. 2015/Dev.Cell/ICCI/1/1 August 2015.
Draft
Schedule of Technical Requirement (STR)
for

On Board
Condition Monitoring System for Indian Railways Rolling Stock

Development Cell Draft STR No. – OBCMS/DCM/N/1

August 2015
Indian Railways Specification: –

A. Key Objectives

Indian Railways wishes to install railway vehicle mounted, ‘On Board Rolling Stock Condition Monitoring System’ that will monitor the health and safety of key components of the coaches, freight cars, locomotives and rail track that would finally result in improved safety, improved reliability, higher utilization, increased up-time and reduced operation cost of the railway assets by enabling Predictive Maintenance and reduction in sudden catastrophic failures of these assets.

The ‘On Board Condition Monitoring System of Rolling Stock’ will enable Predictive Maintenance of coaches, wagons, locomotives and track by meeting the following functionalities:

a. Improving safety by early warning of distress in or impending failures in wheels and wheel bearings. Using the vibration signature of the same sensors that are strategically placed on unsprung mass to do track condition monitoring too to indicate deterioration in the health of tracks thereby avoiding sudden failures in service. The system must have scalability to monitor traction equipment, bogie frame structural health, brake cylinder pressure, brake cylinder stroke and coach interior parameters, like temperature, battery health, battery charging systems and air conditioning systems etc. as a seamlessly scalable option. The respondent must cooperate with Indian Railways in its efforts to scale up the system at a later date. The architecture of the system must be modular so as to enable easy replacement of defective component.

b. Improvement in reliability of these assets by detecting early signs of deterioration in wheels, wheel bearings and track condition thus providing ample time for planning preventive and predictive maintenance and avoiding sudden breakdowns in service.

c. Enabling scientific decision-making for maintenance of assets based on accurate deterioration trending and quantified indices of state of health of these assets so as to plan condition-based maintenance rather than time-based maintenance.

d. Reducing maintenance cost of the railway assets by (i) identifying unnecessary maintenance regimes (ii) reduced replacement of “still serviceable” components and (iii) more efficient deployment of maintenance resources.

e. Ability to Install On Board Condition Monitoring System on Rolling Stock on “in service” trains without having to take them down for major modifications thereby reduced cost of installation, increased asset
availability and prevention of train service disruption while reaping benefits of such predictive maintenance systems.

d. The proposed system should be capable of being used with existing roller bearings and running systems on board the Indian Railways rolling stock without having to make any structural modifications in the stock.

g. Easy operation of the On Board Rolling Stock Condition Monitoring System by simple, automatically generated and actionable alerts.

h. Options to enhance the functionality and capability of this system in the future without requiring major replacement of the existing equipment monitoring system.

B. Key Requirements:

1. Vendors Qualification:

In order to ensure low deployment risk, the vendors must be able to demonstrate commercial and technical credibility. The vendors must be ISO:9001 certified and should have proven experience of delivering these systems in large volume to the rail industry.

Following experience shall be the minimum acceptable experience for the respondents to qualify them for taking part in the bidding process when request for proposal is called for:

a. Installation of at-least 5,000 wireless sensors on trains across different types of Coaches or freight cars. These sensors must have run in the field for at least 2 (two) years.

b. Experience of over 1,000,000,000 sensor-kilometres of accumulated service operation of wireless (non-battery) sensor nodes.

c. Demonstrate to Indian Railways how costs have been reduced with other customers using the system.

d. Names of at least three customers along with their contact details who shall supply testimonials as asked for in (a), (b) and (c) above for the systems installed by the respondent.

e. Ability to demonstrate successful detection of damaged bearings with more than three months of the remaining service life of bearings on in-service train.

f. The effectiveness of the wheel and bearing condition monitoring system shall be already proven in passenger coaching vehicle and freight service. Examples of successful wheel and bearing monitoring
case studies wherein damage to bearing, wheel and track was successfully demonstrated well before occurrence of failure must be furnished with photographs of damages so detected, their laboratory test results and field staff’s observations.

2. **Deliverables expected from the System:**

2.1. System shall be capable of operating effectively with 2G cellular data network coverage. System must be scalable to upgrade to 3G and 4G as and when needed in future without having to replace the complete data concentrator.

2.2. All data shall be captured and transmitted to a central server for inspection and analysis from the data concentrator. It should be possible to decode and extract this data stream at the input to the analysis software for later use by Indian Railways for its own analysis.

2.3. Algorithm for Actionable alerts should be built into the on-board system in such a way that Text Alerts (SMS) should be inferred by the system on board itself. Such alerts should also be transmitted to on-board display, fixed or handheld device via appropriate wireless protocol without waiting for GSM or CDMS network coverage.

2.4. Vibration data shall be captured at time intervals based on speed. If required, it should be held in buffer on board the concentrator and then transmitted to a central database for processing, analysis and alert generation every 5 minutes when the train is in normal service (at speeds over 15 Km/h) and as soon as it comes into 2G cellular data coverage. In the event of cellular network not being available, the data shall be held for the entire required time until cellular network coverage becomes available and then data must be transmitted at the earliest. The data holding buffer must be designed accordingly.

2.5. The condition monitoring system shall not be specific to any particular bearing type or to any specific bearing supplier but should function with multiple types of bearings that are running on Indian Railways.

2.6. **Respondent must specify the accuracy of their system on overall basis with reference to False–Positive and False–Negative alarm performance.** Methodology of verifying the stated accuracy including the test regime to be followed to substantiate their claim must be specified. Indian Railways shall, while calling for technical and commercial bids, take into consideration these details furnished by the vendors. In absence of any numbers given by the respondents,
Indian Railways shall set its own values based on its experience of similar equipment running in the field in India.

2.7. **The reliability of the system, or the acceptable failure rate of defect occurring within the system (hardware + Sensors + Software alerts), should be compliant to Six Sigma standard.**

2.8. Vibration shall be measured and transmitted when train is operating in normal service (speed greater than 15 Km/h) and shall continue to be recorded for a minimum of 60 minutes after the train comes to a halt.

2.9. The system shall be capable of measuring and transmitting an alert /email in the event of detecting a high risk occurrence within typically one minute and maximum five minutes with appropriate 2G/3G/4G data connectivity. Time stamp of the system shall be used to verify this aspect.

2.10. A data concentrator shall be used to collect information from all the sensors fitted on the coach/wagon/locomotive. Each data concentrator shall be capable of monitoring data from at least four vehicles – two in its front and two on its rear.

2.11. Data concentrator must have built in redundancy to ensure that the system does not “blank-out”.

2.12. The system shall have proven capability of detecting bearing damage three months before a bearing change is required, allowing ample time for the activity to be planned in with other maintenance activities.

2.13. The condition monitoring software algorithm should report the state of the health of the bearing, wheels and the track on discreet band zone – “Green Zone” for unconditionally safe to run, “Yellow Zone” - for beginning of noticeable deterioration and “Red Zone” - for indication to pull out the asset as soon as possible since it is reaching an impending failure stage.

2.14. The bearing condition scale shall, after appropriate configuration and calibration, enable the operator to distinguish between bearings with none or low level of damage and those that required increased attention and finally those requiring replacement to allow continued reliable operation of the train without a line-failure of the bearing.

2.15. Besides the above mentioned “Zone Bands”, all parameters of the all assets should be possible to be plotted and trended over time/distance to identify the deterioration rate/trend. This should
enable prioritisation of maintenance activities, thus enabling reducing damage to track and maximising useful wheel life.

2.16. The wheel condition monitoring system must be able to enable the operator to detect defects arising of Rolling contact fatigue like wheel shelling, wheel cracks, wheel flats and wheel disc cracks, etc.

2.17. In the event of sensor damage a warning shall be generated to enable safe replacement at the next inspection interval.

2.18. Alert levels shall be configurable and set by the operator to enable simple, actionable responses. However, the vendor shall take the responsibility of identifying the values and setting the limits and alarm thresholds. A time period of two months shall be given to the supplier to understand the Indian Railways operations and maintenance scenario and practices for setting such thresholds. The supplier shall be obligated to assist Indian Railways personnel in understanding the logics of the thresholds so set by him – to the full satisfaction of the Indian Railways personnel. A maximum period of six months from the date of installation on the last vehicle of the 6800\textsuperscript{th} unit shall be permitted to the supplier to do any fine-tuning of their system algorithms.

2.19. A system of email alerts and acknowledgements shall be available to implement a two level response assurance system.

2.20. The training materials and documentation for the system shall include historical examples of bearing, wheel and track defects that have been monitored successfully, with a correlation between monitored degradation, action taken by operator and parameter levels on return to normal after maintenance.

2.21. All sensor data shall be time, date and location stamped. Data location shall be typically accurate to ±50m or better. Time stamp shall be taken from the GPS system.

2.22. The allocation of sensor nodes to a data concentrator and train will be easily configured either through the terminal input of the data concentrator using non-contact programming device (Bluetooth, NFC, Zigbee) or by remote connection with the user website.

2.23. The only configuration required for sensor nodes shall be the sensor node serial number with railway coach/wagon/locomotive number.

2.24. Only standard Industry Communication protocols and encryption algorithms shall be used in the system from data concentrator to the cloud. Decryption keys shall be provided wherever necessary.
Proprietary communication protocols or data formats/information interchange formats used by the system when interfacing during system integration with other sensors or while scaling up the deployment should be shared with Indian Railways.

2.25. IR should also be able to extract the raw data in usable format and communication protocols being used between sensor and data concentrator.

3. System Configuration:

3.1. The ‘Rolling Stock and Track Condition Monitoring System’ shall have the following elements:

3.2. Sensor module (Sensor Node).

3.3. Communications network.

3.4. Analysis Software.

3.5. Information Display should be provided using web access, dedicated computer tablets and handheld devices that may be carried by the operations staff on board the train. Supplying four tablets/handheld devices for each train shall be a part of the supply of the above equipment – one set per 10,000 (ten thousand) sensors. Also, developing application for such handheld device/tablet and supplying it to Indian Railways free of cost shall be the responsibility of the supplier.

3.6. All the equipment shall conform to EN50126 (Railway Applications - The Specification and Demonstration of Reliability, Availability, maintainability and Safety (RAMS)).

4. Sensor Node:

4.1. The sensor node shall include sensors for both temperature and vibration. A single sensor node shall be capable of monitoring condition data from the track, wheel and bearing when fitted to the axle bearing assembly.

4.2. Sensor node shall be contained in a single robust housing with no external electrical wiring or connections (for sensors powering or communication purposes). This is essential to eliminate damage to cables or connectors and ensure fail-safe operation.

4.3. The sensor node should be deployed close to the axle box assembly and on the unsprung mass.

4.4. The vibration sensor shall meet the following specifications:
4.4.1. 3-axis acceleration data.
4.4.2. Lower limit of detection 0.025 ‘g’ RMS
4.4.3. Sensitivity better than ± 0.025 ‘g’
4.4.4. Sensor Bandwidth of at least 500Hz
4.4.5. Sampling Data rate of at least 1000Hz
4.4.6. Accelerometer measurement range of at least ±16g
4.4.7. Minimum available accelerometer range of ±25g
4.4.8. Minimum survivable shock of 10000g (accelerometer only).
4.4.9. Typical train speed before measurements commence: 10 km/h based on GPS.
4.4.10. Exception alert time lag: typically three minutes subject to a maximum of five minutes with appropriate 2G/3G/4G data connectivity. For sending such alerts to on-board handheld devices, the lag shall not be more than 3 minutes.
4.4.11. Typical vibration reporting interval: 3 minutes
4.4.12. Maximum vibration reporting interval: 15 minutes
4.4.13. Vibration test levels (up to 500Hz):
   4.4.13.1. The sensor will be capable of withstanding:
      4.4.13.1.1. 7 hours at 17g RMS
      4.4.13.1.2. 6 minutes intermittent at 44g RMS
      4.4.13.1.3. 6 shocks in each axis at 4m/s or 600g x 1ms half sine.
4.4.14. Sensor node shall comply with BS 7608:2014 (fatigue) and EN 13749:2011 (structures) assuming 75g fatigue and 105g proof loads for the sensor and fixing to the axle housing assembly.
4.4.15. Each sensor node shall have a unique electronic identification number, accessible from the web/NFC reader and visible on the sensor label.
4.4.16. Sensor node shall be common to all axle bearing assembly types. Customisation may only be required for the fixing bracket arrangement.
4.4.17. Sensor node shall be sealed to IP68 standard.
4.4.18. Sensor node housing shall be surface treated to protect against corrosion.

4.4.19. The bogie mounted sensor nodes mounted on the trains shall operate satisfactorily over the range of -10°C to +85°C.

4.4.20. Sensor node shall either communicate on an unlicensed frequency for instrumentation and monitoring purposes or on a frequency licensed by Indian Railways for the purpose.

4.4.21. No change of battery/power source shall be permitted in the sensor node during the service life of the sensor node in order to comply with EN50126 (Railway Applications - The Specification and Demonstration of Reliability, Availability, maintainability and Safety (RAMS)).

5. On Train Communications Hub (or Data Concentrator):

5.1. The Data Concentrator shall incorporate a GPS location device.

5.2. A single data concentrator shall be capable of receiving sensor data from at least two adjacent rail vehicles and transmitting it onwards for remote processing and presentation.

5.3. The data concentrator shall be powered by Industry Standard 24V or 110V DC on-board power supply with a maximum current capacity of 1 Amp at 110VDC. The power supply shall comply with EN50155 and RIA12.

5.4. The data concentrator shall have a battery power option, either for backup or as a main source of power along with energy harvester for recharging the battery. In case the Data concentrator has to work on Battery Back up, then the battery should be Compliant to UL Specifications and should provide 72 Hours of backup functionality which shall be demonstrated by method as per RAMS standard. In case the data concentrator has to work on the battery only, as in case of freight vehicles, the life of the battery with full functionality of the system should be minimum 5 (FIVE) years.

5.5. The data concentrator shall have one RS232/RS485 and one USB ports for the following functions:

5.5.1. Configuration using a simple serial ASCII terminal.

5.5.2. Continuous data streaming output that is compatible with alternative means of communication.
5.5.3. Taking backup of stored data or for reprogramming the data concentrator.

5.5.4. Data Concentrator should accept industry standard protocols like MODBUS. This will be used for reading the sensor data from “third-party” devices whenever they are fitted on the existing system. Data concentrator should be able to configure and transmit the field data from such devices.

5.6. The data concentrator shall be compatible with dual SIM cellular technology compliant with 2G, 3G and 4G protocols without need to change/replace internal circuit boards.

5.10. The data concentrator shall have low power status indicator LEDs for:

5.10.1. Power indicator.
5.10.2. Battery status.
5.10.3. Activity (“Awake/Asleep”).
5.10.4. GSM/GPRS connection.
5.10.5. GPS position.
5.10.6. Communications with wheel sensor nodes.
5.10.7. Communication with mesh or other sensor nodes.

6. A set of indicators showing mobile data connection health and signal strength at point of reception.

i. The data concentrator shall have a single button that can be used to prompt the following actions:

1. Connection to the local terminal.
2. Data connection for status report.
3. Test mode.

ii. The data concentrator shall have an IP 67 rating.

iii. The data transmitted from the data concentrator to the remote storage and processing centre shall be encrypted to an applicable industry standard.

iv. The SIM card for data communication to the remote server shall be protected inside the data concentrator housing. Special tools shall be required to open the data concentrator (for example, security screws).

v. Radio communication antennas for the data concentrator shall be fit within the space available agreed with Indian Railways in the ‘Schedule of Dimensions’ and preferably “on the box” type.
vi. The data concentrator shall have an accelerometer with a minimum range of ± 2g and a resolution of 16bits.

vii. The data concentrator accelerometer shall have sleep function when the train is stationary and shall be programmed to wake up when the train moves to save battery power.

viii. The data concentrator shall comply with EN 45545:2013 (Railway applications. Fire protection on railway vehicles. Requirements for fire behaviour of materials and components)

7. Software and Algorithms:

i. The software shall analyse the received sensor data and produce simple actionable alerts for maintenance staff.

ii. The algorithms shall be coded into the software so that alerts and condition information are generated automatically without the need for manual intervention.

iii. The output from the software algorithms shall be a simple numerical value to quantify the seriousness of any emerging problem depicting –

   1. Normal Health of bearing or other equipment being monitored.

   2. Beginning of deterioration but degradation does not warrant intervention.

   3. Deterioration in the health of bearing or other equipment being monitored that requires intervention within three months.

   4. Deterioration in the health of bearing or other equipment being monitored that requires immediate pull out from service at the next available attention point.

iv. Actionable alerts that require immediate intervention shall be transmitted to the on-board device/handheld terminals from intelligent sensor based hardware logics and thresholds. These shall, in turn be transmitted to central data servers as per methods and timing described elsewhere in this document.

v. Network configuration and viewing should be possible to create wireless mesh network of all sensors and data concentrators on the vehicles on the train so that it is possible to communicate the status of vehicle raising an alarm to be identified with all its connected coaches or wagons. Such alarm should be possible to be relayed to the locomotive and also at the level of the Cloud monitor.
8. Rolling Stock Monitoring System Requirements:

i. The system shall be capable of monitoring the following:
   1. Condition of wheels e.g. wheel flats, etc.
   2. Surface and Sub-surface wheel damage like cracks and shelling on disc as well as on tread e.g. those caused due to Rolling Contact Fatigue (RCF)
   3. Condition of wheel bearings e.g. race damage, cup faults, cone faults, growlers, etc.
   4. Excessive and/or unusual vibration pattern that indicates abnormal running behaviour of the wheel.

ii. The system shall identify the condition of each specific wheel and wheel bearing separately to enable the maintenance work to be accurately directed to exactly problem area.

iii. The system shall have proven capability of identifying degrading bearing at least three months in advance of the need to replace the bearing.

9. Track Monitoring System Requirements

i. The system shall be capable of monitoring the track condition not only for the level of shock and vibration but also the change of these levels with time so as to identify the deterioration trend.

ii. Information shall be presented in a map view with highlighted areas of highest shock and vibration.

iii. The map view of vibration shall be updated continuously (as data arrives) so as to monitor the progression of track defects as they develop.

iv. The resolution shall depend on the number of wheels monitored and the frequency of service but shall be capable of daily updates subject to train passage frequency.

v. The system shall provide the capability of viewing the vibration data as a function of time and as a function of distance so that the customer can see where the damage is and how it is evolving with time.

vi. The system shall be capable of accurately identifying which of the two rails on a given track has a problem.
vii. The system shall be capable of determining the train orientation.
viii. The track condition monitoring system must enable the track maintainer to prioritise track maintenance and repair based on quantitative indicator(s).

10. Installation

i. Sensor node shall typically be installed in less than 30 minutes by one skilled worker under normal conditions and the required special (proprietary) tooling will be supplied to all depots and maintenance sheds/workshops of the Indian Railways.

ii. Sensor node shall be capable of being fitted to the existing in-service axle bearing assemblies at any time in the lifecycle of the bearing.

iii. Sensor node shall be capable of being fitted to both legacy and **new rolling stock** without the need for buying special bearings or special bearing housings/parts.

i. Sensor node fitment shall not require any change to the existing bearings. The sensor nodes fitment shall be non-intrusive i.e. no requirement to modify the bearing or the bearing cap/casing.

ii. Sensor node for wheels and wheel bearings shall be mounted on the unsprung part of the bogie to ensure monitoring of accurate vibration data with adequate sensitivity.

iii. Necessary anti-pilferage measures as per international norms shall be built into the installation so as to reduce the danger of theft or vandalism.

iv. No hardwiring shall be permitted for provision of power or communication links to the sensor node.

v. The bogie frame mounted sensor nodes for monitoring unusual bogie frame vibrations, at a later date, shall be self-powered.

vi. Sensor node configuration shall be facilitated by a wireless communication/NFC/Bluetooth on each sensor that can be read using a handheld reader and then downloaded directly to the system

vii. **Configuration Diagnostics:** A suitable display and log shall be provided to clearly show the list and health of all sensor nodes attached to each data concentrator. If any data concentrators are not shown as attached, the technician shall be able to remotely check the concentrator pairing. The replacement of the sensor node shall be possible in typically less than 30 minutes.
viii. Data concentrator should be designed as vandal proof to international standards and should be mounted on freight cars in a position and using means so as to minimize possibility of theft.

11. **Environmental Requirements:**

   i. Sensor node shall comply with IP68 specifications.

   ii. Sensor node shall comply with the following test specifications for resistance to vibration and shock (both as applied to equipment bolted to the axle box):

      1. GM/RT 2100

      2. EN61373:2010

   iii. The data concentrator shall comply with the requirements of GM/RT 2100 and EN61373:2010 as applied to equipment mounted above secondary suspension.

   iv. The sensor node and data concentrator shall both comply with the requirements of BS EN 50125-1:1999 (or the latest edition where required).

12. **Communications:**

   i. Communications to and from the sensor nodes shall be wireless.

   ii. 2G/3G/4G Cellular or satellite communications shall be used to send data to and from the train.

   iii. Data compression and filtering will be part of the “on train” systems so that communications can be achieved effectively with 2G/3G/4G cellular data communications.

   iv. The wireless communication from the sensors shall be free from interference by passenger communication systems such as Wi-Fi, Bluetooth and cellular radio.

13. **Front-end presentation:**

14. i. A user website shall be provided to display the current status of all monitored rail assets.

   ii. The user website shall be used to configure sensor nodes to monitored rail assets.
iii. Information about the monitored rail assets on the user website shall be compatible of accessibility with common mobile devices (iPhone, Android, Windows phone, tablets) as well as standard desktop computers running a web browser.

iv. Sensor information shall be available as simple coloured status diagrams, tables of numerical values indicating alert, equipment health and diagnostic information, and graphical display of historical condition information allowing comparison of on all common Internet browsers, including mobile platforms.

v. The information for monitored rail assets with sensors shall include but not be limited to:

1. Location (shown on a map and available as a downloaded data file).
2. Speed.
3. Direction.
4. Health state (including state of the sensors and data concentrator).
5. Condition as indicated by vibration (monitored axles must include bearing, wheel and track condition as output options).

Necessary APIs (Application Program Interface) with for this, along with the mapping software, should be developed by the supplier of the system – including obtaining any authorization for use of Geo-mapping data and software.

vi. The website shall be hosted on a non-proprietary cloud computing system with scalability, and geographical resilience with adequate redundancy and with mirrored redundant servers at each geographical location. The preferred platform for this purpose shall be the secure ones that are hoisted by Internationally certified platform like those by Microsoft, Hewlett-Packard, etc. whose Security Audit Certificate would require to be submitted with the Technical Bid to begin with. This shall be later shifted on to India-based Cloud services of choice that shall be jointly decided between the supplier and Indian Railways. Cost of shifting over to Cloud in India shall be borne by the supplier of the equipment.

vii. The website shall display the train sets with the correct vehicles order displayed on a single or layered webpage.
viii. The website shall have a top-level summary page displaying summary status of the fleet.

ix. The website shall have multi-level query menu as per the demands of Organizational hierarchy – relevant to that particular administrative level of person logging in.

14. Access to Data and Alerts:

14.1. Condition Monitoring information shall be securely accessible on computer, tablet or smartphone from anywhere with broadband internet access

14.2. Access to the information shall be passcode protected to a recognised industry standard and shall be of hierarchical in nature depending on the administrative position/privilege of the accessing client.

14.3. Email/SMS Text alerts shall be provided when problems arise (with an option to provide text alerts to cellular phones).

14.4. The software shall escalate the urgent alerts to successive end users in the event of acknowledge of the alert not being confirmed by its first intended recipient.

15. Safety in design of system:

15.1. Sensor node shall be Rolling stock mounted to ensure repeated and frequent monitoring so as to identify faults at the earliest opportunity, avoid missed events and allow reliable trending of condition information.

15.2. Vibration sensors shall be provided for with auto calibration and temperature and humidity variation compensation for added accuracy, reliability and safety.

15.3. An escalation mechanism shall be provided to support alert acknowledgement and ensure response in the event of high level alerts.

15.4. An audit trail shall be available to monitor and record website activity as well as data concentrator logs.

15.5. System shall be capable of self-monitoring for faults at least once in 24 hours.
16. Scalability and universality of the Onboard Condition monitoring system:

16.1. Both *Rolling stock* and *track related information* shall be monitored and transmitted from the same sensor node.

16.2. The data communications system shall be scalable to allow addition of sensor nodes in future.

16.3. Data concentrator shall be modular and should be scalable to accept connection of additional sensors. For the protocol to be used for communications of the Data concentrator, kindly refer to clause 5.5.4. Apart from the hardware connectivity, software handshaking with sensors must also be ensured.

16.4. Additional input device in wireless fashion to the data concentrator to add more sensors.

16.5. The system shall be applicable to both passenger and freight trains/operations.

16.6. System shall be capable of being scaled-up in future, with simple addition of sensors by connecting them to data concentrator, to monitor the following parameters. The list of parameters is not exhaustive and is not limited to only the ones mentioned in Annexure – 1.

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**ANNEXURE – 1**

The following performance parameters of the coach, locomotive and freight car shall be required to be optionally measured and monitored from the point of view of predictive maintenance in the same lines as the standard parameters for which the main system has been developed by the firm. All equipment (and sensor) standards that are being demanded in the main system shall apply to the expanded functionality requirement systems too.

1. **Additional parameters to be monitored in Passenger Coach:**
   a) Water level monitoring in water tanks on board the coach. Monitoring of internal temperature of carriage shall be available.
   b) Air-spring pressure (where ever pneumatic suspension springs are fitted).
   c) Wheel slip and slide control system.
   d) Air brake system piston travel and Brake cylinder pressure.
   e) Brake pipe and feed pipe pressure.
   f) Distributor Valve performance of the Air Brake system.
   g) Automatic door closer system.
   h) Additional wheel damage differentiation such as flange wear, out of round, etc.
   i) In case of Diesel Engine driven Diesel Multiple Units (DMUs), the health of Gearbox, traction motors and compressor(s).

2. **Additional parameters to be monitored in Freight Car (Wagon):**
   a) Brake system’s brake piston travel.
   b) Brake cylinder pressure.
   c) Brake pipe and feed pipe pressure.
   d) Brake system Distributor Valve health – functional or non-functional.
   e) State of wagon – whether Empty or Loaded.
   f) Additional wheel damage differentiation such as flange wear, out of round, etc.
   g) Broken spring in the suspension system.
   h) Crack on bogie frame.
3. **Additional parameters to be monitored in Locomotive:**

   a) Brake system’s brake piston travel.
   
   b) Brake cylinder pressure.
   
   c) Brake pipe and feed pipe pressure.
   
   d) Brake system Distributor Valve health – functional or non-functional.
   
   e) State of wagon – whether Empty or Loaded.
   
   f) Additional wheel damage differentiation such as flange wear, out of round, etc.
   
   g) Broken spring in the suspension system.
   
   h) Crack on bogie frame.

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ANNEXURE - 2

The following standards or equivalent standards shall govern the specifications to which the equipment and systems shall comply with. Whenever there is any ambiguity regarding interpretation of standards, procedures and norms, the stricter of the conflicting norms shall be applicable.


MECHANICAL STANDARDS:
Bogie mounted equipment must conform to
   BS 7608:2014 (fatigue)
   EN 13749:2011

Bogie and coach mounted equipment must conform to:
   EN 61373:2010 (shock and vibration tests)
   EN 12663 (2010) (equipment mounted to vehicle bodies)
   EN 45545 (2013) (fire precautions)

ELECTRICAL STANDARDS
   EN 62311 and EN 62479 (exposure to EMI)
   EN 50121 (electromagnetic compatibility)
   R&TTE directive 1999/5/EC
   EN 301 489

Power supply: EN 50155 and EN 50121

ENVIRONMENTAL STANDARDS:
   EN 50125-1
   EN 60529

GENERAL:
   ENS0126 (Railway Applications - The Specification and Demonstration of Reliability, Availability, maintainability and Safety (RAMS)).
   Equipment to be designed and manufactured under ISO 9001.

   IEC 60571: Electronic equipment used on railway vehicles.
   NEMA-3 Compliant enclosure unit.

   Indian Railways Standard (IRS) General Conditions of Contract (GCC) shall prevail while doing interpretation of the various financial, operative and purchase conditions in executing the above-mentioned work.

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