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Manak Nagar, Lucknow - 226011.

Signature			
Name & Designation	SSE Design/ Carriage Prepared By	Joint Director /Carriage Checked By	Joint Director/ Carriage Approved By

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SPECIFICATION FOR IOT BASED WATER LEVEL INDICATOR SYSTEM FOR INDIAN RAILWAY PASSENGER COACHES.

1. PREAMBLE :

1.1. This technical specification covers general conditions, technical & operational requirements, design, supply, installation & commissioning, inspection, testing procedure of **IOT based water level indicator system for water tanks in passenger coaches.**

1.2. This specification also covers the preventive maintenance by supplier/vendor during warranty and AMC for post warranty period.

1.3. Real time water level indicator system for water tank of passenger coaches shall be designed primarily for monitoring of water level of water tank in real time and generating alerts / report of low water to the monitoring officials for refilling of water tanks at the nearest watering stations.

List of normative standards for reference

Sl. No.	Standard	Description
1	EN50155	Railway applications — Rolling stock — Electronic equipment.
2	IEC 60571	Railway applications – Electronic equipment used on rolling stock.
3	EN 61373	Shock & vibration tests of rolling stock equipments.
4	ELRS/SPEC/ELC/0019	Technical specification for electron beam irradiated/chemically cured cross linked thin walled flexible elastomeric cables with copper conductors.

2. PARTICULAR REQUIREMENTS

2.1. Make in India policy of Govt. of India will apply

2.2. Water level indicator system for passenger coaches requires higher reliability of various components especially the critical components and reliable internet connectivity during entire journey for real time water level monitoring and syncing data with existing railway network (CRIS server).

Note: During tendering the firms shall comply the eligibility criteria specified by the purchaser.

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2.3. Supplier / vendor should have design capability in the field of electronic instrumentation and IoT based networked devices for customized application. Documentation and credential for successful completion of design, installation and after sales service for at least one such application.

2.4. Firm should posses ISO: 9001 certificate issued by International Accreditation forum (IAF) under multilateral Recognition arrangement (MLA) for its works address covering the items under manufacture, supply and installation etc. Firm should have established quality control system and organization to ensure quality of the product.

2.5. Firm should have well-established design facilities with qualified & competent design personnel and well established manufacturing facilities required for real time water level indicator system.

2.6. Firm should have in-house testing facilities to test the performance of all critical components of the complete system.

3. DEFINITION OF TERMS USED:

3.1. **“ WLI system** ” means IOT based water level indicator system for water tanks in passenger coaches.

3.2. “**Supplier**” means the firm/company on whom the order for the manufacture, supply, installation and commissioning and maintenance of the WLI System is placed or will be placed.

3.3. “**Purchaser**” means the Indian Railways on behalf of the President of the Republic of India who is purchasing the WLI system.

3.4. **“Inspecting Authority”** means the Organisation or its representative nominated by the Purchaser to inspect the WLI system on his behalf.

3.5. The Research Designs and Standards Organization, Manak Nagar, Lucknow-226011 is here after referred to as **RDSO**.

3.6. Indian Railways is hereafter referred to as **I.R**.

3.7. In case of any clarification in respect of any clause of this specification or drawings, the same shall be obtained from purchaser / ED Standard (Carriage), RDSO.

3.8. “ **MPU** ” Means main processing unit.

3.9. “ **Web Server** ” intended web server of Indian Railway /CRIS

3.10. “ **IOT Device** ” Internet of thing Device.

3.11. “ **M2M** ” means Machine to Machine communication.

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4. SCOPE OF WORK

The scope of supply includes the following subsystems:

4.1. Each Coach shall be equipped with following separate units along with required connectors and wiring for communication & power supply etc.

Sl. No.	Description of unit	Quantity per coach
1	**Main Processing Unit along with enclosure unit.** Description of Main Processing Unit shall be as per clause no. 7.1, 7.2, 7.5 of this specification.	01 per coach
2	**Water level Sensor along with connector and wiring**. Description of water level sensors shall be as per clause no. 7.4 of this specification.	01 per coach (for AC and SCN with under slung water tank pack)
		02 per coach (for Non AC coaches fitted with Roof water tanks)
3	**Supply and maintenance of e-SIM for M2M data connection for MPU main processing unit.** Description and other requirement for maintenance shall be as per clause no. 7.3 of this specification.	01 per coach
4	In addition to above all items, hardware, pipe fittings etc required for installation and commissioning of WLI system shall be supplied by vendor.	As per requirement

5. COACH OPERATING CONDITIONS

Water level indicator system should function with full efficiency under following coach operating conditions.

5.1. **Car-body dynamics:**

Equipment shall withstand satisfactorily the vibrations and shocks normally encountered in service as indicated below:

i) Maximum vertical acceleration 1.0g
ii) Maximum longitudinal acceleration 3.0g
iii) Maximum transverse acceleration 2.0g

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The vibrations are of sine wave form and the frequency vibration is between 1 Hz to 50 Hz. The amplitude 'a' expressed in millimeters is given as a function of f, by equations

a = 25/f for values of f from 1 Hz to 10 Hz.

a = 250/f^2 for values of f exceeding 10Hz and up to 50 Hz.

In the direction corresponding to the longitudinal movement of the vehicle, the equipment is subjected for min. 2Hz to 50 Hz Vibrations of such a value that the maximum acceleration is equal to 3.0g. Maximum value for vibration level of the equipment shall be tested as per IEC 61373.

5.2. **Coach-body displacement encountered under dynamic conditions.**

i) Vertically- ±100 mm
ii) laterally - ± 80 mm
iii) longitudinally- ±10 mm
iv) bogie rotation about center pivot- $\pm 4^0$
v) Maximum Speed of train - 160 KMPH

5.3. **Ambient Condition:**

(i) Altitude : Sea level to 2500m
(ii) Operating temperature : -10^0C to 55^0C
(iii) Max. Temperature under Sun : 70° C
(iv) Relative humidity : 40% to 95%
(v) The rainfall is fairly heavy.
(vi) During dry weather, the atmosphere is likely to be dusty.
(vii) Temperature variations can be quite high in the same journey or short period of time.
(viii) Coaches operate in coastal areas with continued exposure to salt laden air.
(ix) Airborne contaminants like smoke, chemical vapours, conducting particals etc.
(x) Coaches may be subjected to frequent external washing with detergents and cleaning of toilets by cleaning agents.
(xi) LHB type coach length over coupler is approximately 24 meters.

6. DESIGN REQUIREMENTS:

6.1. System shall be designed with hydrostatic water level sensor & IoT based MPU having connectivity of internet using 4G/5G /LTE (M2M) through e-SIM of GSM network. In case of non availability of network automatic switching to available 3G/2G network.

6.2. Water tank shall be fitted with wired hydrostatic water level sensor and output signal shall be mapped / calibrated in main processing unit for water tank capacity in % available water out of installed capacity water tanks. Non AC coaches fitted roof water tanks shall have separate sensor for both end of coach.

6.3. The MPU shall monitor the corresponding signal of each water level sensor for conditioning & converting into digital form for uploading on cloud platform (preferably on CRIS sever). Frequency of polling water level data along with

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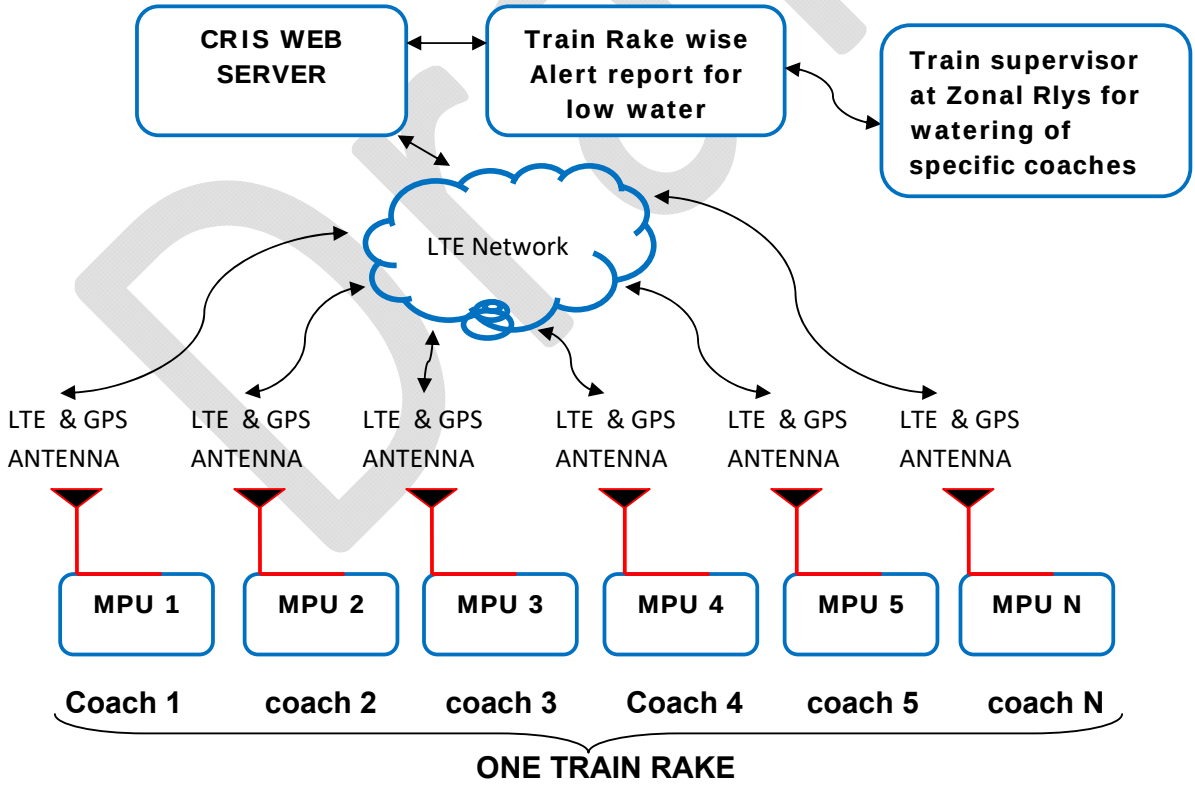
location, battery health, date and time stamp etc shall be 15 minutes or as agreed by purchaser.

6.4. The sensor calibration program (program to convert the output signal of the sensor which is in mA (milli-ampere) to a percentage) should be stored in the EEPROM of MPU unit to facilitate conversion from raw data to water level percentage. Software should be able to compensate the atmospheric pressure variation of different geographic location of pan India rail network.

6.5. All MPU must have a unique ID (MAC ID of the microprocessor unit / microcontroller) registered along with the corresponding coach numbers in CMM portal (CRIS server). CRIS will map the all unique ID to Rake Link ID with running train status and upcoming stations accordingly. CRIS shall use HTTPS GET or any other protocol to push data from CMM to MPU and update the unique ID of the coach if required.

6.6. MPU shall have appropriate low power modes and watchdog timer to ensure that the sensor keeps running continuously and system restarts automatically in case of a software fault. For power saving of battery, MPU shall be designed to go in sleep mode, if GPS location is same for more than 6 hour and wake up every hour to check the GPS location to return the MPU in Normal mode.



BLOCK DIAGRAM OF SYSTEM ARCHITECTURE FOR WATER LEVEL INDICATOR

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6.7. The MPU should call the HTTPS GET API every 6 hours to update the database in the form of feedback from CRIS & MPU shall send data only once per cycle (i.e.15 minutes) and there should not be any repetition of data. In case of no network data shall be queued and uploaded to CRIS server as soon network restores.

6.8. The data communication between the transmitter (MPU) and the receiver (CRIS server) shall be encrypted with AES 128-bit and the key for encryption/ decryption will be issued by CRIS. Further data communication protocol between the MPU and the CRIS server shall be HTTPS.

6.9. Communication protocol for transceiver between MPU and CRIS server shall be as per cloud service provider (preferably CRIS). Details of communication protocol shall be shared by CRIS during design stage / installation & commissioning.

6.10. MPU shall be capable of sending broadcast / RCS messages to all predefined numbers of concerned watering supervisors at next watering stations enroute.

6.11. The server displays the water level of the all coaches in a rakes / trains to the user depots as well as sends alert messages to the supervisors of upcoming watering points in case it detects any coach is running with low water level (predefined water level of 40%) / out of water (Empty water tank).

6.12. CRIS shall update the database of each coach by using the link between the Unique ID, Rake link ID and coach number already filled by the depots in the water level fitment form.

6.13. A WEB interface shall be developed by CRIS for monitoring the water level, viewing on PC/Mobile apps train rake wise, depot wise, zone wise of all coaches by all concerned users at watering station, depot, zone etc and automatic alert messaging to the concerned train supervisor of next upcoming watering station.

6.14. System design should be modular to ensure the interchangeability of sensor, MPU, battery etc. Devices / modules interface should be interoperable for hardware / software level.

6.15. Power consumption of the complete system Per /Hour /Day shall be worked out and clearly defined.

7. TECHNICAL REQUIREMENT

7.1. MAIN PROCESSING UNIT

Main processing unit (MPU) shall be designed with 32 bit Microprocessor / microcontroller based system with inbuilt e-SIM LTE (M2M) module, Wi-Fi module, Bluetooth Low Energy (BLE) module, GPS module for real time location & USB, RS232 and RS485 ports etc. it should have Minimum 16 channel A/D Converter (analogue to digital converter) and 16 channel DIO (digital input output) port should be onboard to handle future up-gradation of the system, system shall also have Ethernet port and VGA/HDMI port along with system software and application program for easy configuration of the system.

7.2. ENCLOSURE UNIT OF MPU

7.2.1. Main processing unit, battery pack and other electronic circuit shall be enclosed in a Stainless steel (AISI 304) enclosure unit (preferable size 300mm x 300mm x 150 mm) & shall have IP65 ingress protection. Enclosure unit and system shall have IK-10 rating for impact resistance to withstand ballast hit etc.

7.2.2. Enclosure unit shall be mounted under slung with suitable brackets on cross member of under frame with the help of prevailing torque type nut bolt. Provision of connection of level sensor shall be done through M12 4 pole A-coded male connector provided on Enclosure unit. Antenna and other connections shall be suitably sealed to prevent ingress of dust and water.

7.2.3. Enclosure unit along with MPU and all electronic items should withstand the coach operating conditions of clause no.5 of this specification and it shall be ensured the compliance of EN50155 specification for electronic equipment on rolling stock application.

7.2.4. Necessary test certification for compliance of EN50155 specification shall be done on one system for design validation by national accredited labs for this purpose.

7.3. 4G/LTE MODULE

The SIM module shall have 4G network support with 2G fallback using M2M eSIM with URL white listing. It should be from reputed vendors like SimCom, Quectel, etc. It should be provided with a good antenna tuned for 4G and 2G having a minimum gain of 3dBi. The SIM module should be GNSS-supported so that the current location of the train can be sent to the CRIS server.

E-SIM provided in IOT shall have active data and SMS through leading GSM service provider with national roaming for pan-India connectivity.

7.4. LEVEL SENSOR

7.4.1. Level sensor type shall be hydrostatic pressure transducer of Reputed make RS Pro, Siemens, TE or any other make with prior approval of RDSO, suitable for fitment on ¼" BSP threaded socket of water tank piping and shall be capable to measure absolute pressure.

Following common specification shall be followed for the water level Sensor

i.	Level sensor body	-	stainless steel 316L
ii.	IP rating of sensor	-	Minimum IP-65 & above
iii.	Diaphragm	-	Piezo-Resistive Ceramic
iv.	Operating voltage	-	10V to 30 V D.C.
v.	Load /impedeance	-	~ 500 Ohm
vi.	Measuring range	-	0 to 1Meter water column.
vii.	Response time	-	~ 500 ms

viii. Accuracy - 99 %

ix. Interface connection - 1/4" BSP male Thread

x. Cable length - To suit the requirement with M12 socket 4 pole A coded connector.

7.4.2. Level sensor shall be fitted with lowest portion of water tank with suitable compatible pipe fitting or water column provided for this purpose.

7.4.3. Connection between level sensor and signal processing unit shall be made with shielded wire and shall be routed through protective conduits to prevent accidental damages in transit /service of the coaches.

7.4.4. All wing and cabling shall be fire retardant and as per RDSO specification ELRS/SPEC/ELC/0019 latest revision.

7.5. BATTERY

Power requirements for power supply of MPU shall be met with Lithium Iron Phosphate (Li-$FePO_4$) / Lithium Thionyl Chloride ($LiSOCl_2$) Batteries only, which should last for at least 6 months without recharge / exchange.

Specification of Lithium Iron Phosphate (Li-$FePO_4$) Batteries shall be as below:

Battery Type	Lithium Iron Phosphate (Li-$FePO_4$) / Lithium Thionyl Chloride ($LiSOCl_2$)
Max Voltage of Battery Pack	12.6 to 12.8V
Min Voltage of Battery Pack	10 V
Capacity of Battery Pack	Minimum 48AH to suite 6 months operational life without charging.

Note: Battery certification shall be required for safety against fire.

8. TESTING AND APPROVAL

8.1. The supplier / vendor shall submit the design details of the WLI system complying the technical, design requirements of this specification including layout drawings, coach interfaces required, integration requirement, operation and maintenance manual, including the requirement of spares and consumables for the approval by Vendor approving authority. Quality assurance plan covering all stages of manufacturing, quality control and testing at various stages of the sub-assemblies and final system shall be submitted for approval by vendor approving authority.

8.2. Supplier/vendors who have already met the requirements of para 8 of this specification by vendor approving authority shall be exempted to clause no. 8.3. However in case of any design change / sub vendor change by supplier fresh prototype approval shall be required.

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8.3. **PROTOTYPE APPROVAL:**

8.3.1. Prototype approval of the WLI system will be done by Vendor approving authority. Prototype approval shall be done as per approved QAP of the firm on test bench at firm's premises for verification of the technical, design requirements and testing of the system followed by actual fitment on a coach and successful functional test as per this specification.

8.3.2. Following parameters and system functionality will be checked during prototype approval. :

A. DIMENSIONAL CHECK AND VISUAL INSPECTION:

I. Dimensional check as per design / interface drawing.
II. Working of system controls & indications.
III. Functional check of the complete system including web interface.
IV. Demonstration / calibration of level sensors.
V. Any other tests considered necessary.

Note: Actual working conditions shall be simulated in a depot and live reporting shall be checked for water level indicator system.

B. TYPE TESTING:

Type testing of water level indicator system including battery shall be done from any Govt. Lab or NABL accredited testing lab and test report shall be submitted to the vendor approving authority.

Type testing shall be done for all test (Mandatory & optional) as specified in clause 13.3.1 of EN50155 specification (latest revision).

9. FIELD TRIALS:

9.1. After successful prototype approval of the complete system, 10 coach set shall be installed & commissioned by the vendor / supplier for field trials of at least 6 months before bulk supply, shortfall in trial period due to stabling of coaches or any other unforeseen reasons shall get extended.

9.2. Field trials shall be jointly monitored by concerned Zonal Railways /PUs and supplier/vendor as per trial scheme finalized by vendor approving authority for this purpose. Criteria for successful completion of field trial shall be elaborated in trial scheme.

9.3. Performance monitoring of the coaches fitted with water level indicator will be done in actual train service for the trial period with an objective to monitor the following:

a) Low water alerts issued in real time basis at 15 minutes intervals.
b) Battery life span (last change date) and residual battery capacity
c) Proper Working of level sensors without error.

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d) Intactness of Enclosure unit & mounting arrangement of enclosure unit.
e) Proper functioning of the complete system.
f) Details of attention /maintenance requirement with coach number, date and time.

10. INSPECTION:

10.1. The inspection will be carried out generally as per firm's approved drawings, RDSO drawing; firms approved QAP and any other specification given in water level indicator specification.

10.2. The inspection of material will be carried out at contractor's premises by authorized representatives of nominated Inspecting agency as per manufacturers drawing, physical & chemical properties, various critical dimensions as per approved Quality Assurance Program (QAP) as by vendor developing authority.

10.3. Contractor shall provide free of charge labour, material, tools, gauge and appliance etc. required by the inspecting authority for inspection at manufacturing location.

11. MARKING

Manufacturer's name plate with Purchase order no. & date, serial/batch number along with month and year of manufacture shall be fitted at a visible location for identification on major assemblies of the system supplied.

12. DOCUMENTATION AND TRAINING

12.1. Following the acceptance of the prototype, contractor shall provide technical manuals as given below about the system in English. The information should be both printed and in electronic format and shall be provided to IR.

I. Operating and maintenance instructions
II. Periodic Maintenance Schedule (Daily / Trip/ Monthly) in line with maintenance schedule of LHB & Train-set coaches.
III. Schematic diagrams of Installation & commissioning and their instructions
IV. Schedule of operating principles.

12.2. The contractor shall provide theoretical and practical training to the staff of workshops and zonal railways for a period of 05 days free of cost. Supplier / vendor shall also be able to deliver optional testing equipments for supplied toilet system.

13. WARRANTY AND SPARES.

13.1. Supplier /vendor shall be liable for warranty of 72 months including compulsory CAMC (Comprehensive Annual Maintenance Contract) from the date of fitment. CAMC of the supplied WLI system including the cost of active e-SIM, Battery and its maintenance for 6 years shall be part of supply order and the supplier / vendor shall make arrangements for day to day maintenance as well as scheduled maintenance of WLI System to make it operational at all times.

13.2. Spares & consumables required shall be all inclusive part of CAMC. Strict provisions of imposing penalty on vendors for unreasonable downtime and

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repeated failures of the components / sub-assemblies shall be ensured by purchaser.

13.3. The warranty period would get extended on a pro-rata basis if warranty repairs / replacement are not provided within 5 days of notice. If supplier/vendor fails to provide warranty services within 5 days of notice, Railway reserves the right to take action as per extant rules.

13.4. Minimum 02 (two) Preventive maintenance visit(s) per year has to be undertaken by the supplier / Vendor during the warranty period. During these preventive maintenance visit(s), the supplier / vendor should attend the scheduled maintenance, as specified in OEM's technical manual and supplier / Vendor should also change the parts which are required to be changed as per OEM's technical manuals to achieve 72 months warranty.

13.5. CAMC offer should provide details of the spares (indicating Make/OEM) and their recommended frequency of replacement, cost etc. Supplier /vendor shall ensure the availability of spare parts of the supplied system for a period of at least 10 years.

13.6. Supplier / vendor shall submit the report of preventive /scheduled maintenance carried out during CAMC to the purchaser /consignee.

14. INFRINGEMENT OF PATENT RIGHTS:

The supplier /Vendor are required to give undertaking on "INFRINGEMENT OF PATENT RIGHTS". The undertaking shall be as under:

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

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

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