SPECIFICATION OF BIO-VACUUM HYBRID TOILETS FOR LHB TYPE COACHES.

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Manak Nagar, Lucknow - 226011.

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SPECIFICATION OF BIO-VACUUM HYBRID TOILETS FOR LHB TYPE COACHES

1. **PREAMBLE**: 
   1.1. This technical specification covers general conditions, technical & operational requirements, inspection, testing procedure of bio-vacuum toilets for LHB type coaches. This spec also covers the maintenance by supplier during warranty and AMC for post warranty period.
   1.2. Bio-Vacuum toilet are integration of vacuum toilet with existing IR-DRDO bio digester already being fitted in LHB type coaches. Bio vacuum toilets shall be customised with existing lavatory module being fitted along with bio digester. However supply of the IR-DRDO bio digester is not in scope of the supply.
   1.3. Vacuum evacuation system for Bio-tanks will transfer the fecal matter from the bowl/pan to the bio tank by positive suction and also clean the lavatory bowl/pan with pressurised jet automatically, without affecting functionality of bio digester.

2. **ELIGIBILITY CRITERIA**
   2.1. Firm should be a proven supplier of vacuum evacuation system and should have supplied at least 500 vacuum evacuation systems or vacuum toilets for rolling stock application, either by firm or by their principals (OEM), which should have been in satisfactory operation for at least 2 years. They should submit records of previous supplies and credentials.
   2.2. For firms not covered under clause 2.1, however, if firm has developed bio vacuum toilets Indigenously or in collaboration with OEM and meeting the technical and functional requirements of this specification, they can be considered for developmental order followed by prototype approval and field trial for 12 months from the date of fitment as per clause no. 9 of this specification. Firms approved under this clause shall be treated at par to the firms approved under clause no. 2.1 after successful supply and commissioning of at least 500 units in Indian Railways.
   2.3. Firm or their principal should have well-established manufacturing and testing facilities. Firm & their principal should have established quality control system and organization to ensure quality of the product and should be an ISO 9000 certified company or should have an internationally certified quality control system.

3. **SCOPE OF WORK:**
   Fitment of vacuum toilet in existing lavatory module shall be interfaced with existing IR-DRDO bio-digester already fitted by Indian Railways in LHB type coach. Supply, Installation and commissioning of complete system will be in the scope of tenderer.

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3.1. The main system components of the supply would be:

a) Lavatory pan/ bowl (Indian squatting/ Western design).

b) Vacuum toilet system and pressurised flushing arrangement including interfacing for supplies like water & compressed air etc.

c) PLC/ Microcontroller/ Microprocessor based pneumatic/electro pneumatic Control panel and associated accessories for the system operation.

d) Associated plumbing & water hoses, pneumatic piping and electrical wiring etc.

e) Any other material and interface required with existing coach systems to make the vacuum toilet fully functional & operational without any constraints.

Note: IR-DRDO bio digester tank is not part of scope of this specification. However the system supplied must interface with existing design of bio digester tanks for different coaches.

4. TECHNICAL REQUIREMENTS

4.1. Vacuum toilet system shall be installed within the space envelope earmarked. The space envelope for control panel and tank location etc. of LHB type coaches is shown in RCF drawing No. MI005426 & MI005710 respectively.

4.2. LHB type coaches have different combination (Indian squat pan type and western commode type) of toilets having 2, 3 or 4 toilets. Bio-Vacuum toilet system should be suitable for application on all LHB type coaches. Its fitment should be done without losing coach / lavatory module aesthetics and ensuring serviceability however, minor changes may be necessary while installation of prototype, which shall be ensured during regular supply.

4.3. The vacuum evacuation system shall be designed such that it sucks out the waste from each toilet with minimum use of water into the Bio- digester tank installed under the carriage. The toilet system shall be isolated from the bio-tank to avoid bad odour in the passenger area.

4.4. The toilet system should be of robust design, reliable, safe, simple to operate and passenger friendly and require minimum maintenance. It has to be a proven design, suitably modified to match Indian condition and passenger habits.

4.4.4.5. It shall be ensured that bio-vacuum toilet shall remain usable as normal bio toilet and isolated from bio tank, in case of non-availability of pressurized air and / or electrical power. In such case, It shall also be ensured that gases / odour generated in bio digester does not enter in toilet room in any situation. Same flush button / knob should work as By-pass flush to work as normal bio-toilet.

4.5.4.6. The design of the toilet system should have protection from pilferage and Components used in vacuum toilet system shall be made of corrosion resistant material.
4.6.4.7. The equipment should neither impede free movement of the bogies, nor the routine inspection & maintenance of various bogie/coach sub-assemblies. To ensure this the system should be contained within the space envelop as mentioned earlier.

4.7.4.8. The maintenance requirement of the toilet system should be clearly spelt out by the supplier.

4.8.4.9. The system should be able to handle normal waste and even some foreign objects thrown in and which are smaller than the toilet bowl outlet hole (such as bottle caps, napkins, plastic bags & cups etc.) either by segregating or suction by the pump into the tank.

5. OPERATING CONDITIONS

All parts of the bio vacuum toilets installed under the carriage shall be atleast 225 mm above the head of rail level and it shall not restrict the free movement of bogies or the periodical repair-maintenance work.

All mechanical, pneumatic, hydraulic, electrical and electronic components of the vacuum evacuation system shall operate under the following conditions without any problems.

5.1. Ambient Conditions:

(i) Altitude: Sea level to 2500m
(ii) Operating temperature: 1°C to 55°C
   Max. Temperature under Sun: 70°C
(iii) Relative humidity: upto 95%
(iv) The rainfall is fairly heavy.
(v) During dry weather, the atmosphere is likely to be dusty.
(vi) Temperature variations can be quite high within range specified in the same journey or short period of time.
(vii) Coaches operate in coastal areas with continued exposure to salt laden air.
(viii) Coaches may be subjected to frequent external washing with detergents and cleaning of toilets by cleaning agents.

5.2. Car-body dynamics:

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

   a. Maximum vertical acceleration                 1.0g
   b. Maximum longitudinal acceleration             3.0g
   c. Maximum transverse acceleration              2.0g

5.2.2. 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.
5.2.3. In the direction corresponding to the longitudinal movement of the vehicle, the equipment is subjected for 2 min. to 50 Hz. Vibrations of such a value that the maximum acceleration is equal to 3g.

5.2.4. LHB type coach length over coupler is approximately 24 meters.

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

i) Vertically- ±100 mm  
ii) laterally - ±55 mm  
iii) longitudinally- ±10 mm  
iv) bogie rotation about center pivot- ±4°  
v) Maximum Speed of train - 160 KMPH

6. **SYSTEM INTERFACE AVAILABLE**

6.1. **Water Supply:**

i. There is one tank of 30 ltr capacity available over each toilet at a height of about 2030 mm from toilet floor in air conditioned coaches. Water is pumped to these from under-frame mounted main water tanks. Water flow to the flushing valve is by gravity. These tanks are not pressurized and the water flow from these tanks is by gravity.

ii. For Non-AC LHB coaches tank of 390 liter approx. is available at the same height.

6.2. **Pneumatic Supply:**

i. A limited quantity of air supply of around 15 lit/min/Per Coach can be made available connected to feed pipe at 6 kg/cm² with provision of one 75 ltr. reservoir in the coach exclusively for toilet system.

ii. It is desirable that at least mMinimum 2 (two) number of normal usages/per toilet are feasible of the bio-vacuum toilet shall be ensured (using 75 liter air reservoir) when the pressurized air supply as specified above is disconnected/ cut-off.

iii. Requirement of compressed air per toilet used and per coach shall be clearly specified by the firm.

6.3. **Power Supply:**

i. 110 Volt AC/ DC power supply is available in all AC LHB coaches. If any power is required, the equipments be so designed to withstand 30% voltage fluctuations. However 110V DC only is available in Non-AC coaches.

ii. AC-DC / DC- DC converter fitted should be able to withstand +/- 30% voltage fluctuations, 2 KVA surge, +/- 10% ripple and **power backup, if**
required, may be provided by supplier ensuring the duty cycle and fitment within the space envelop. All electrical and electronic equipment should be complying with IEC 60571 or any equivalent international standards.

iii. Industrial Grade Components are to be used in all electrical /electronic items.

iv. Total peak power requirement per coach shall not exceed 800 watts.

v. Requirement of power shall be clearly specified by the supplier.

7. DUTY CYCLE:

The toilet should be ready preferably within 01 minute & maximum of 2 minutes after each use. One toilet may be used upto 150 times for defecations in 24 hrs.

8. DESIGN REQUIREMENT

8.1. The system offered must be modular and must be supplied as a complete system to handle human waste as specified. It should take minimum possible time for replacement of modules (Say two to three hours maximum). The supplier should indicate replacement time module wise.

8.2. The technical implications/reasons for capacity rating of important components of the system must be explained in detail by the supplier. Similarly, critical dimensions in the fixing & location drawings shall be clearly indicated by the supplier together with details of all mechanical and electrical interfaces between toilet system and the coach.

8.3. The system should be so designed that day to day maintenance does not require contact with waste by maintenance personnel. Before extensive repairs, complete evacuation and flushing of the system should be possible.

8.4. The supplier must indicate the consumption of power, air, water & cleaning chemical if any, each usage and hourly basis by the toilet system offered.

8.5. Flushing System:

8.5.1. The water consumption shall be minimum {with 0.5 liter (min.) to 0.8 liter (max.) water per flush} for 100% cleaning of the commode or pan. The system should have the facility to adjust water consumption further to a lower or higher value, if required.

8.5.2. The vacuum suction system and the design of toilet bowl should be such that the toilet can be cleaned / flushed properly with minimum possible water consumption as specified above. System should be designed such that it can work satisfactorily with reduced level of normal vacuum level and it should be possible to increase the level of vacuum in case of choking etc.

8.6. Water pressurizing unit

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8.6.1. Adequate pressurised water should be used for efficient flushing of entire toilet bowl through nozzles /Spray Ring for 100% clean bowl/ lavatory pan and at the same time it should also be ensured that fecal matter should not splash during flushing cycle. For this purpose pneumatic / electro pneumatic water pressuriser should be used subject to overall consumption of max. allowable air of 15 Liter per minute /coach.

8.6.2. Water supply for flushing may contain dirt and other suspended impurities. Water filter need to be provided to ensure trouble free operation of flushing system. Maintenance free and leak proof Isolating valve is to be provided for filter cleaning.

8.7. TOILET PAN/ BOWL /Trough Floor

8.7.1. In Western commode toilets, material of toilet bowl shall be stainless steel to AISI 316L or better grade with surface finish no. 7 or better of IS:6911-92 Tab. No. 8. Toilet bowl should have strong mounting and fittings to the coach interface. Design of western commode shall be similar to RCF drawing no. LS63117.

8.7.2. Toilet seat and seat covers of WC shall be non-metallic and will be made of Nylon or a superior Non Metallic material suitable for intended use with ruggedness. Height of the seat may be 400 to 425 mm above the toilet floor.

8.7.3. Requirement of Indian style toilet pan shall be similar to RCF Drawing no. LE63202 alt. 2 or latest of stainless steel to AISI 316L or superior. Drawings referred in the specification are representative in nature. Purchaser may ensure the issue of applicable drawings.

8.7.4. The diameter of the toilet bowl outlet hole should be 35 to 45 mm optimal to fulfill the requirements of clause No. 4.5 & 8.10 of this specification and shall be so designed as to prevent any obstruction in outflow of waste. The waste should never be visible or flow backwards into the bowl even in cases of malfunctioning.

8.7.5. The toilet system must be provided with an effective sealing arrangement of a proven design to ensure the sealing of odour from the waste tank to the toilet room. This condition must be satisfied not only during normal operation but also when there is loss of air or power or both.

8.7.6. Western/Oriental bowls shall be equipped with level sensor / any other sensor in the system to avoid flooding due to any circumstances of blockage in the system. By sensing the water level, the system should render to idle till it is rectified.

8.7.7. In case of malfunctioning of the toilet the indication shall be provided so that the passengers refrain from using it.

8.8. BIO DIGESTER TANK

8.8.1. Bio digester tank shall be provided by the railway authorities to the applicable design for LH and RH side. Vendor / supplier shall be required to
ensure that they have acquired sufficient know how of IR-DRDO bio digester for interfacing vacuum toilet to the existing bio digester.

a) Interface System with bio digester should be so designed and manufactured that no unprocessed waste should spill, leak or overflow from the waste retention tank either during run or during maintenance in Depot. It should also not allow foul smell to come out.

b) Details of mounting arrangement to be worked out by supplier in consultation of purchaser with clearly indicating the scope of work.

8.8.2. List of Drawings applicable for provision of IR-DRDO bio digester in LHB type coaches are attached as annexure 1. Drawings listed at annexure 1 are for reference purpose only, Intellectual property rights of Designs /Drawings shall remain with Indian Railways.

8.9. CONTROL PANEL

The system is to be designed with PLC/ Microcontroller/ Microprocessor based Electro Pneumatic Control panel which will also provide indications for easy maintenance of the system and shall fulfill requirements of para 8.9.2.

8.9.1. The Control panel should be modular and plug in type for easy fitment and maintenance and shall be fitted inside the coach. The supplier shall indicate its size, location and fixing arrangements suiting to existing provisions made in lavatory module and coaches. The control panel should be provided in the space mentioned in the RCF drawing no. MI005425 alt. Nil.

8.9.2. PLC/ Microcontroller/ Microprocessor Control panel unit, should be enclosed insidea sturdy, unbreakable and corrosion resistant box having IP67 protection from dust and water. Control unit and other electronic/electro-pneumatics shall be enclosed in a box with lockable opening doors/ panel (Preferably special tooling for locking and unlocking the panel) A sealed inspection window with polycarbonate glass may also be provided. Entire box should conform to minimum IP54 protection from dust and water. Mounting holes required for box shall be interfaced to the existing studs on lavatory module.

The unit must have the following characteristics:

i. Maintenance friendly modular design

ii. Rugged construction to withstand vibration, heat & dust of IR coaches

iii. Control panel should have provisions to allow adjustment of variables such as air supply / pressure, vacuum level, flush water volume and pressure etc. by authorized persons only.

iv. All electrical and pneumatic devices and connections on control panel should be plug in type.

v. All the electronic module of Control Panel should confirm to IEC 60571 or any equivalent international standards. Industrial Grade Components shall be used in all electrical/electronic items.
vi. Manual override switch in the control panel be provided to operate the valves in case of emergency.

vii. Control panel should be able to provide alarm signals /indications with sufficient memory to log all important events along with date and time stamp of last 6 months in case of the following cases. System should have facilities to generate text report of the recorded data and transfer through USB or Removable storage media. If there is requirement of specific software for data transfer viewing, the same is to be provided by the supplier.

   a. Failure of Compressed air supply
   b. Failure of Water supply / shortages
   c. Indication of Electrical supply
   d. Vacuum failure and blockage in the system

   viii. Other standard communication port such as RS485 etc. may also be specified by PUs/ZRs for interfacing with SMART coach system (Optional).

8.10. VACUUM GENERATION

8.10.1. Reliable and easily maintainable ejector should be used for vacuum generation to achieve optimal capacity with least possible air consumption. Minimum 34% vacuum level (i.e. 500 mmHg vacuum) should be achieved after each cycle of flushing and system should be ready within two-one minutes of each cycle, however supplier shall ensure that all the waste from the toilet bowel shall be transferred efficiently without clogging. The minimum evacuated air volume shall be at least 3.5 liters. (Evacuated air volume is the air extracted from the transfer tank during each flush).

8.10.2. An odour filter should be provided to prevent foul smell when the ejector is activated. The filter should be suitably located for easy replacement.

8.10.2. Alternatively any other method for vacuum generation (Minimum 34% vacuum level i.e. 500 mmHg vacuum) may also be accepted subject to compliance of functional, operational and technical requirements of this specification.

9. TESTING AND APPROVAL

9.1. The supplier shall submit the details of the toilet system including layout drawings, interfaces required, integration requirement, operation and maintenance manual, Quality assurance plan, including requirement of spares and consumables for approval of approving authority (Production Units / Zonal Railways).

9.2. Already approved suppliers to this specification shall be exempted to clause no. 9.3.

9.3. Prototype Approval:

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SSE Design/ Carriage
Prepared By

Praveen Kumar
Dy. Director/ Carriage
Checked By

Sanjeev Garg
Director Carriage
Approved By
9.3.1. Prototype approval of the toilet system (01 Western style and 01 Indian Style) will be done by approving authority (Production Units / Zonal Railways). Prototype approval shall be followed by actual fitment and service field trial on coaches as per clause no. 9.3.4.

9.3.2. All moving parts of the system specially the stench trap system, water & pneumatic valves are to be tested up to a minimum 50,000 cycles of continuous trouble free operation. The supplier / OEM's of the valve manufacturer may do this test in consultation with Production Units / Zonal Railways for which trial scheme be submitted and got approved by Production Units / Zonal Railways and test certificate should be submitted before approval of the prototype.

All the Test certificates shall also be submitted by the supplier/OEM’s for testing of all the critical components/assemblies of vacuum toilet. These test certificates should contain details of test conducted and measurements recorded.

9.3.3. Following parameters will be checked during prototype approval:

I. Dimensional check
II. Air & water pipelines connections.
III. Working of system controls & indications.
IV. Odour sealing arrangement.
V. Water consumption per flush.
VI. Functional check of the flush cycle.
VII. Demonstration / testing of vacuum generation as per clause no. 8.10.
VIII. Any other tests considered necessary.

9.3.4. After successful prototype approval, 05 coach set each of (01 Western type and 03 Indian Style) complete toilet system shall be installed & commissioned by the manufacturer / supplier for field trials of at least 03months before bulk supply.

Vendors having developmental orders and not covered under clause no. 2.1 of this specification shall require 12months field trials in place of 03months.

9.3.5. Field trials shall be jointly monitored by Zonal Railways/PUs and concerned supplier in association with RDSO as per trial scheme finalized for this purpose. Criteria for successful completion of field trial shall be elaborated in trial scheme.

9.3.6. Performance monitoring of the coaches fitted with prototypes will be done in actual train service for a minimum period of 03months (for vendors under clause no. 2.1) / 12months (for vendors under clause no. 2.2) with an objective to monitor the following:

a) Proper & leak free connections in the complete system including air, water pipelines and interface piping up to retention tank.
b) Proper working of system control & indications.

c) Proper stench trap and no odour passing through to the toilet room from the bio digester tank.

d) Functional check of the flush cycle.

e) Proper functioning of the complete system including cleanability & maintenance of hygiene.

f) Details of attention /maintenance requirement with coach number, date and time.

10. MARKING

10.1. Manufacturer's name plate with 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.

10.2. Bright coloured push button for flushing / operation cycle shall be provided with description in bold letter and graphic symbol for ease of passengers.

11. DOCUMENTATION AND TRAINING

11.1. Following the acceptance of the prototype, contractors shall provide technical manuals as given below about the vacuum toilet systems in English. The information should be both printed and in electronic format and shall be provided to IR.

   I. Operating and maintenance instructions
   II. Schematic diagrams of Installation & commissioning and their instructions
   III. Schedule of operatingon principles.

11.2. List of Do's and Don'ts for operation of vacuum toilet shall be provided by supplier fixed at mutually agreed suitable location of the toilet, to match with look and feel of other signage provided in the toilet.

11.3. 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 shall also be able to deliver optional testing equipments for supplied toilet system.

12. WARRANTY AND SPARES

12.1. Firm shall be liable for warranty of 42 months from the date of supply or 3672 months from the date of fitment, whichever is earlier. During warranty, the supplier shall rectify the equipment by repairing or replacing components with original spares at his cost. The warranty period would get extended on a pro-rata basis if warranty repairs / replacement are not provided within 05 03 days (72 hours) of notice. If supplier fails to provide warranty within 05 03 days (72 hours) of notice, Railway reserves the right to take action as per extent extant rules.

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12.2. Supplier shall ensure the availability of spare parts of the supplied system for a period of at least 10 years.

13. **ANNUAL MAINTENANCE CONTRACT (AMC)**

13.1. The firm should submit separate offer for comprehensive AMC for 9–12 years after end of the warranty. In case the user Railway wants to operate the Comprehensive AMC, firm shall follow the rates quoted in the tender. To meet the operating requirements of the Indian Railways, firm shall provide pan-India service unless otherwise specified in the tender conditions.

13.1.13.2. AMC offer should include the list of the spares (indicating Make/OEM) and their recommended frequency of replacement, cost etc.

**Annexure-1**

Drawings listed for Lavatory module of LHB type coaches are for reference purpose only, Intellectual property rights of Designs /Drawings shall remain with Indian Railways.

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**Signature**

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<th>Checked By</th>
<th>Approved By</th>
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<td>Sanjeev Garg</td>
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<td>SSE Design/Carriage</td>
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**Note:** All the drawings should be read with latest alteration applicable only.