Chapter I: Introduction

1.1 Introduction

Indian Railways (IR) run about 13,313 passenger trains with a large fleet of 54,506 coaches (including Diesel Electric Multiple Unit/ Diesel Hydraulic Multiple Unit) carrying 22.21 million passengers daily throughout its network of 1,19,630 track kilometers[1]. The toilet system conventionally used in passenger coaches of IR is flush-type. This involves untreated human waste (night soil) being discharged directly onto tracks and platform aprons. As a result, there is organic pollution and un-hygienic environment at Stations causing inconvenience to passengers and difficulty in proper maintenance of tracks.

IR started efforts in 1993 with limited trials with biological toilet system imported by Integral Coach Factory (ICF) from the United States of America (USA), fitted in six Broad Gauge/ General Sleeper and two AC II tier coaches in Southern Railway (SR). Controlled Discharge Toilet System (CDTS) was introduced on IR in May 2000 with design of bottom slide valve. This valve opens and discharges waste on the run when the train speed reaches 30 kmph. Discharge takes place away from the stations, thus helping in keeping the stations clean.

In November 2009, Railway Board set up a Core Group to decide suitable environment friendly toilets for use in IR by carrying out feasibility studies, techno-economic analysis and drawing up an Action Plan for implementation of environment friendly toilets. The Core Group recommended (January 2010) amongst others[2], adoption of the bio-digester technology for development of suitable bio-toilets to be fitted in passenger coaches. The *'bio-digester*' is a technology developed for disposal of human waste in an eco-friendly manner. This technology was developed by Gwalior-based Defence Research and Development Establishment (DRDE) and Tezpur-based Defence Research Laboratory (DRL). A *'bio-toilet'*, (using bio-digester technology) is an eco-friendly waste management solution which reduces solid human waste to bio-gas and water with the help of a bacterial inoculum through biological degradation of human waste. The advantages of bio-toilets are:

- Elimination of direct discharge of human waste from coach toilets onto railway tracks and platform aprons in stations; and
- Avoiding manual scavenging while cleaning platform aprons and trains

[1] As on 1 April 2016, Source: IR Year Book 2015-16
[2] Zero Discharge Toilet System, Vacuum toilet system, trial of new technologies/products not tried in past

In March 2010 IR entered into a Memorandum of Understanding with Defence Research and Development Organization (DRDO) to work jointly for development of a bio-toilet system for use in passenger coaches. The bio-toilets developed by IR and DRDO, have a colony of anaerobic bacteria[3], kept in a container under the lavatories that convert human waste into water and a small amount of gases. These gases are released into the atmosphere and the water is discharged on to the track after disinfection. A Joint Working Group (JWG) comprising of IR Engineers and DRDO bio-technologists was formed in March 2010 for joint development of technology using DRDE bio-digester for toilet system on coaches of IR. First prototype rake, fitted with IR-DRDO bio-toilets (hereafter called *bio-toilets*) turned out from Rail Coach Factory (RCF), Kapurthala was put in service in January 2011 in the Gwalior-Varanasi Bundelkhand Express.

Campaigns against open defecation have gained momentum the world over. International organizations advocate immediate eradication of open defecation. The Government of India (GoI), aided by partners like UNICEF, is looking at the challenge of open defecation very seriously. GoI launched the Swachh Bharat Mission, a cleanliness drive in the country on 2nd October 2014. GoI has a target to make India 'Open Defecation Free' by 2019. Speeding up the process of induction of eco-friendly toilets in passenger coaches would improve cleanliness and the image of IR. Taking forward, the momentum on 'Swachh Rail, Swachh Bharat', IR has given a commitment to induct bio-toilets in all coaches by the Year 2019, for which every year minimum 50,000 bio-toilets have to be fitted in passenger coaches.

1.2 Earlier Audit coverage

A comment on providing environment friendly coaches with CDTS was included in C&AG's Report No. 6 of 2007, Chapter 2 'Cleanliness and Sanitation on IR'. The Public Accounts Committee (PAC) in their 83rd report (2008-09) recommended expediting the process of up-gradation of toilets in trains. In their Action Taken Note (ATN), Ministry of Railways (MoR) stated (October 2013) that field trials were being conducted with different designs/ types of environment-friendly 'Green Toilets' and based on those trials, a final view would be taken.

A comment on delay in developing a suitable model of toilet for passenger trains for the Indian environment was made in C&AG's Report No. 11 of 2013. In the Action Taken Note, MoR (September 2014) stated that IR-DRDO type bio-toilets were found to be the most promising to suit IR's service conditions. Based on the performance, these IR-DRDO bio-toilets were being proliferated over IR.

[3] Bacteria which does not require oxygen to work

Ministry further stated that total 7295 bio-toilets had been fitted in 2,774 coaches till 31 December 2013 for trial purposes and the following strategies were adopted by IR to increase the pace of fitment of bio-toilets:

- Fitment of bio-toilets in all new coaches manufactured by ICF, RCF and Bharat Earth Movers Limited (BEML),
- Speeding up fitment of bio-toilets during Mid-Life Rehabilitation (MLR),
- Gear-up for retro fitment of bio-toilets during Periodic Overhauling (POH) of passenger coaches, and
- Streamlining the supply chain of bio-toilet materials, etc.

Subsequently, evolution of environment friendly toilets was highlighted in C&AG's Report No. 21 of 2012-13 - 'Environment Management in IR', Chapter 4 Waste Management. In their Action Taken Note (ATN), MoR stated (October 2013) that a Joint Working Group (JWG), consisting of IR's Mechanical Engineers and DRDO's bio-technologists was dedicated to the successful development of bio-toilets. Ministry further stated that from 2016-17 onwards, all new coaches would be inducted with bio-toilets and they would cover the entire fleet by 2021-22. Earnest efforts were being made to eliminate direct discharge system from passenger coaches. MoR also added that teething problems of this new technology were being regularly addressed and the pace of fitment of bio-toilets was being accelerated.

Minister of Railways (MR) in his Budget speech in July 2014 stated that bio-toilets would be increased in sufficient numbers in trains in order to mitigate the problems of direct discharge of human waste on the tracks and platform aprons at Stations. In his Budget speech in February 2015, MR further stated that the condition of toilet facilities in our stations and trains needed major improvement for which bio-toilets are being fitted in coaches. In his Budget speech in February 2016, the MR stated that in pursuance of our mission 'Swachh Rail Swachh Bharat', 17,000 bio-toilets would be provided in trains before the close of this financial year 2015-16 and 30,000 in the next financial year i.e. 2016-17.

1.3 Organizational Structure

At the apex level, Mechanical Directorate of Railway Board is responsible for introduction of appropriate technology for bio-toilets and monitoring induction of bio-toilets in passenger coaches. Research, Design and Standardisation Organisation (RDSO) is responsible for development and finalization of suitable bio-toilet designs and required accessories thereof and to address design/maintenance issues brought out by Production Units (PUs) and Zonal Railways. General Managers of PUs are responsible for ensuring induction of

bio-toilets in new coaches as per the targets set. General Managers and Chief Mechanical Engineers (CMEs) of Zonal Railways are responsible for ensuring retro fitment of bio-toilets in existing in-service passenger coaches in Workshops and Coaching Depots.

1.4 How bio-toilets works

A bio-toilet is a complete waste management solution which reduces solid human waste to bio-gas and water, with the help of a bacterial inoculum. Human waste is biologically decomposed in bio-digester tanks with the help of anaerobic bacteria. Bio-toilet disposes solid human waste in an eco-friendly, economical and hygienic manner. The residual water from bio-toilet is odourless and devoid of any solid particles, requires no further treatment / waste management.

The working of bio-toilets being inducted in passenger coaches in IR is explained below:

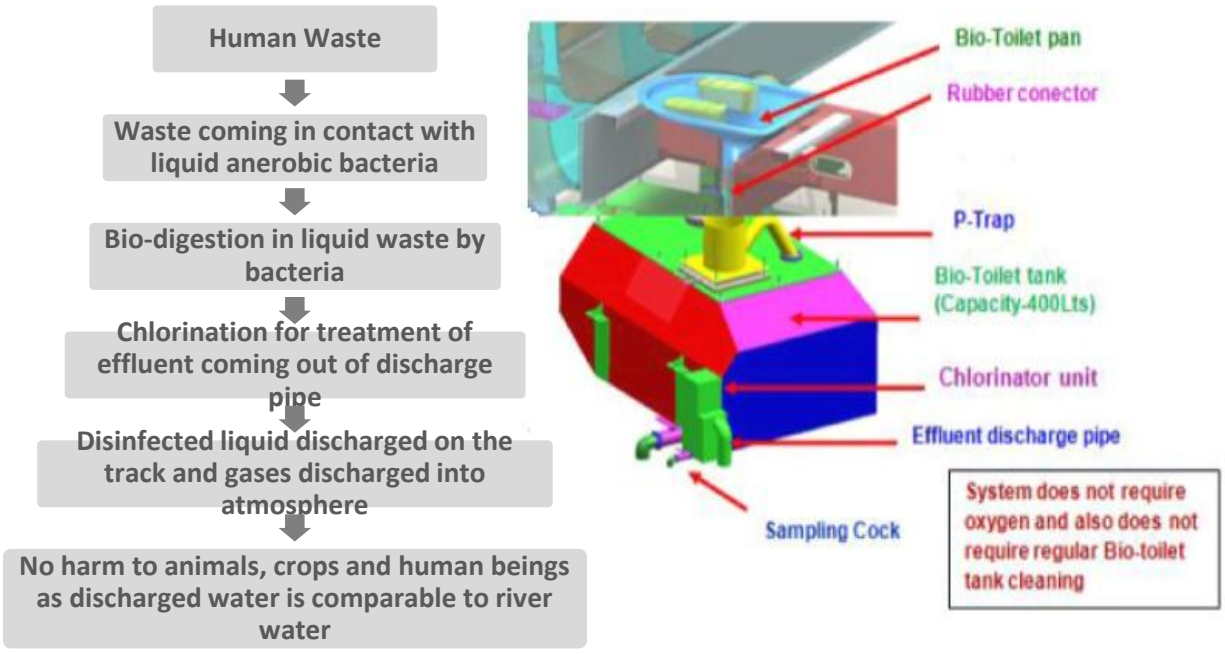

Figure 1: Working of bio-toilets

As can be seen, the faecal matter passes from lavatory pan having diameter of 150/100mm, to bio-tank via rubber connector and P or S trap. Anaerobic bacteria already filled into bio tank, converts faecal matter into water and gas (Co2+ Methane).Water gets discharged on the track after disinfection and gases released into the atmosphere through outlets provided on bio-tanks.

Bio-tank is fitted below the headstock with the help of J/C type of bracket or direct mounting. The following variations in design of bio-toilets are currently in use in IR:

A. On the basis of clamping mechanism for fixing the bio-tank below the lavatory pan
   (i) Direct welding – 'J' brackets
   (ii) Direct welding – 'C' brackets
   (iii) Direct mounting Bolted design – Bio-tank with integral brackets is mounted directly on headstock
B. On the basis of the passage for discharge of faecal matter from the pan to bio-tank
   (i) 'P' trap type
   (ii) 'S' trap type
C. On the basis of ball-valve opening mechanism, provided to facilitate direct discharge in case of choking of the toilet.
   (i) Lever
   (ii) Rack & pinion
   (iii) Wire rope & pulley arrangement
D. On the basis of size of discharge diameter of the lavatory pan
   (i) 150mm
   (ii) 100mm

While recommending large scale proliferation of bio-toilets in passenger coaches in November 2011, JWG also recommended that all the units (PUs and workshops) should follow the same standardized design of bio-toilets, so that universality may be ensured. For bio-digester procurement, RCF drawing developed on the basis of key design drawings issued by RDSO may be followed. It was seen that JWG in July 2013 suggested that RDSO may standardize the opening size of pan and P-trap, ball valve design, dust bin and opening and closing mechanism. However, a variety of designs with respect to pan size, ball valve, opening/closing mechanism of valve, design of connector between pan and p trap etc. continue to be deliberated in various monitoring meetings and are yet to be standardized. Provision of dustbin inside the toilet was recommended by JWG in 2ndmeeting held in April 2011. In 7th meeting held in October 2012, JWG recommended that RCF and ICF were to prepare design of dustbin inside the lavatory as per guidelines issued by Railway Board and submit to RDSO for standardization. The design of dustbin could be finalized only by November 2013.

As of March 2017, the design and development of bio-tanks was yet to be finalized for BEML coaches, coaches of tourist trains like Maharaja Express and Deccan Odyssey, SLRs/Railway Administration coaches, MEMU/TC, retrofitment of LHB coaches and LHB Double decker coaches, DEMU and DHMU, and retrofitment of ICF types coaches fitted with CBC and CDTS.

1.5 Audit Objectives

The Audit was conducted with a view to assess:

1. Whether IR has been able to adhere to the Action Plan and achieve the targets set for induction of bio-toilets in passenger coaches and implementation of Green Stations and Corridors? and
2. Whether the supply of bio-tanks and other materials and infrastructure required for induction of bio-toilets was adequate?
3. Whether Coaching Depots and Workshops were able to ensure proper maintenance and upkeep of bio-toilets in passenger coaches?

1.6 Audit Criteria

The various sources from where we derived the Audit Criteria for this review are as follows:

- Budget speeches of Minister of Railways,
- Recommendations of Public Accounts Committee on related topics,
- Railway Board Orders/Circulars on introduction, development, induction, maintenance and upkeep of bio-toilets and its accessories,
- Handbook brought out by CAMTECH[4] on IR-DRDO bio-toilets for Open Line maintenance,
- Guidelines for POH of coaches fitted with Bio-toilets issued by CAMTECH
- Compendium on IR-DRDO bio-toilets for IR issued by CAMTECH,
- Guidelines on bio-tank for IR brought out by RDSO,
- Orders/Instructions issued by Zonal Railways on implementation/ induction/ retrofitting of bio-toilets; and
- Minutes of the meetings held by the Joint Working Group.

1.7 Audit Scope, Methodology and Sample Size

The audit review covered a three-year period from 2014-15 to 2016-17. Audit methodology included examination of records at Railway Board, Zonal Railway Headquarters, Workshops undertaking periodic overhauling of passenger coaches and Coaching Depots, where coaches with bio-toilets are being maintained. Joint Inspections of selected trains and Green Train Stations were undertaken with Railway officials to study the status on ground. A Passenger Survey Questionnaire was also administered to selected passengers to record user perception and experience of bio-toilets fitted in passenger coaches.

Relevant records of three PUs, 27 Carriage Workshops, 32 Coaching Depots, RDSO and six Green Train Stations were examined. Further, joint inspections with Railway Officials on-board 33 selected Mail /Express trains were conducted and passenger survey carried out to ascertain their opinion about the bio-toilets fitted in passenger coaches.

[4]Centre for Advanced Maintenance and Technology, Gwalior

Table 1 - Details of sample selected for review				
S. no	*Details of units*	*Total population over IR*	*Sample size*	*Sample selected*
A	*B*	*C*	*D*	*E*
1	Production Units	Three	100 *per cent*	1. Rail Coach Factory, Kapurthala, 2. Integral Coach Factory, Perambur 3. Modern Coach Factory, Raebareli
2	Mid-life rehabilitation Workshops	Three	100 *per cent*	1. Bhopal (WCR) 2. Jhansi (NCR) 3. Parel (CR)
3	Carriage Workshops	25	100 *per cent*	25 POH Workshops
4	Coaching Depots	--	2 Major Depots per Zonal Railway	32 Coaching Depots
5	Joint Inspection of Green train stations	Six	100 *per cent*	Six stations – Sri Mata Vaishno Devi Katra, Rameswaram, Machilipatnam, Mysuru, Okha and Porbandar
6	Joint Inspection of trains having bio-toilets	--	Two trains having 100 *per cent* bio-toilets	33 Trains
7	Passenger feedback of trains with bio-toilets	--	25 passengers in each train	825

Details of units selected in the sample are given in **Annexure 1**. Entry and Exit conferences were held in all Zonal Railways. Audit findings and recommendations were discussed with the Ministry of Railways during an Exit Conference in July 2017. Their responses have been duly incorporated in the Audit Report.

1.8 Acknowledgement

Audit acknowledges the co-operation extended by the Railway Board and the Zonal Railway Administrations during the field audit as well as joint inspections conducted.