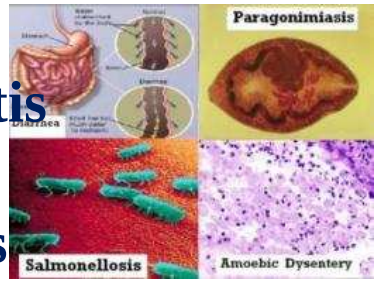
BIO-TOILETS
For
INDIAN
RAILWAYS

Problems of Open Defecation

- **Pollution of fecal matter with drinking water leads to contamination of food, fruits & vegetables, animals (direct contact, flies & rodents)**
  - **Water borne diseases**
    - **Viral gastroenteritis**
    - **Typhoid**
    - **Cholera epidemics**
    - **Diarrhoea (annually kills 5 Lakhs children)**
    - **Viral hepatitis (100 cases per 100,000 people)**
  - **Organic pollution**
  - **Aesthetic nuisance**



World's largest mobile toilet

Indian Railways

- **World's largest rail network more than 80000 km**
- **Runs approx. 10000 trains daily**
- **Approx. 20 million passengers travel by train every day**
- **Approx. 60000 passenger coaches**

The Indian Railways

Stages of Bio-Toilet development

- **Trials of Microphor biotoilets (1993-95) by Indian Railway in AC coaches**
  - **Failure due to**
    - **Foul smell from tank**
    - **Cockroaches & flies infestation**
    - **Clogging of tanks**
    - **Regular dosing with Bacteria and enzymes**
    - **Manual removal of residual solid waste**

- **Trials with Integral Coach factory modified biotoilets (1995-96)**
  - **Failure due to**
    - **Visible fecal matter from the tank**
    - **tanks getting filled non-biodegradable waste**
    - **Foul smell**

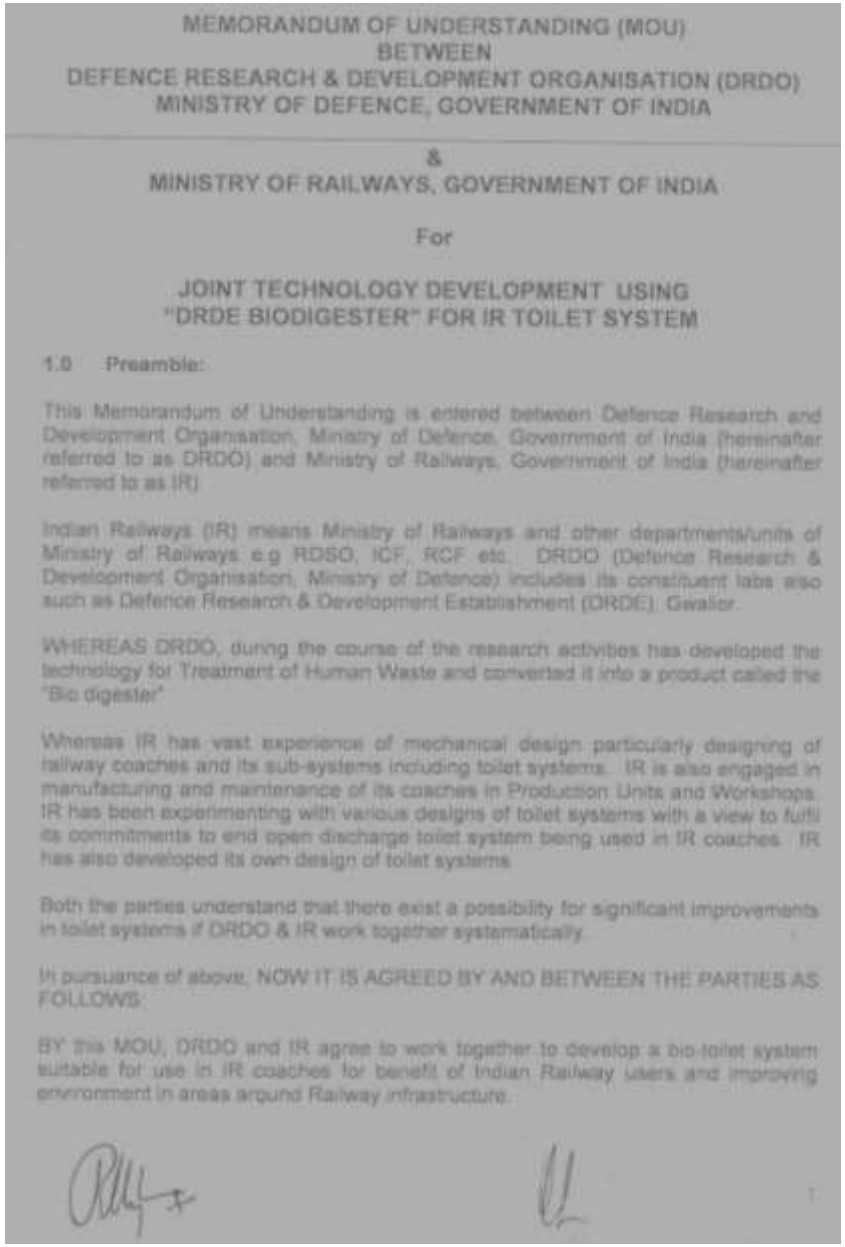
- **Director RDSO approached DRDO in 2004 for the solution in view of the expertise in the field of bioremediation of human waste at low temperature areas**

- **DRDO's Approach**
  - **Laboratory investigation**
  - **Design and fabrication of digester**
  - **Laboratory trials**
  - **Onboard trial in Barauni Mail**

Memorandum of Understanding DRDO - IR

Memorandum of Understanding (MoU) has been signed between DRDO and Ministry of Railways, Government of India

MARCH 09, 2010



MEMORANDUM OF UNDERSTANDING (MOU)
BETWEEN
DEFENCE RESEARCH & DEVELOPMENT ORGANISATION (DRDO)
MINISTRY OF DEFENCE, GOVERNMENT OF INDIA

&
MINISTRY OF RAILWAYS, GOVERNMENT OF INDIA

For

JOINT TECHNOLOGY DEVELOPMENT USING
"DRDE BIODIGESTER" FOR IR TOILET SYSTEM

1.0 Preamble:

This Memorandum of Understanding is entered between Defence Research and Development Organisation, Ministry of Defence, Government of India (hereinafter referred to as DRDO) and Ministry of Railways, Government of India (hereinafter referred to as IR)

Indian Railways (IR) means Ministry of Railways and other departments/units of Ministry of Railways e.g RDSO, ICF, RCF etc. DRDO (Defence Research & Development Organisation, Ministry of Defence) includes its constituent labs also such as Defence Research & Development Establishment (DRDE), Gwalior.

WHEREAS DRDO, during the course of the research activities has developed the technology for Treatment of Human Waste and converted it into a product called the "Bio digester"

Whereas IR has vast experience of mechanical design particularly designing of railway coaches and its sub-systems including toilet systems. IR is also engaged in manufacturing and maintenance of its coaches in Production Units and Workshops. IR has been experimenting with various designs of toilet systems with a view to fulfil its commitments to end open discharge toilet system being used in IR coaches. IR has also developed its own design of toilet systems.

Both the parties understand that there exist a possibility for significant improvements in toilet systems if DRDO & IR work together systematically.

In pursuance of above, NOW IT IS AGREED BY AND BETWEEN THE PARTIES AS FOLLOWS:

BY this MOU, DRDO and IR agree to work together to develop a bio-toilet system suitable for use in IR coaches for benefit of Indian Railway users and improving environment in areas around Railway infrastructure.

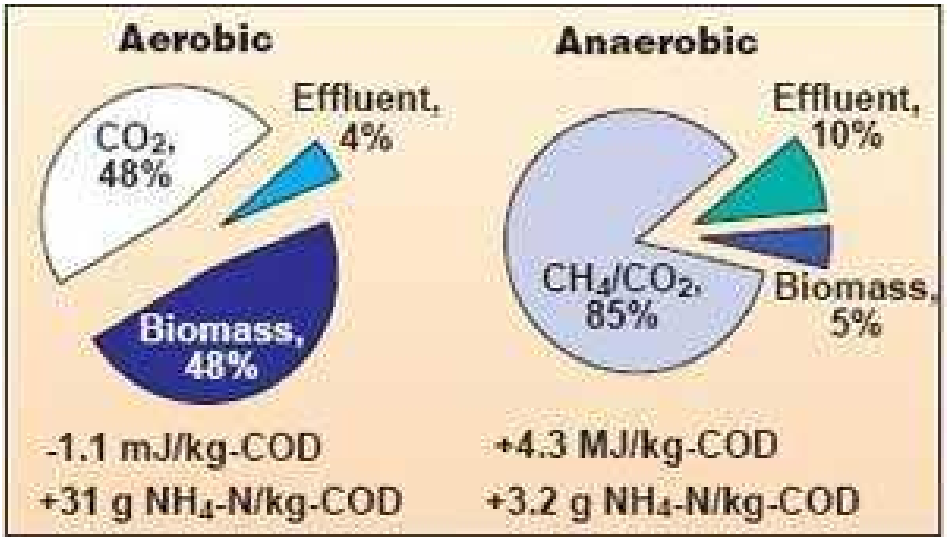
The bio toilets being used in IR are first of its kind in Railway Systems in the world.

The anaerobic bacteria has been carefully collected and analysed by DRDO from Antarctica and the efficiency of this system has been tested by DRDO in extreme climates and conditions like those at Siachen Glacier. The anaerobic bacteria in the bio-designer not only survive extreme cold and heat but also survives when subjected to commonly available disinfectants.

AEROBIC Vs. ANAEROBIC

Aerobic biodegradation	Anaerobic biodegradation
Forced aeration/ agitation is essential and is energy intensive	No aeration is required
Incomplete aeration (partial aerobic condition) leads to foul smell	Complete anaerobic conditions
Can not tolerate detergents/ phenyl	Anaerobes can even degrade detergents/ phenyl
Generates large amount of sludge	Sludge generation is very less
Repeated addition of bacteria/ enzyme is required for the process	One time bacterial inoculation is enough
Maintenance & recurring cost is high	Minimal maintenance & no recurring cost

Aerobic Vs Anaerobic Biodegradation



- **This comparison shows the respective fate of organic materials that are biodegraded under aerobic versus anaerobic conditions**
- **Aerobic treatment requires energy input for aeration whereas a net energy surplus is generated during anaerobic treatment, in the form of methane bearing biogas that can be used for various purposes**

Types of Green Toilets

Bio Toilet

- Discharge processed waste on track

Vacuum Toilet

- Transportation from toilet bowl to tank by vacuum

Zero Discharge Toilet

- Waste is collected at terminus and processed

Benefits of Green Toilet

- Environment friendly
- Preventing damages to tracks due to corrosion
- Improved aesthetics at Railway Stations

First Rake with Bio Toilets

- Bundelkhand Express Since 18th January 2011(Gwalior-Varanasi)

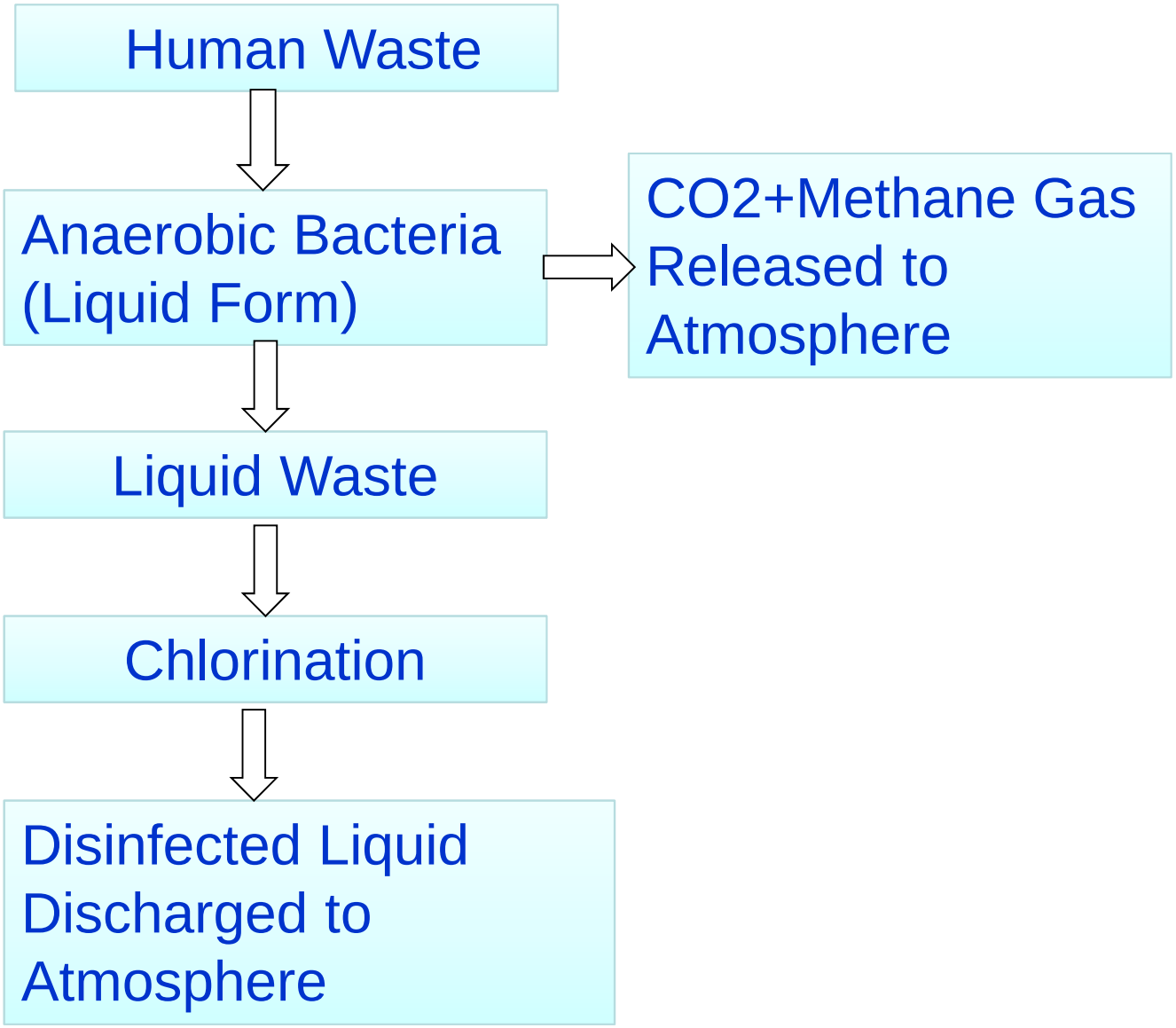
Advantage of Anaerobic Bio-Toilet

- Require less maintenance
- Simple in design
- Easier Retro fitment on existing coaches in service
- Can be in operation up to years together

Advantage of IR-DRDO Bio-Digester

- No bad smell in toilets from the tanks
- No infestation of Cockroaches & Flies
- Fecal matter in the tank not visible
- Effluent is free from off odour and solid waste
- No maintenance required
- Reduction in organic matter by 90%
- No requirement of adding bacteria/ enzyme
- No need of removal of solid waste

Working of BioToilet System(Anaerobic)



Performance Parameters of Bacteria Culture

SN	Parameter	Recommended Values
1	pH	6.5 -7.5
2.	Percentage methane	40-70%
3.	MPN count for methanogens	Max. 1000/ml

Performance Parameters Effluent

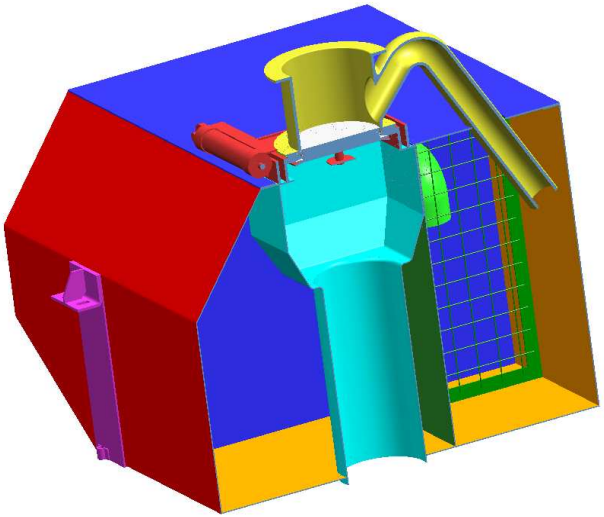
SN	Parameter	Recommended Values	Targeted value (Max.)
1	pH	6 to 9	6 to 9
2	Total Solids	Max 750mg/100 ml	750mg/100ml
3.	Total Volatile solids	Max 500 mg/100 ml	500 mg/100 ml
4	Total Dissolved solids	Max 350mg/ 100ml	350mg/100ml
5	COD levels	Max 2000 MgO_2/ Lts	Max 2000 MgO_2/ Lts
6.	Fecal Coli Forms count	99% Red(Less than 10^8/100ml)	

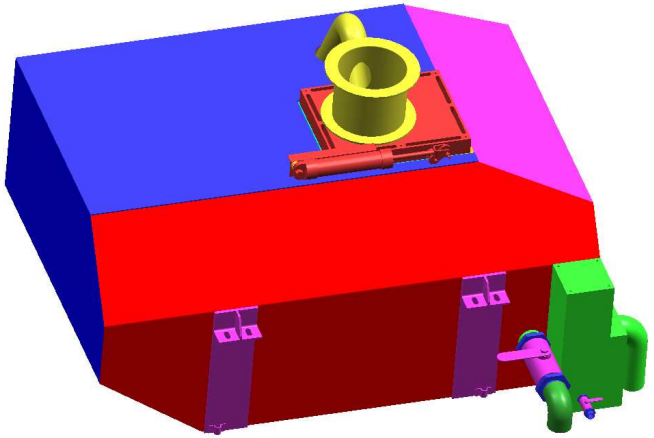
Purpose & Frequency of Effluent Test

Test	Purpose	Freq	Testing Spot
Ph	To measure pH value ensure environmental safety.	90 Days	Railway Lab
TS	To estimate amount of total solids in the effluent.	90 Days	Railway Lab
TDS	To estimate amount of total dissolved solids.	90 Days	Railway Lab
TVS	To estimate amount of total volatile solids.	90 Days	Railway Lab
COD	To estimate COD to ensure environmental parameters.	90 Days	Govt. approved Labs./DRDE
Faecal Coli Forms count	To estimate the faecal coli form bacteria count on effluent.	90 Days	Only in Govt. Labs.

Earlier Variant-01

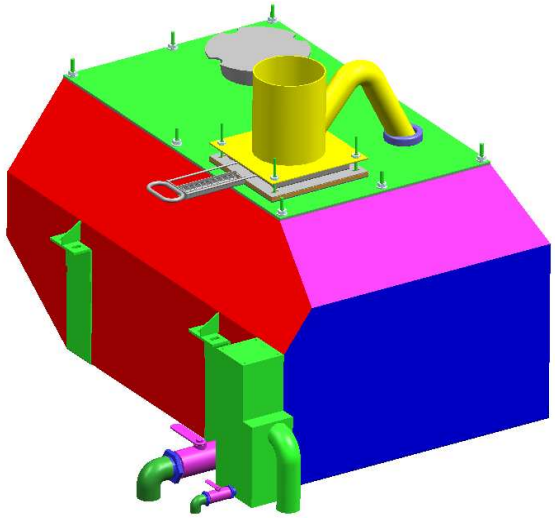
Brief description	Features			
	Pneumatics	Electrics	PLC	Flush
System with flapper valve	Yes	Yes	Yes	Pressurized

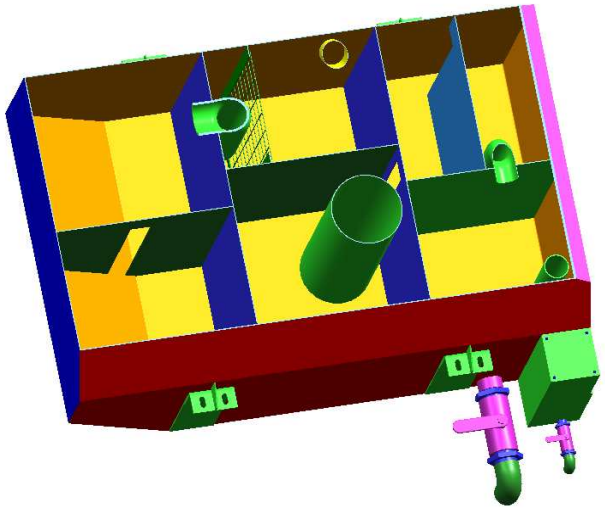




Earlier Variant -02

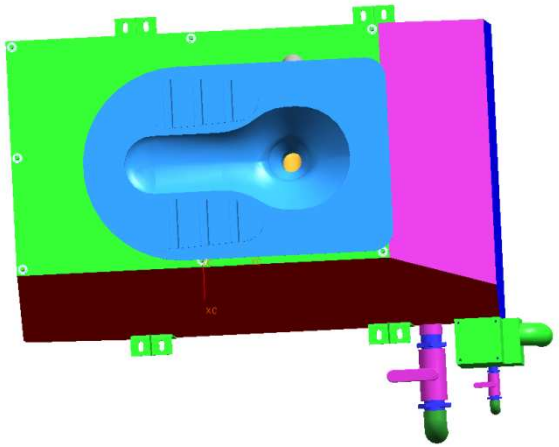
Brief description	Features			
	Pneumatics	Electrics	PLC	Flush
System with manual slider valve	no	no	no	gravity

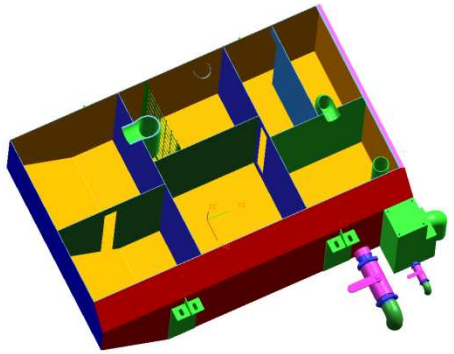




Earlier Variant-03

Brief description	Features			
	Pneumatics	Electrics	PLC	Flush
System with reduced opening at inlet	no	no	no	gravity





Earlier Variant-04

Brief description	Features			
	Pneumatics	Electrics	PLC	Flush
System with solid liquid separator	no	no	no	gravity