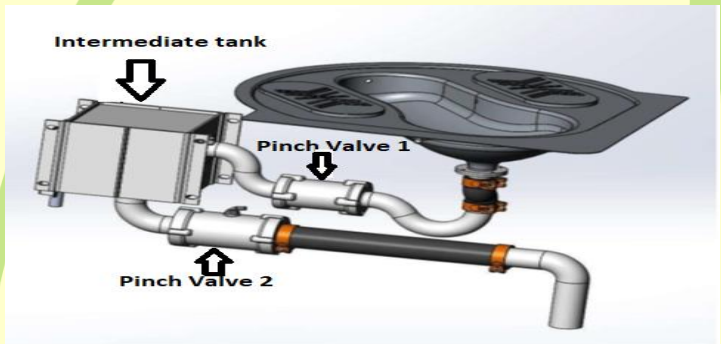




सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

Pamphlet Bio-Vacuum Toilet System



CAMTECH/GWL/M/Bio-Toilet
August 2020

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रेल अग्रवृत्त Transforming Railways



Indian Railways
Centre for Advanced Maintenance Technology

Bio-Vacuum toilet system.

- Bio-Vacuum toilets are integration of vacuum toilet with existing IR-DRDO bio digester. Bio vacuum toilets shall be customised with existing lavatory module being fitted along with bio digester.

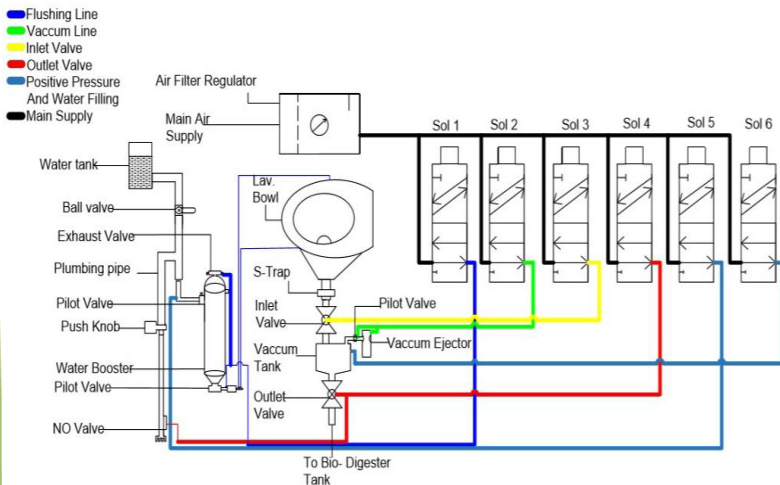
Principle of Working of Bio-Vacuum Toilet System

- 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. The vacuum evacuation is designed in such a way 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 is isolated from the bio-tank to avoid bad odour in the passenger area.

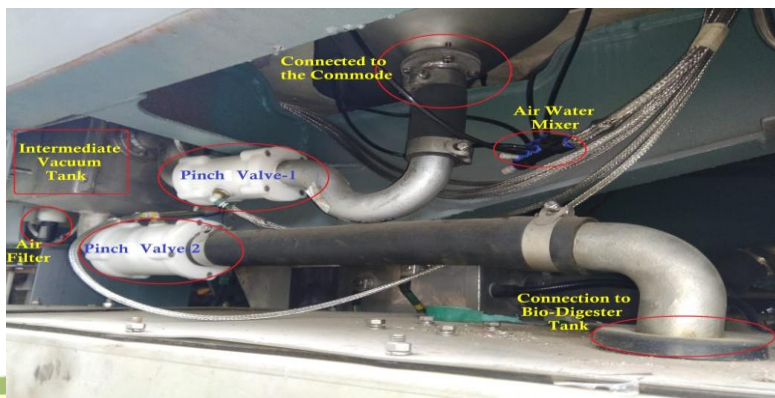
The main component of the system

- Lavatory pan/bowl (Indian squatting/Western design).
- Vacuum toilet system and pressurised flushing arrangement including interfacing for supplies like water & compressed air etc.
- Pneumatic/Electro pneumatic Control panel and associated accessories for the system operation.
- Associated plumbing & water hoses, pneumatic piping and electrical wiring etc.
- Any other material and interface required with existing coach systems to make the vacuum toilet fully functional & operational without any constraints.

Line Diagram of Bio-Vacuum Toilet System.



Actual Layout of Bio-Vacuum Toilet System.



System Interface

1. Water Supply:

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 whereas for non-AC LHB coaches tank of 390 litre is available at the same height. 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.

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 minimum 2 (two) number of usages are feasible when the air supply as specified above is disconnected/cut-off.

3. Power Supply:

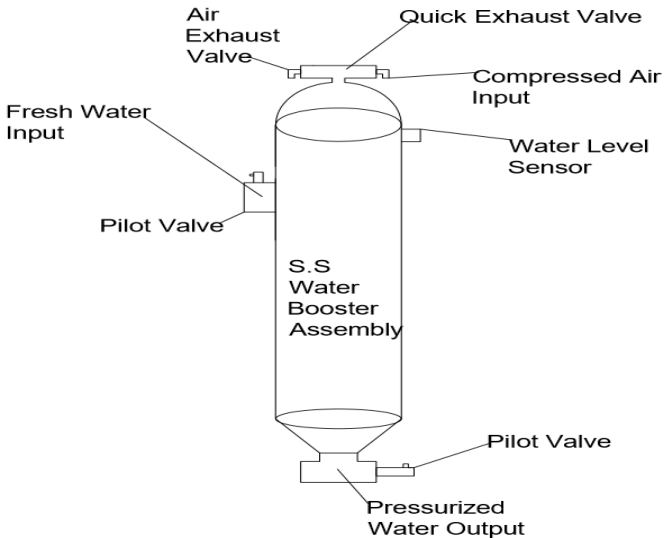
- i. 110 Volt AC/DC power supply is available in all AC LHB coaches. If any power is required, the equipments are so designed to withstand 30% voltage fluctuations. However 110V DC only is available in Non-AC coaches.
- ii. AC-DC / DC-DC converter fitted which is able to withstand +/- 30% voltage fluctuations, 2 KVA surge, +/-10% ripple and complying with IEC 60571 or any equivalent international standards. Total peak power requirement per coach is 800 watts max.

4. Flushing System

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.

5. Water Pressuring Unit

Pressurised water through nozzles/spray ring is used for bowl cleaning. To avoid splashing of fecal matter, pneumatic/electro pneumatic water pressuriser of max. allowable air of 15 litres per minute/coach is used.



6. TOILET PAN/ BOWL /Trough Floor

Bowl of western commode and Indian style toilet pan is made up of SS AISI 316L or better grade with surface finish no.7. RCF Drawing no of RCF of western commode is LS63117 and Indian style toilet pan is LE63202 alt.2.

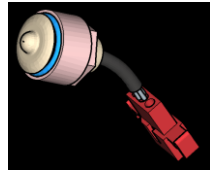
Material	Bowl	Stainless Steel
Weight		Approx. 12.5 Kg
Supplies	Compressed air	4 to 10 bar
	Water	Pressure: 0.2 bar to 1.5 bar Minimum flow rate: 2 Lit/min
	Electrical	24 V DC
External Connections	Mechanical	Mounting holes \varnothing 6.5 mm (8x)
	Compressed air	\varnothing 6 mm
	Water	\varnothing 12 mm
	Outlet	\varnothing 48 mm

6.1 Interfaces of Toilet Pan

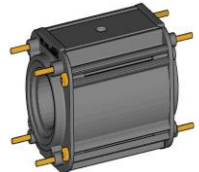
I. Flush Nozzle: - The bowl is equipped with five plastic nozzles that will flush the bowl efficiently. Due to the design and placement of the flush nozzles the water consumption of the squatting is low, just approx. 0.5-0.7L.



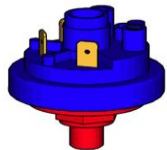
II. Liquid Level Guard: - The optical liquid level guard ensures that the bowl will not overflow. The sensor is activated with a delay to avoid accidental activation during the flush cycle or while cleaning. It is maintenance-free.



III. Pinch Valve: - One Pinch valve is installed into the piping between squatting pan and the intermediate tank and one pinch valve is installed between the intermediate tank and the bio-digester.



IV. Pressure Guard: - The preset pressure guard controls the compressed air supply of the pinch valve. Switching point 300/250 Kpa.

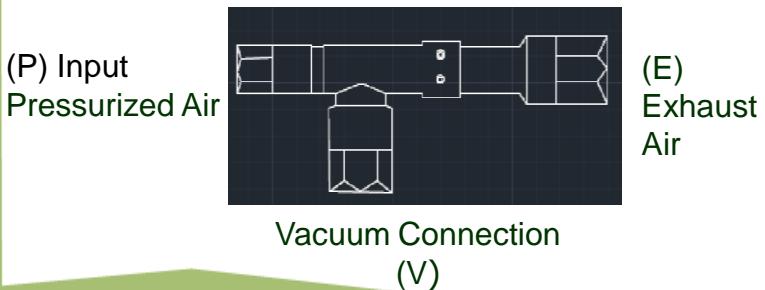


7. Intermediate tank/Vacuum tank:

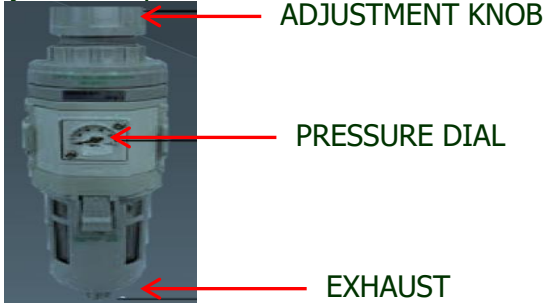
Intermediate tank is the vacuum reservoir and hence is also commonly called as vacuum tank. The negative pressure is generated here which will eventually create suction action in the bowl. This tank is to also hold the waste during the flush cycle which will be flushed out to the waste tank with a positive pressure. The intermediate tank can handle -80KPa of working pressure.



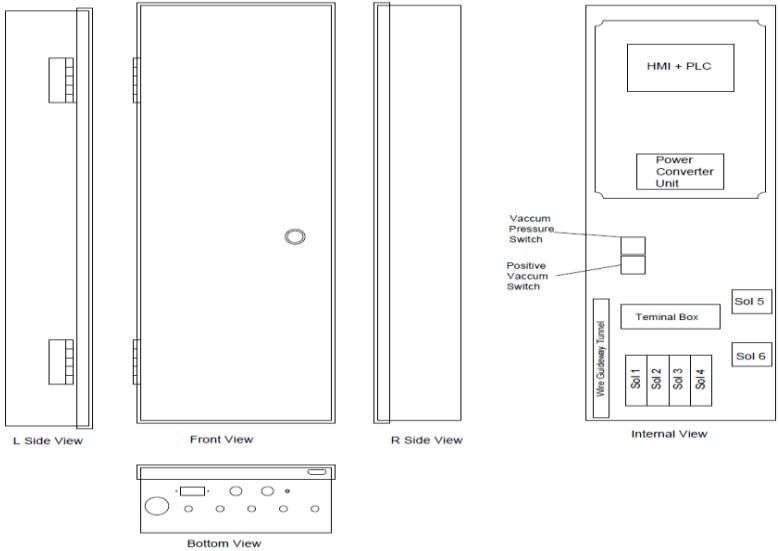
8. Vacuum Ejector:- Generates the vacuum by a flow of compressed air in the vacuum tank. It also exhausts the unwanted gases from the system.



9. Air filter Regulator:- The unit is fitted before the Control panel box and it provides a clean air input to the solenoid valves in the Control panel. This unit also helps to regulate the desired air pressure as per system requirement.



10. Electronic Control Panel:- The control board controls and monitors the functionality of the compact toilet system and consists of a RS-Box, a DC/DC converter, the control unit (STC), an LED board vacuum pressure switch, vacuum pressure switch, pneumatic solenoid valves, digital pressure switch and a Human machine interface(HMI) integrated with PLC. Control unit which designed with the PLC/Microcontroller/Microprocessor Control unit, having IP67 protection from dust. Control unit and other electronic/electro-pneumatics are enclosed in a box with lockable opening doors/panel. The panel is provided in the space mentioned in the RCF drawing no. MI005425.

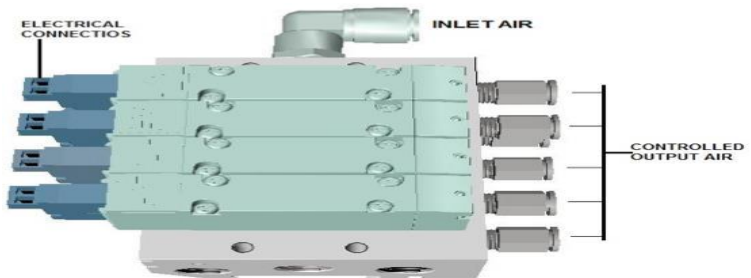


10.1 PLC



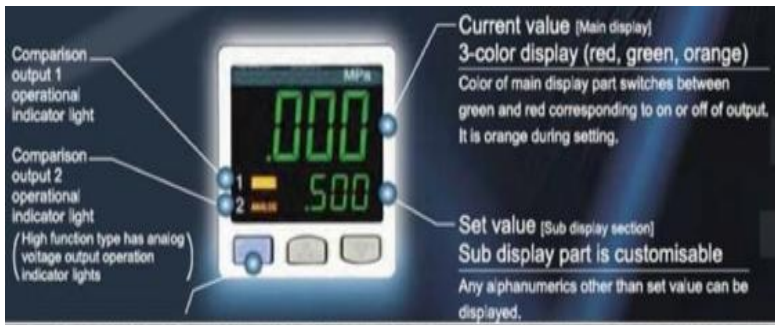
10.2 Pneumatic Solenoid Valves

To generate air flow through the ejector for vacuum to be generated in the intermediate tank. Control of the inlet valve. Control of the outlet valve. Activates the flush valve and the water pressurizer.

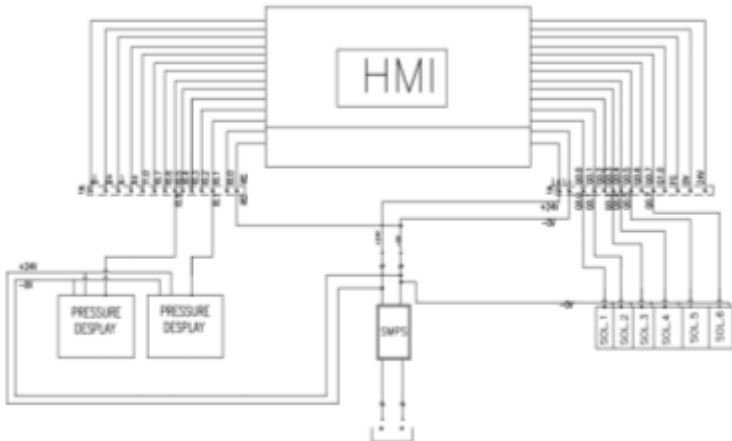


S. N	Technical Parameters	Specifications
1	Input /Supply Voltage	24 V DC
2	Inputs	8
3	Outputs	8
4	Continuous current	10 A with resistive load; 3 A with inductiv load
5	Switching frequency	10 Hz
6	Cycle time	20 sec
7	Display	Yes
8	Programming cable	Ethernet
9	Connection cables	0.5 mm ²
10	PLC to PLC communication (Ethernet)	Yes

10.3 Vacuum Pressure switch

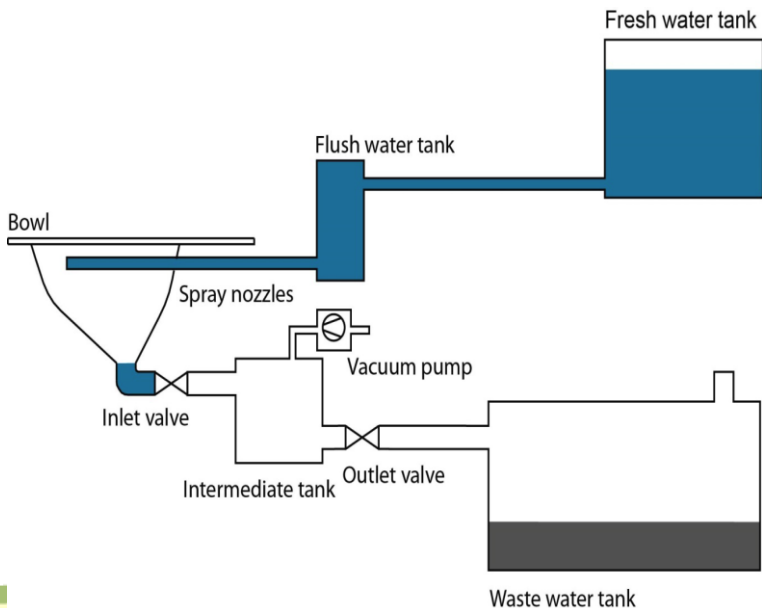


10.4 HMI (with integrated PLC)



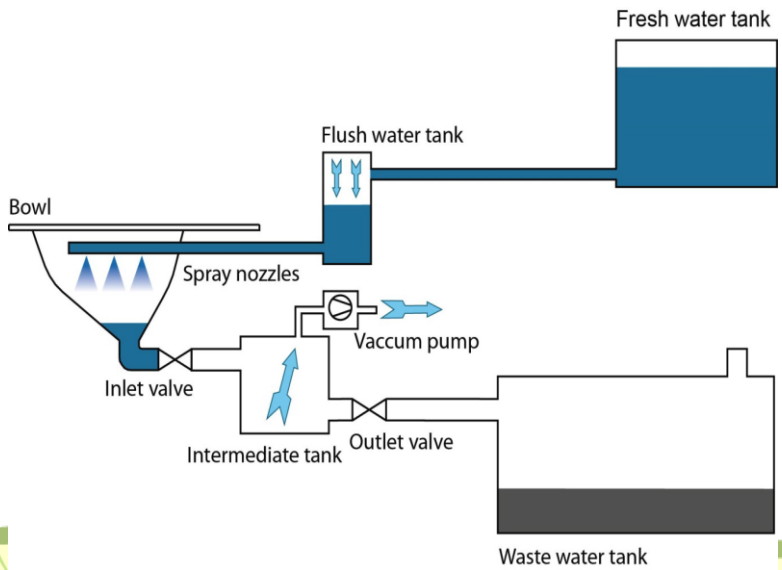
11. Operating Description: - Squatting toilet assembly is designed to transport human waste from the toilet bowl to bio-digester. The complete process is described as follows.

11.1 Stand-By: - In stand-by the squatting bowl is filled with an initial water supply, the flush water tank on the water system panel is filled up and the base unit is empty. Inlet Pinch valve and outlet Pinch Valve are closed and the LED on the flush button illuminates permanently.

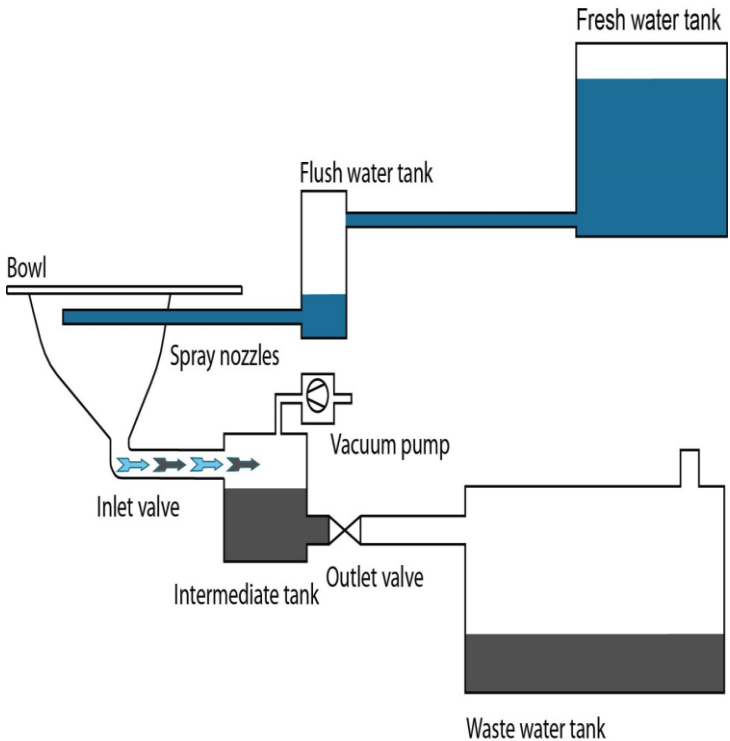


11.2 Flushing the Toilet Bowl and Evacuating the Intermediate tank:

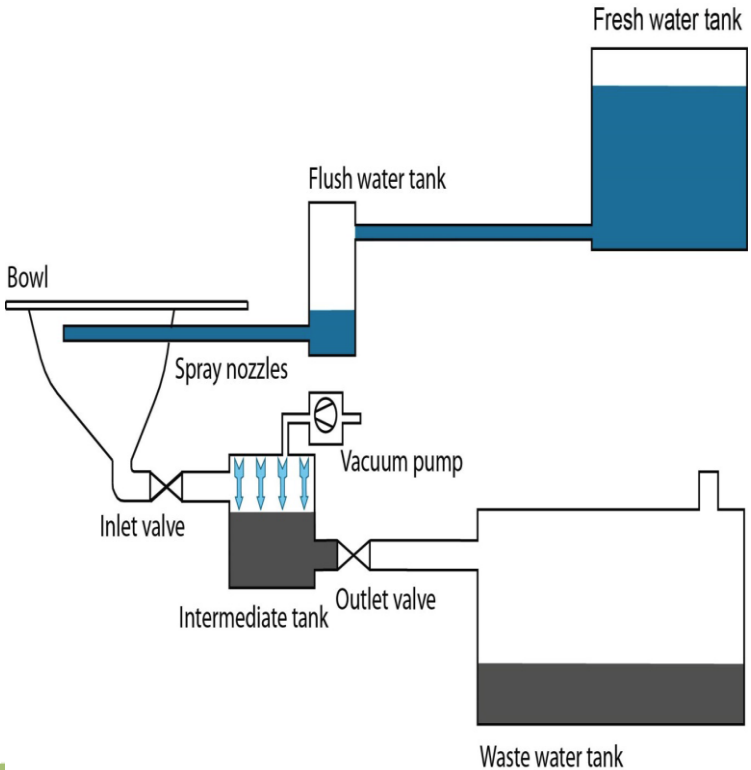
- The flush button is pressed, the LED on the flush button begins to flash and the squatting toilet starts the flush cycle. The complete cycle takes approx. 25 seconds. Compressed air is pressed into the flush water tank, positioned on the water system panel. Flush water is pressed through the spray nozzles by the pressurized flush water tank. The squatting bowl is flushed with high efficiency. At the same time the vacuum pump evacuates the Intermediate tank until the necessary vacuum level - 0.05 to -0.5 bar is reached.



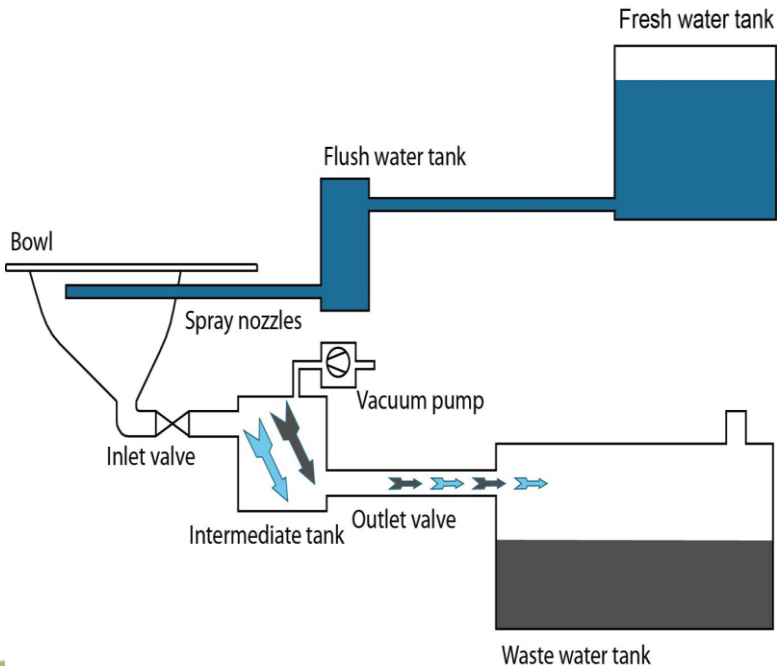
11.3 Emptying the Bowl: - As soon as the required level is reached the pinch valve between squatting bowl and intermediate tank is opened for a short time. The vacuum inside the intermediate tank sucks the contents of the bowl into the base unit.



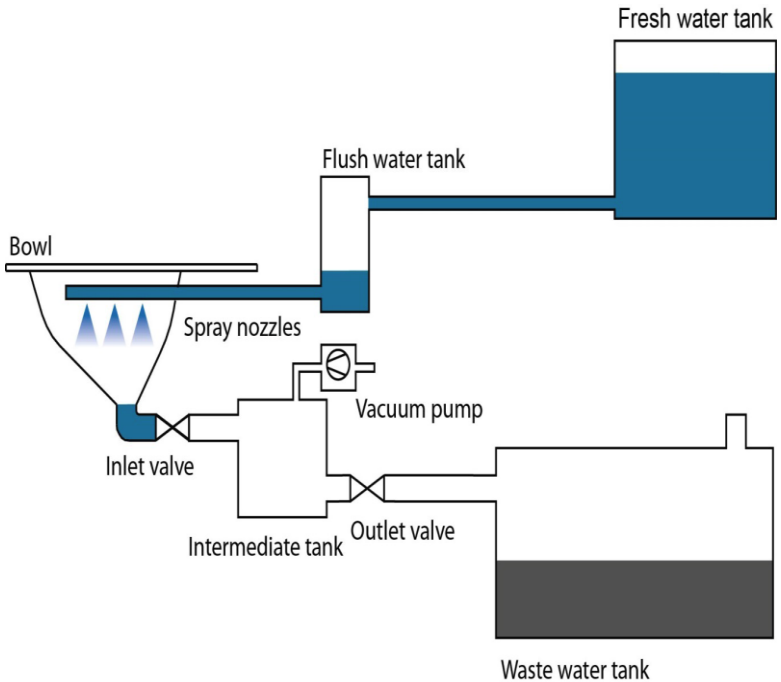
11.4 Pressure Built-Up Intermediate Tank: - The pinch valve is closed and now compressed air is blown into the Intermediate tank until a pressure of approx. +0.6 bar is reached.






11.5 Emptying the Intermediate Tank: - The Outlet valve shortly opens the piping to the Bio digester. Two pressure surges emptied the the contents of the Intermediate tank into the Bio digester. At the same time the water inlet valve positioned on the water system panel opens and the flush water tank is refilled.




11.6 Initial Water Supply: - Compressed air is pressed into the flush water tank and presses water through the spray nozzles and in the toilet bowl again. The bowl is flushed efficiently and an initial water supply is build up. The system switches to stand-by mode.




12. Trouble Shooting:-

Sr. No	Fault/ Errors	Check Points	Figure
1	No Power	In case of no power (110 V DC) to control panel , the LED will be OFF. Power indicator should be always ON.	
2	Air Fault	<ul style="list-style-type: none"> • Air supply lever should be open. • Air pressure value to be confirmed from air filter regulator / digital switch inside the Panel. • Positive Pressure wire connection to be checked. • Air pressure must be at least 4 bar. Lower pressure can cause the toilet to be plugged. Pressure below 2.5 to 3.5 bar will cause the toilet to shut down and no air indicator will light up. 	 <p data-bbox="658 751 913 784">Normal Pressure</p>  <p data-bbox="658 1163 868 1196">Low Pressure</p>

<p>3</p>	<p>Water Fault</p>	<ul style="list-style-type: none"> •There is a sensor inside the water tank overhead. If water level goes below it, NO WATER indicator will light up. •Water supply lever should be open. •Check the water in overhead water tank. • Water sensor wire connection to be checked. 
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<p>4</p>	<p>No Flushing</p>	<ul style="list-style-type: none"> •Flush wire connection to be checked at dual flush knob and terminal block inside the panel box. •Pan sensor functionality to be checked in HMI display. •Output end of solenoid valve to be checked for air pressure. •Nozzle blockage to be cross checked. •No tangling of outlet water pipe from water booster.
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5	Chocking	<ul style="list-style-type: none"> • If the intermediate tank gets filled up to its limit, the indicator will light up. • Operate manually solenoids 2, 3, 6 and 4 of flushing cycle. Conduct the steps repeatedly, for optimum restoration of system (in Oasis System). • Close the air input to switch the complete system in manual mode and press knob to flush water gravitationally in order to keep system operational. • Foreign material presence from S trap end to Pinch valve outlet.
6	No Vacuum Generation	<ul style="list-style-type: none"> • Output end of solenoid valve to be checked for air pressure. • No tangling of tube (green) from solenoid valve outlet to Vacuum ejector inlet.
7	Damaged/ Loose/Open connection of system:-	<ul style="list-style-type: none"> • This problem may due to hitting of foreign particles or lose connection due to any reasons which may cause no air, no vacuum or spread over of fecal matter over tank. 

**8 Soft Reverse
(in old design
Bio-Vacuum
toilet system
& in Amit
Engineers
System)**

For soft reverse press and hold S1,S2 and S3 for 3 seconds. Pinch hole open and suck the clogging about 20 to 25 times. This is recommended in en-route trouble.



**9 Hard Reverse
(in old variant
of Bio-
Vacuum toilet
system)**

- It is just opposite of Soft reverse. In this mode waste moves in the opposite direction to the one used in normal operation. In this process bowl should be closed/covered.
- The purpose is to remove or clear the blockage of bowl/pipe which are unable to suck by Pinch Valve.
- Procedure- Press S1,S2 and S4 and hold for 3 sec to activate and then confirm the mode by pressing S3.



Maintenance Instruction

1. Do not clean the bowl with brush which may scratch the bowl surface because the toilet has a polished stainless steel bowl.
2. Polished surface prevents any dirt from sticking to it and shortens the time needed for cleaning.
3. Use only approved washing agents.
4. Discoloration on the surface can be removed using mild cleaning pastes.
5. Do not use any chemical agents based on aggressive acids or strong bases.
6. Using such agents may result in weakening of the rubber elements which the clamp valves and the gaskets are made of, which result in loss of tightness and incorrect operation.

DISCLAIMER

THE INFORMATION GIVEN IN THIS PAMPHLET DOES NOT SUPERSEDE ANY EXISTING PROVISIONS LAID DOWN IN RDSO AND RLY. BOARD'S INSTRUCTIONS. IF AT ANY POINT CONTRADICTION IS OBSERVED, RLY. BOARD/RDSO'S GUIDELINES OR ZONAL RLY.'S INSTRUCTIONS MAY BE FOLLOWED.

The information given in this pamphlet is only for guidance.

If you have any suggestion or comment, please write to:

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Gwalior (M.P.) – 474 005*