PRESENTATION ON VACUUM EVACUATION SYSTEM FOR BIO-TOILETS OF LHB TYPE COACHES

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ECO FRIENDLY VACUUM EVACUATION SYSTEM

The basic reason behind using a vacuum toilet is being eco- friendly as it consumes 80% less water than conventional (currently used) toilets in Indian Railway coaches

Overview of Vacuum Evacuation System

- Our vacuum evacuation system for Bio-tanks transfer the fecal matter from the bowl/pan to the bio tank by positive suction and also clean the lavatory bowl/pan with pressurized jet automatically.
- Our vacuum evacuation system is of compact design.
- Vacuum generation is with compressed air ejector.
- No rotating devices is used in the passage to bio-digester.

CONT.

- Our vacuum evacuation system is 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.
- To indicate and ensure seal, water retention column is available up to the neck of discharge outlet of bowl.
- Our toilet system seal hermetically (air tight) the bio-tank from the passenger area.

CONT.

- Major components of the system used is of stainless steel grade AISI-316
- Our system is neat & clean, free of odor, hygienic and aesthetically pleasing.
- Compact Intermediate tank is provided in order to avoid clogging and to collect and discharge the waste into Bio-digester tank.
- There should be no maintenance requirement like painting, lubrication, oiling, periodic tightening of fasteners etc.

TYPES OF VACUUM EVACUATION SYSTEM

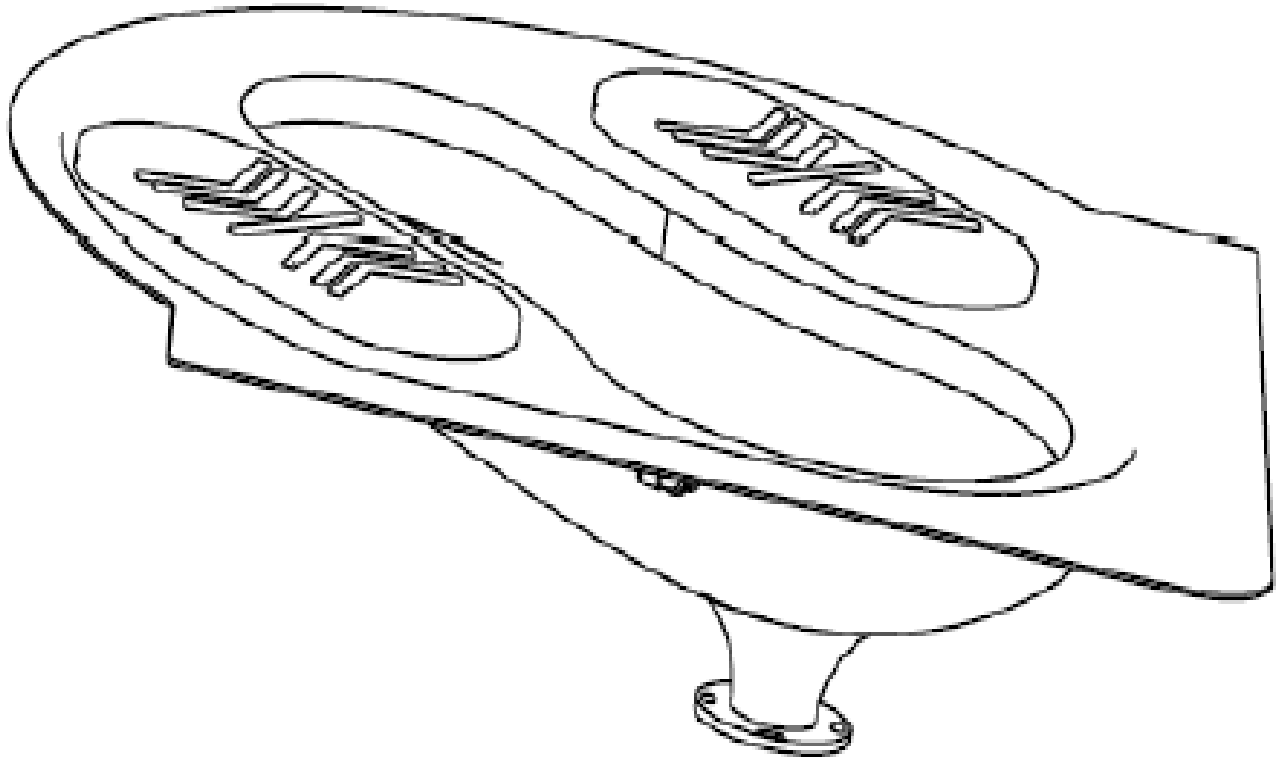
Western Style

Indian Style

MAIN SYSTEM COMPONENTS:-

- The main system components would be:
  - SS Lavatory bowl (Indian squatting/ Western design).
  - SS Intermediate Tank.
  - Control Panel Plate with Microprocessor Controller, FRL & Pressurizing Pump.
  - Associated water hoses, pneumatic piping and electrical wiring.

Indian Bowl with pressure nozzle (Toilet bowl is equipped with flood sensor.)



Western Bowl with pressure nozzle (Toilet bowl is equipped with flood sensor.)

INTERMEDIATE TANK

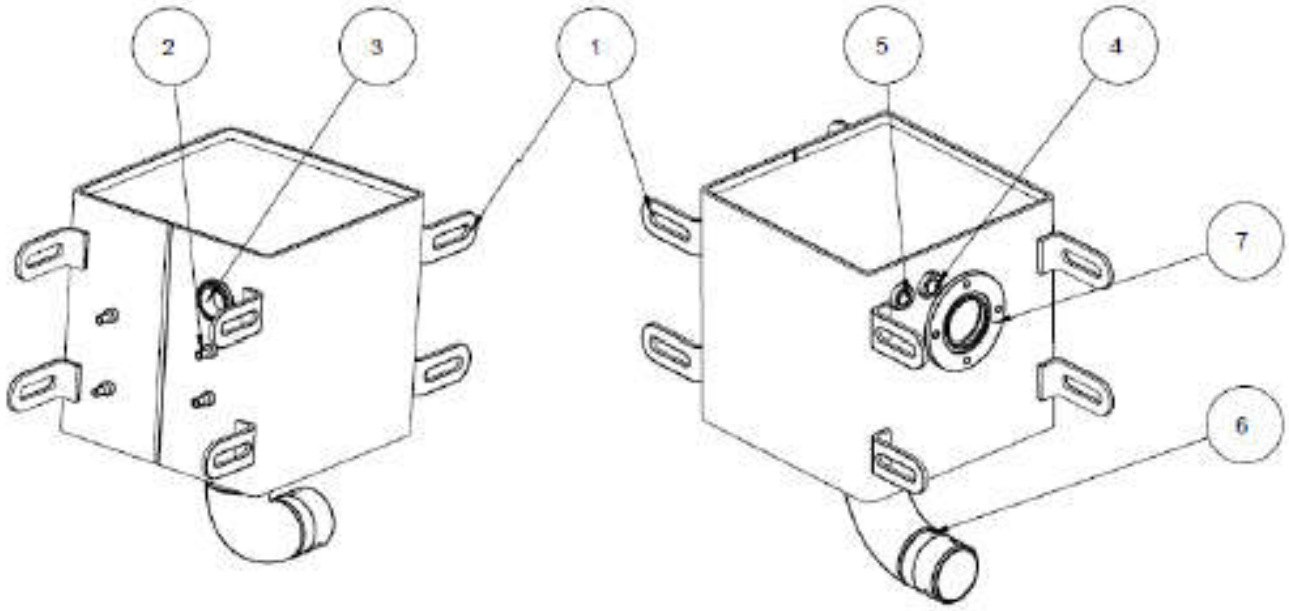


FIG. INTERMEDIATE TANK

(1) Mounting point, (2) Ejector module mounting points,
(3) Inspection plug ,(4) Ejector connection,
(5) Pressure sensor connection, (6) Drain tank, (7) Connection the tank to the bowl

Control Panel Plate Components Fitments

Panel Plate Components

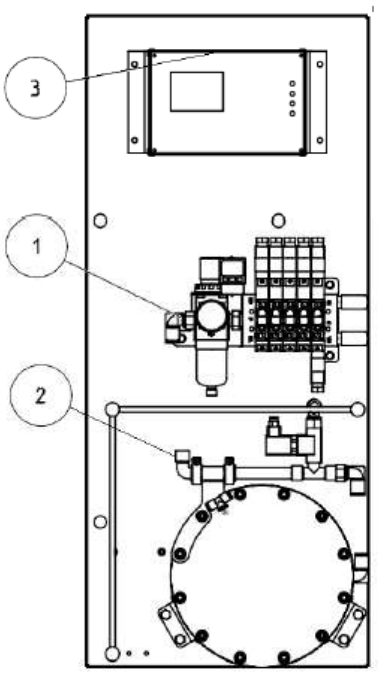
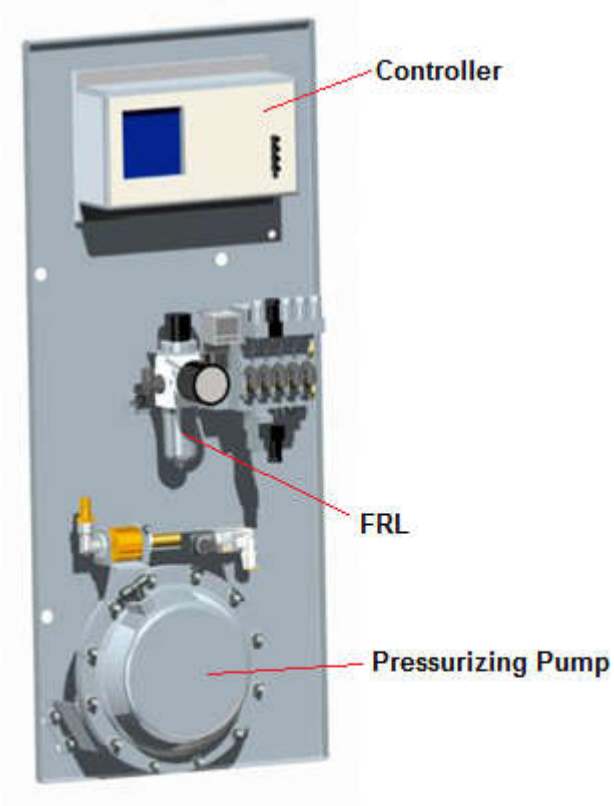


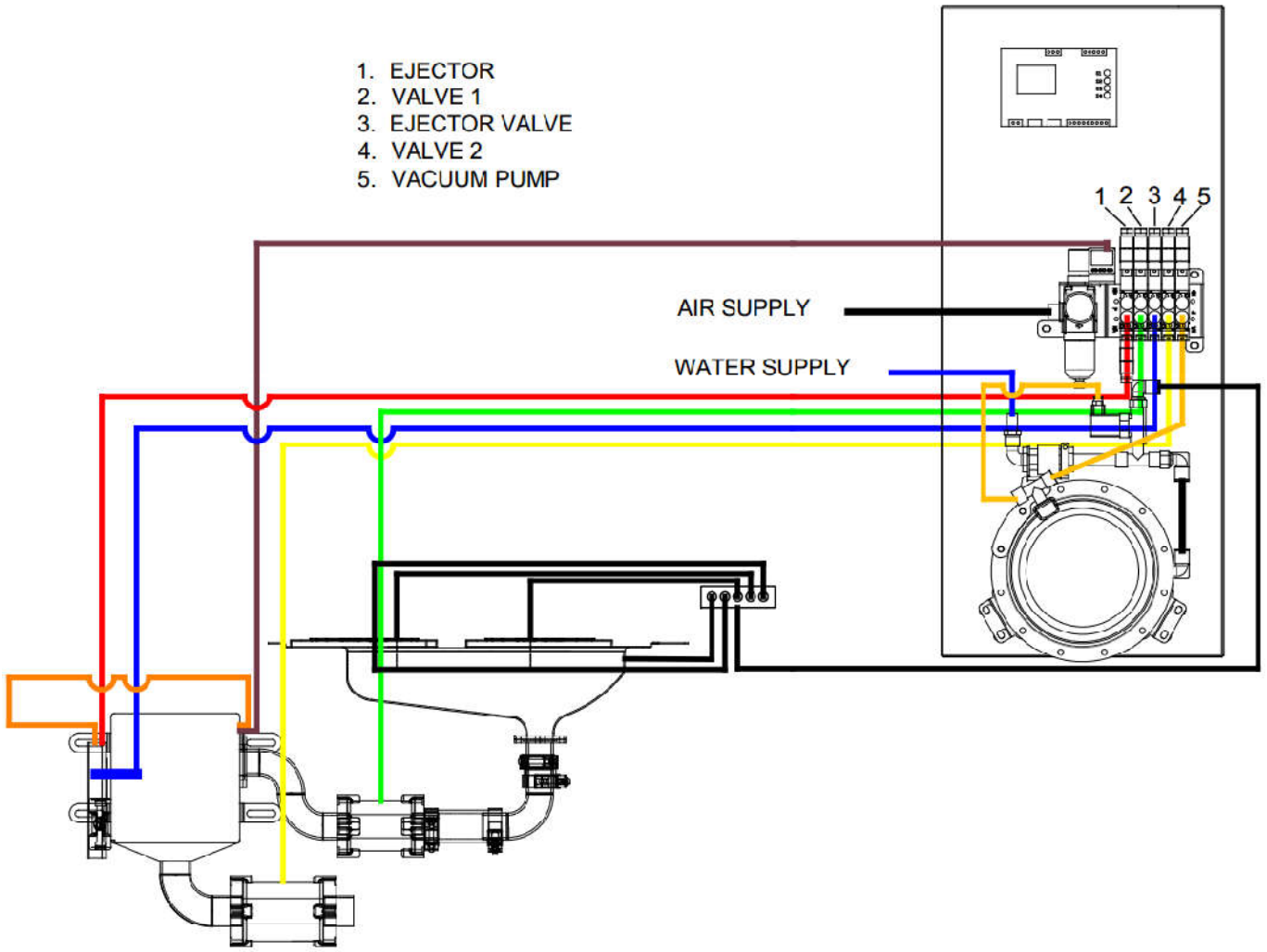
FIG. 4 TOILET MODULE – CONTROL PLATE

(1) Air quick coupling ø8x1, (2) Water coupling for pipe ø 16x2mm, (3) Power supply 110VDC

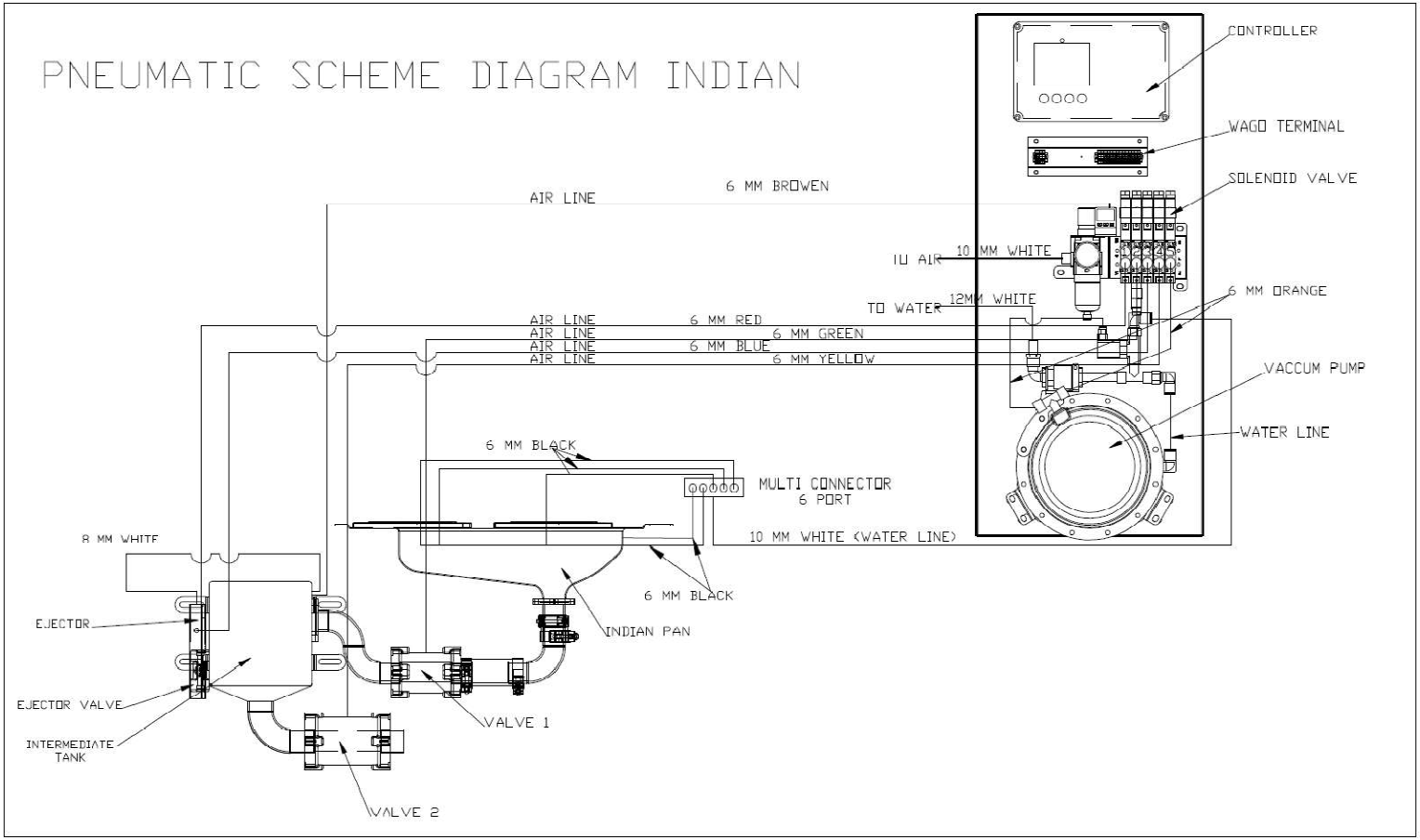
Panel Plate Components



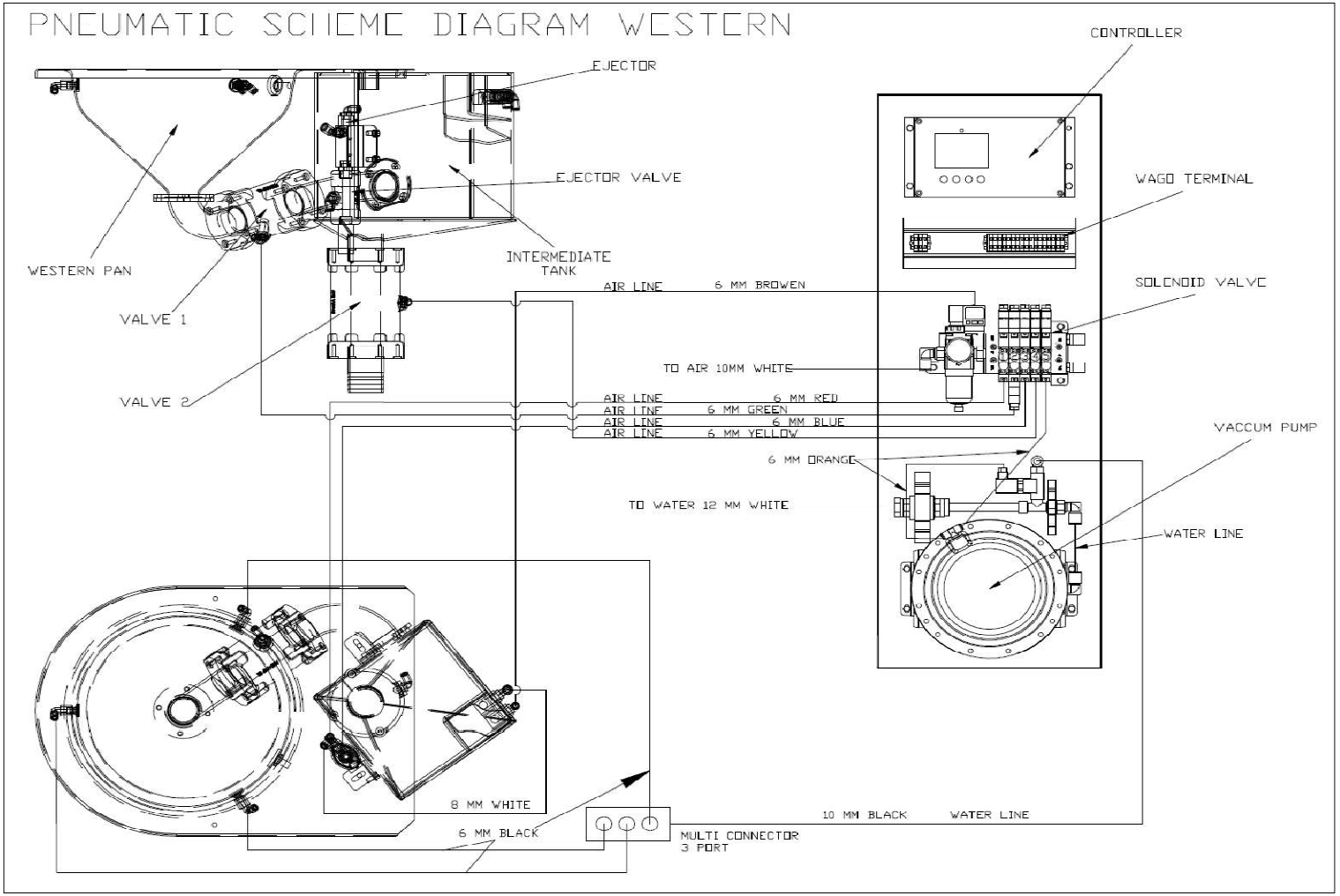
PNEUMATIC AND HYDRAULIC SCHEME



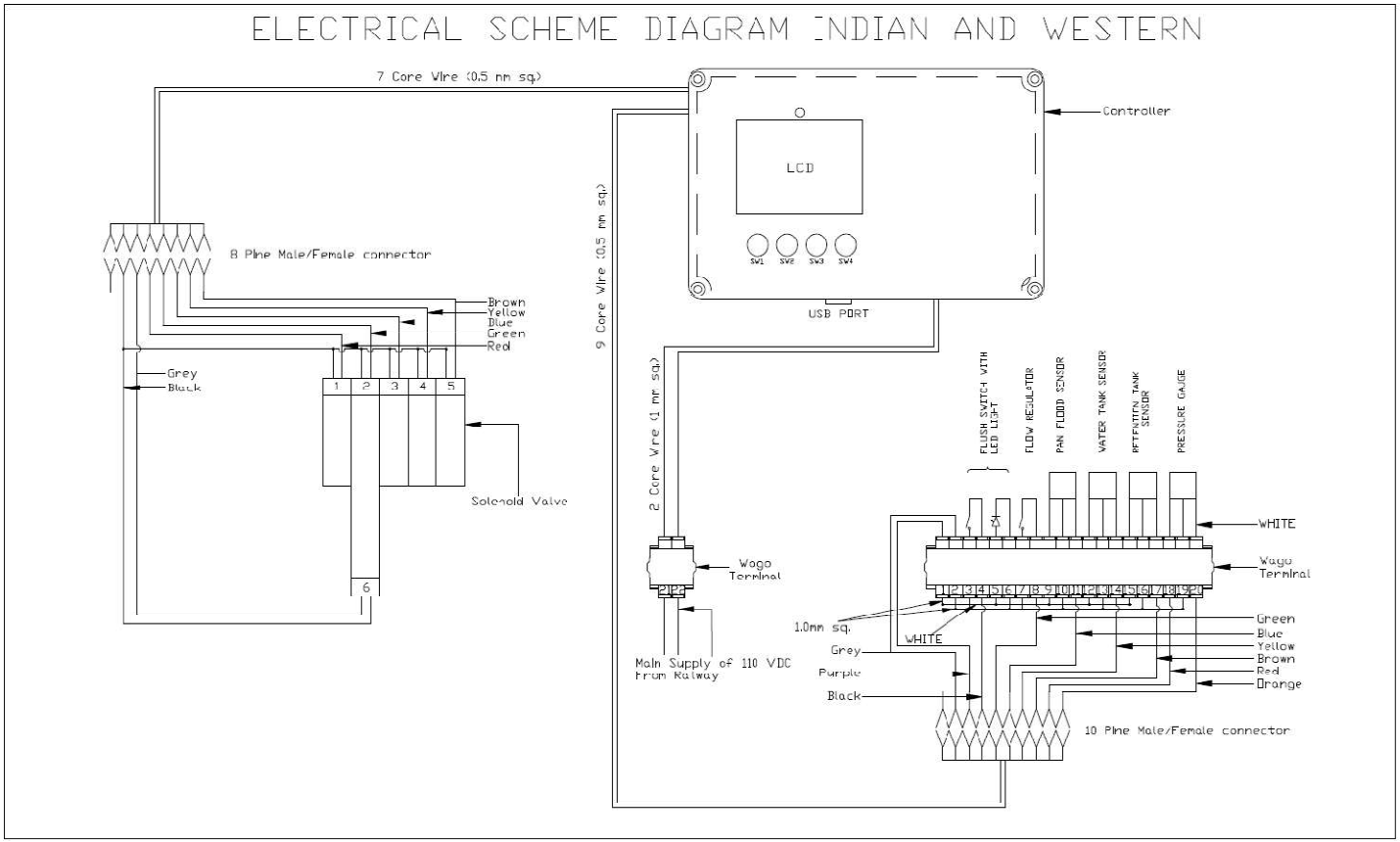
PNEUMATIC SCHEME DIAGRAM (INDIAN TYPE)



Pneumatic Scheme Diagram (Western Type)



Electrical Scheme (Indian & Western)



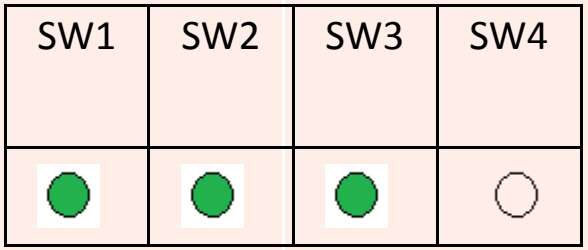
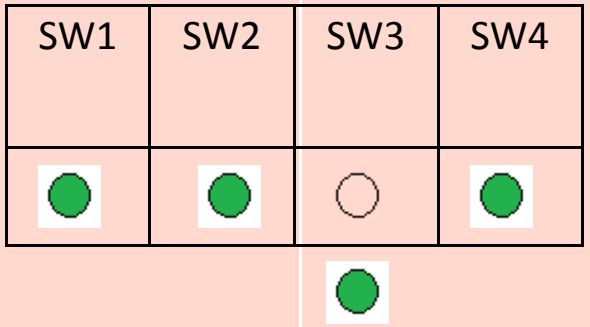
TECHNICAL

- 110 Volt DC power supply is available in coaches.
- Our Controller is designed to work on 110V DC supply and no further requirement of DC-DC converter (110V-24V DC supply)
- Western/Oriental bowls is equipped with level sensor to avoid flooding due to any circumstances of blockage in the system.
- The amount of water consumption needed for effective cleaning of the Western/Oriental bowl is about 0.5 to 0.7 liters.
- The air is supplied at 6 bar, but the system is able to work at 4 bar.

Brief Working of Vacuum Evacuation System

- It is basically a **VOD (VACUUM ON DEMAND)** system which produce vacuum when the toilet is need to be flushed.
- This system uses air together with water for the sucking out the waste.
- As the user pushes the flush button , **Ejector** starts working , creating a negative pressure (**vacuum**) in the intermediate tank.
- As soon as the vacuum is created the excreta is sucked out of the bowl to the intermediate tank.
- After that the outlet valve is opened and the waste is transported to the biodigester tank.

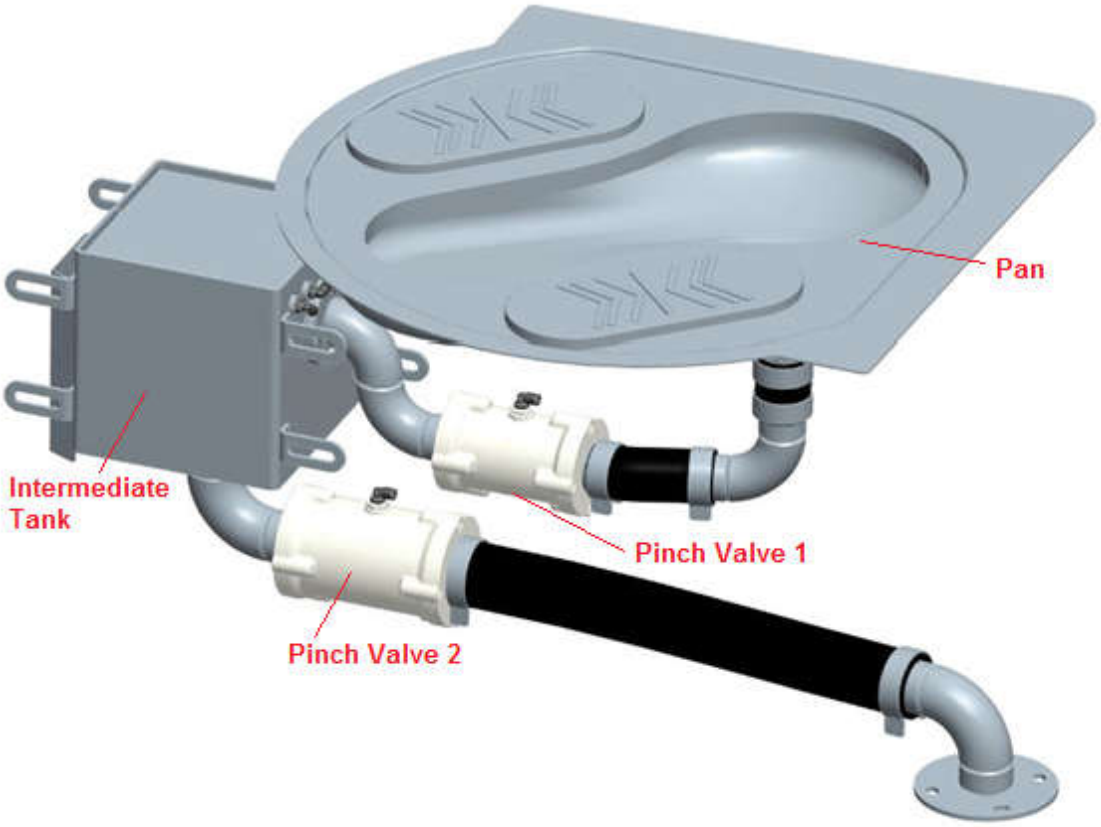
OPERATION OF VACUUM EVACUATION SYSTEM

TOILET NORMAL CYCLE TEST	Activate the WC flush pushbutton to starts the cycle.	
SOFT REVERSE MODE (hold 3 sec)	Press SW1, SW2 & SW3 buttons simultaneously on controller for 3 sec. to starts the soft reverse mode cycle.	
HARD REVERSE MODE (hold 3 sec)	Press SW1, SW2 & SW4 buttons simultaneously on controller for 3 sec. to starts the Hard Reverse Mode cycle. It requires confirmation to start Hard Reverse Mode, hence press SW3 button.	

NORMAL CYCLE OPERATION

- Activate the WC flush pushbutton 
  - Controller starts the cycle.
  - Water in toilet bowl is rising
  - Vacuum generation start in intermediate tank
  - Inlet pinch valve open, bowl is emptied and valve close again.
  - The toilet bowl is rising again
  - Pressure generation start in intermediate tank
  - Outlet pinch valve open, waste flows to waste water tank.

OPERATION OF VACUUM EVACUATION SYSTEM NORMAL CYCLE OPERATION



Normal Cycle Working

Normal Cycle Working

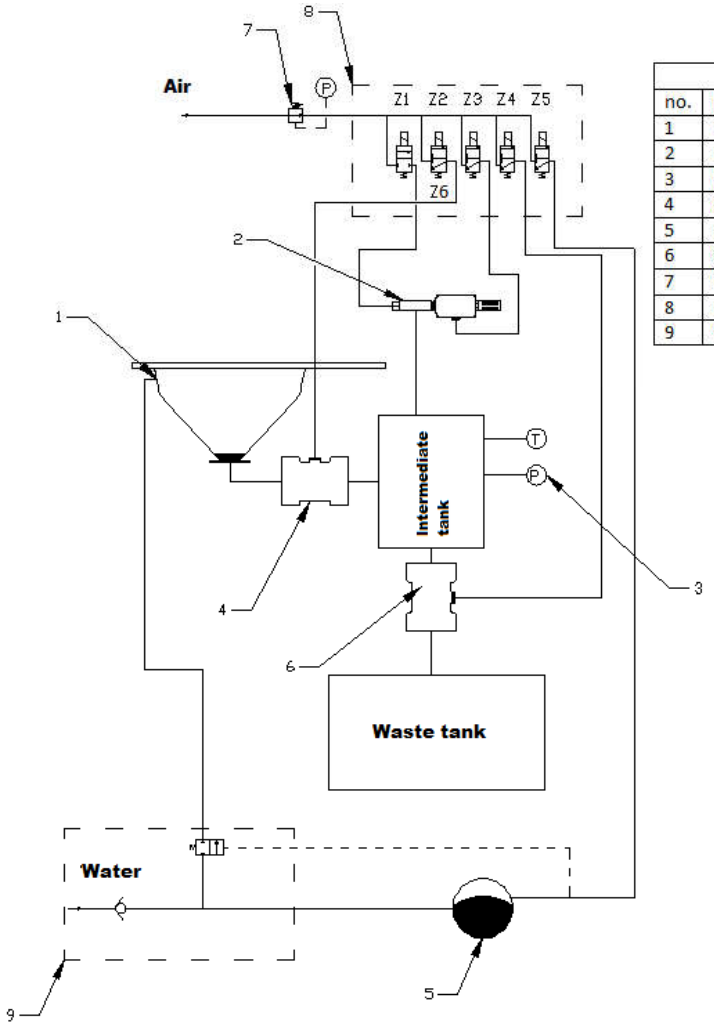
1. When a passenger push WC push button near pan, Controller give command to solenoid for Water flushing in pan.
2. The flush is done with pressurizing of water with air (for effective cleaning).
3. The water in toilet bowl is rising in pan and simultaneously vacuum generation starts in intermediate tank.
4. When sufficient vacuum is generated then pinch valve 1 opens, bowl is emptied and pinch valve 1 close again.
5. Then again water in toilet bowl is rising to maintain water seal.
6. Now pressure generation starts in intermediate tank and pinch valve 2 opens, waste flows to waste water tank (Retention Tank).
7. Cycle Completes

WORKING OF SOLENOID VALVE AS PER NORMAL CYCLE OPERATION

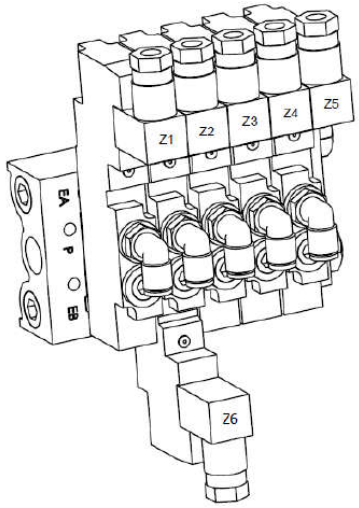
Sr. No.	DIFFERENT OPERATIONS PERFORMED
1	STAND BY MODE
2	FLUSHING MODE
3	CREATING VACUUM
4	EMPTYING THE BOWL
5	CREATING PRESSURIZING
6	EMPTYING INTERMEDIATE TANK
	STAND BY MODE (READY FOR NEXT PASSENGER)

STAND BY MODE

Z1 - stable position – flow through ejector cut off
Z2 - stable position – pinch valve I open
Z3 - stable position – ejector valve open
Z4 - stable position – pinch valve II open
Z5 - stable position – prepared portion of water

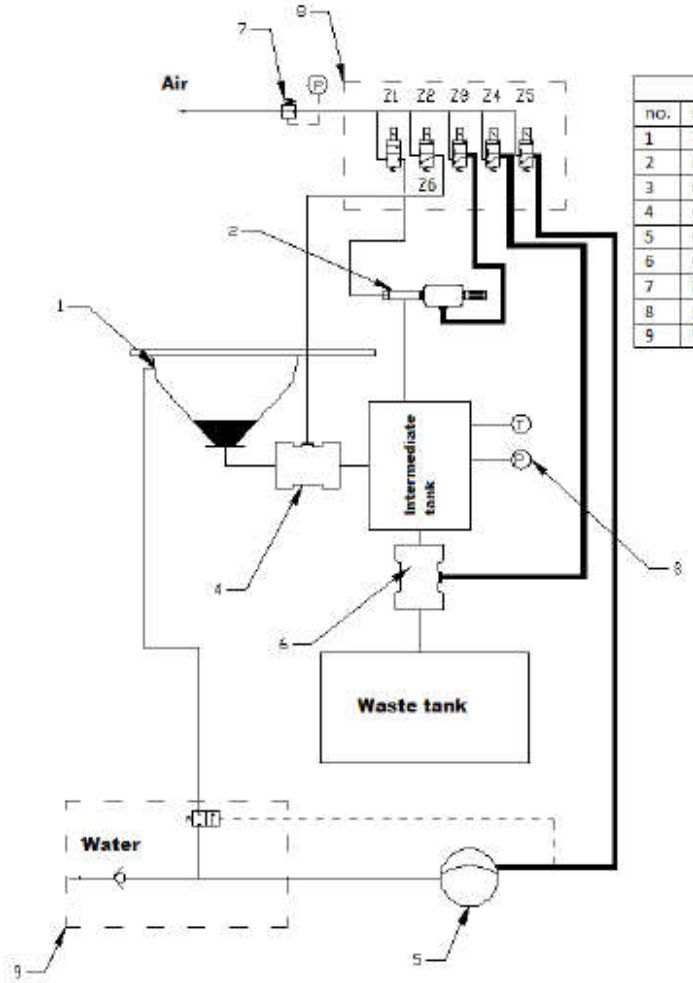


Agenda	
no.	Description
1	Toilet bowl with flushing nozzle
2	Ejector module
3	Pressure converter
4	Clamping valve I
5	Pump
6	Clamping valve II
7	Pressure reducer
8	Electrovalve assembly
9	Water assembly



Flushing Mode

Z1 - stable position – flow through cut off ejector
Z2 - stable position – pinch valve I open
Z3 - working position – ejector valve close
Z4 - working position – pinch valve II close
Z5 - working position – portion of water fed to flushing nozzles



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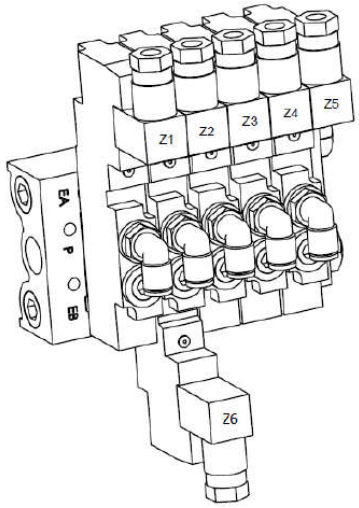
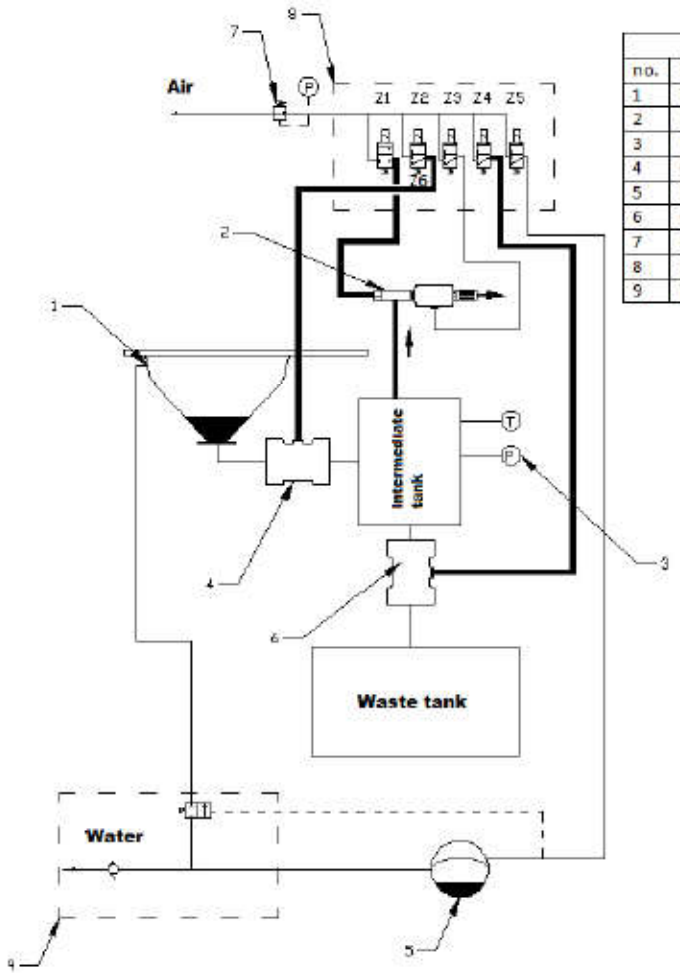


CREATING VACUUM

Z1 - working position – flow through ejector active
Z2 - working position – pinch valve I close
Z3 - stable position – ejector valve open
Z4 - working position – pinch valve II closed
Z5 - stable position – preparation of portion of water



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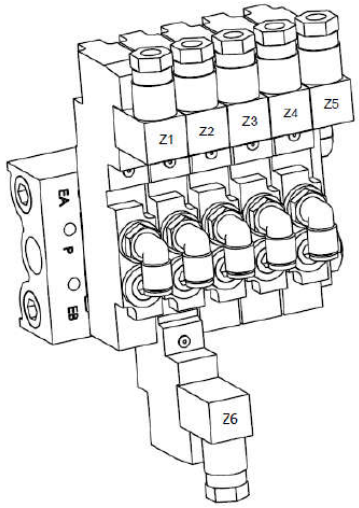
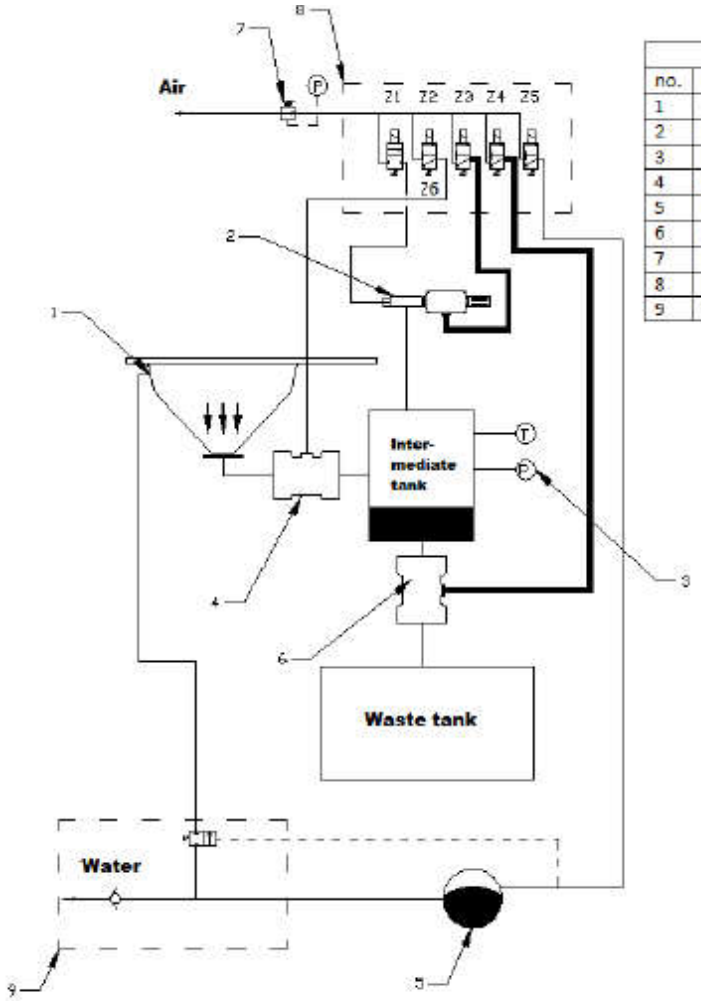


EMPTYING THE BOWL

Z1 - stable position – flow through ejector cut off
Z2 - stable position – pinch valve I open
Z3 - working position – ejector valve close
Z4 - working position – pinch valve II close

Z5 - stable position – prepared portion of water



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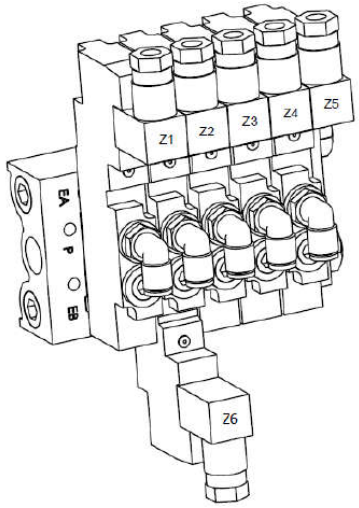
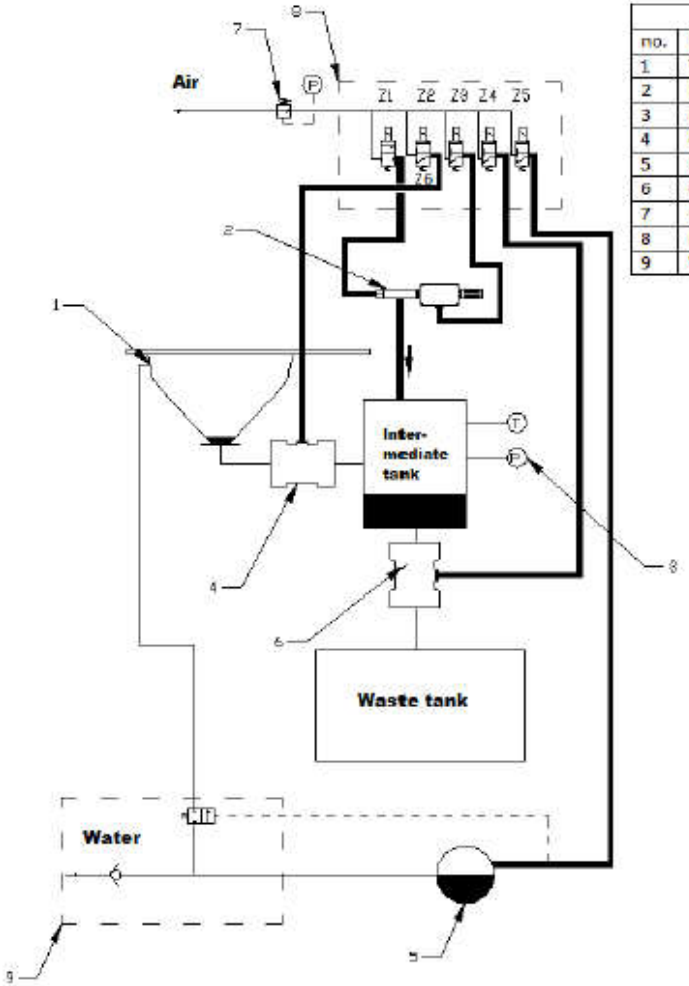


Creating Pressurizing

Z1 - working position – flow through ejector active
Z2 - working position – pinch valve I close
Z3 - working position – ejector valve close
Z4 - working position – pinch valve II close
Z5 - working position – portion of water fed in the amount needed to form an air-trap



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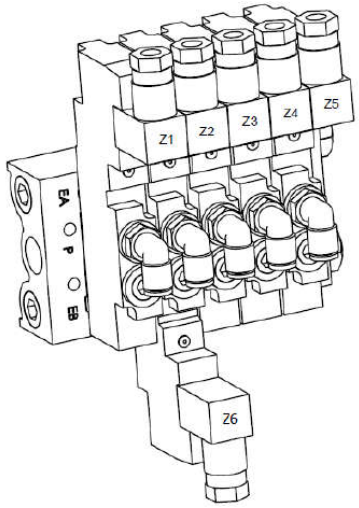
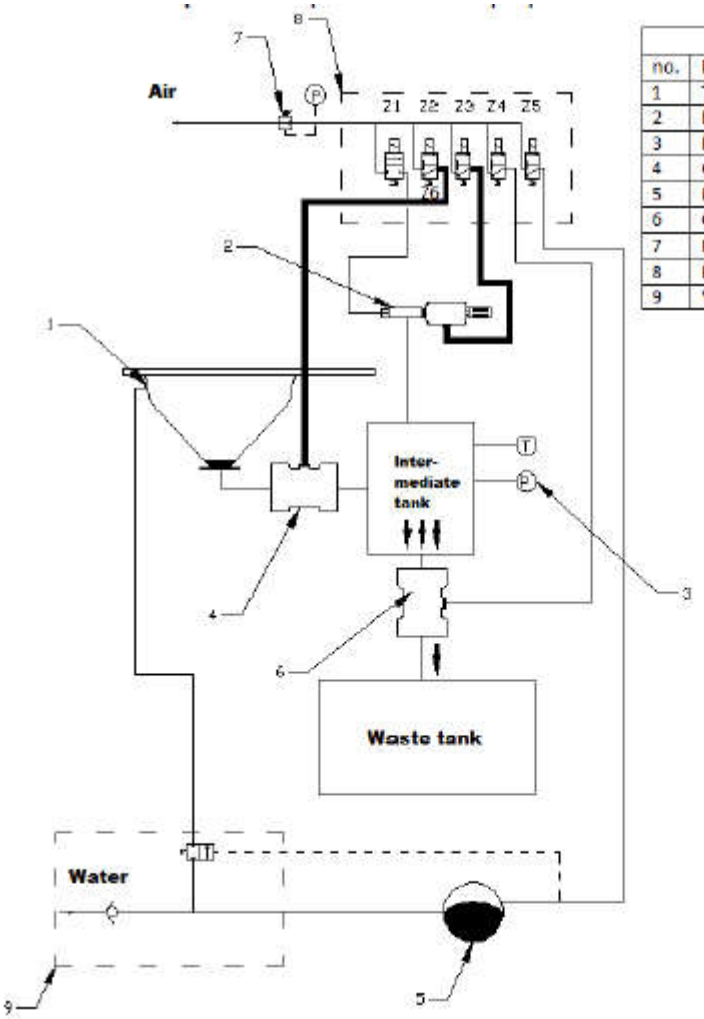


Z1 - **stable position** – flow through ejector cut off
Z2 - **working position** – pinch valve I close
Z3 - **working position** – ejector valve close
Z4 - **stable position** – pinch valve II open
Z5 - **stable position** – portion of water prepared

EMPTYING INTERMEDIATE TANK



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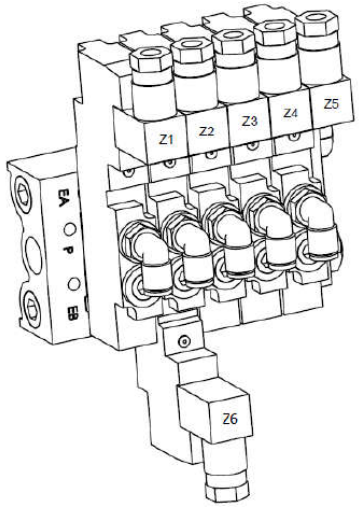


TROUBLESHOOTING / SERVICE / MAINTENANCE OPERATION

Sr. No.	Cause / Fault	Reason
1	No Air	Air pressure is low / No Air
2	No Water	Water is empty in water tank
3	Flood pan	Blockage in line (Use Soft Reverse Mode)
		Blockage in line (Use Hard Reverse Mode if not cleared by Soft Reverse Mode)

TROUBLESHOOTING / SERVICE / MAINTENANCE OPERATION THROUGH CONTROLLER

SOFT REVERSE MODE

- SOFT REVERSE MODE
- Press SW1, SW2 & SW3 buttons simultaneously on controller for 3 sec. to starts the soft reverse mode cycle.

SW1	SW2	SW3	SW4
●	●	●	○

HARD REVERSE MODE

- HARD REVERSE MODE
- Press SW1, SW2 & SW4 buttons simultaneously on controller for 3 sec. to starts the Hard Reverse Mode cycle.
- It requires confirmation to start Hard Reverse Mode, hence press SW3 button.

SW1	SW2	SW3	SW4
●	●	○	●

●

SPECIAL FEATURES TO TROUBLESHOOT

- **SPECIAL FEATURES**
  - If the toilet gets clogged up, make it passable by using one of the two maintenance modes:

  - **HARD REVERSE – moving the waste in the opposite direction to the one used in normal operation- required bowl closing!**

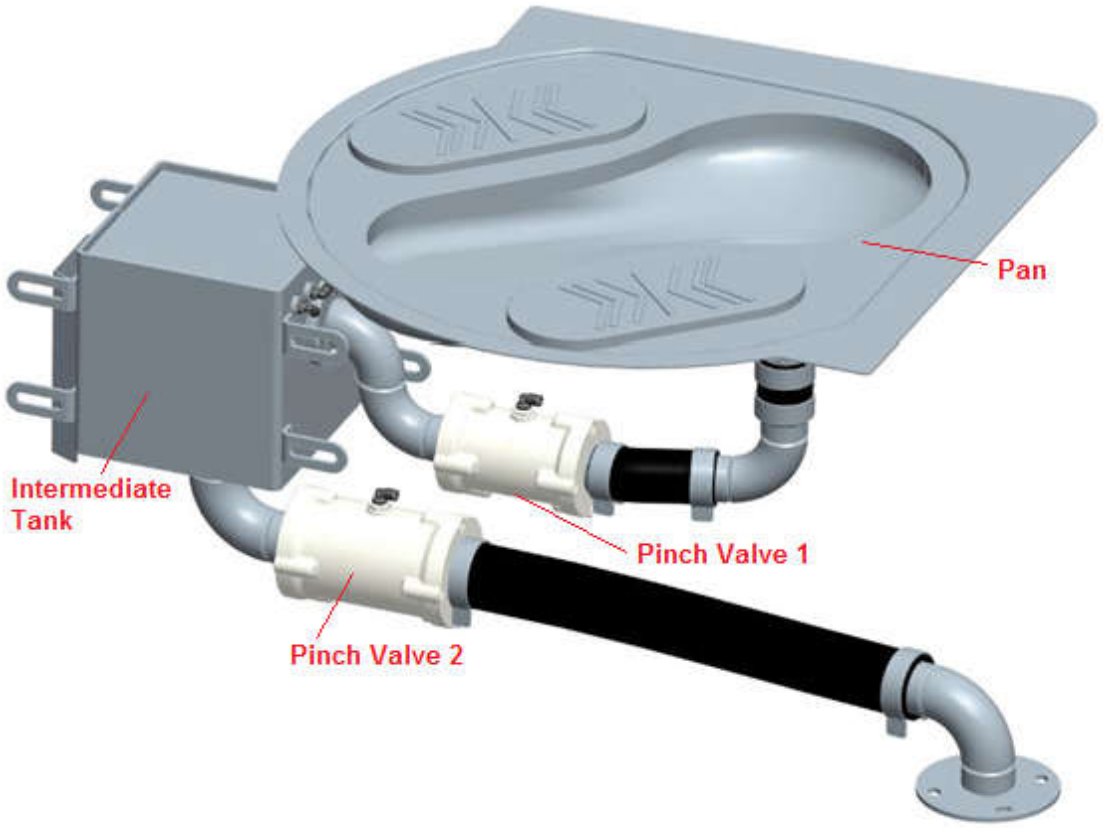
  - **SOFT REVERSE – the mode cause the pinch valve to be multiply opened and closed, while pumping the air to the intermediary tank which affects flushing the toilet in the normal direction with increased pressure for couple of times**

SOFT REVERSE MODE

SW1	SW2	SW3	SW4
●	●	●	○

- Controller starts the cycle.
- Pinch valve squeeze for ~25s
- Pumping mode
- Vacuum generation start in intermediate tank
- Inlet pinch valve open, bowl is emptied and valve close again.
- Pressure generation start in intermediate tank
- Outlet pinch valve open.
- Pressure generator start in intermediate tank again (higher pressure than last cycle).
- Outlet pinch valve open. This continuously done to remove blockage.
- Block is removed from pipes to the waste tank.
- A normal cycle mode is ON to maintain water siphon in pan.

OPERATION OF VACUUM EVACUATION SYSTEM
SOFT REVERSE MODE

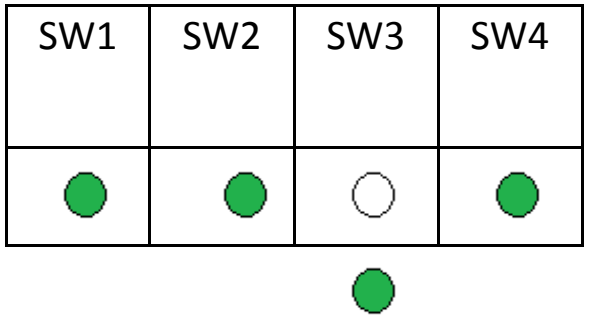


Soft Reverse Mode

Soft Reverse Mode

- When SW1, SW2 & SW3 switch press simultaneously for 3 seconds, Controller starts the Soft Reverse Mode to clear the blockage to retention tank.
- As blockage is in between pinch valve, during soft reverse mode, Pinch valve squeeze for ~25s
- During this Pumping mode (pushing blockage towards retention tank) starts.
- Vacuum generation start in intermediate tank to suck blockage to intermediate tank.
- For that Pinch valve 1 opens, bowl is emptied and pinch valve 1 close again.
- Now pressure generation starts in intermediate tank to push blockage to retention tank with pressure.
- For that pinch valve 2 opens and push blockage to retention tank.
- Pressure generator starts in intermediate tank again (higher pressure than last cycle).
- For that pinch valve 2 open again.
- This Pumping is done continuously to remove blockage from pipes to the waste tank.
- A normal cycle mode is ON after completion of Soft Reverse Mode to maintain water siphon in pan.

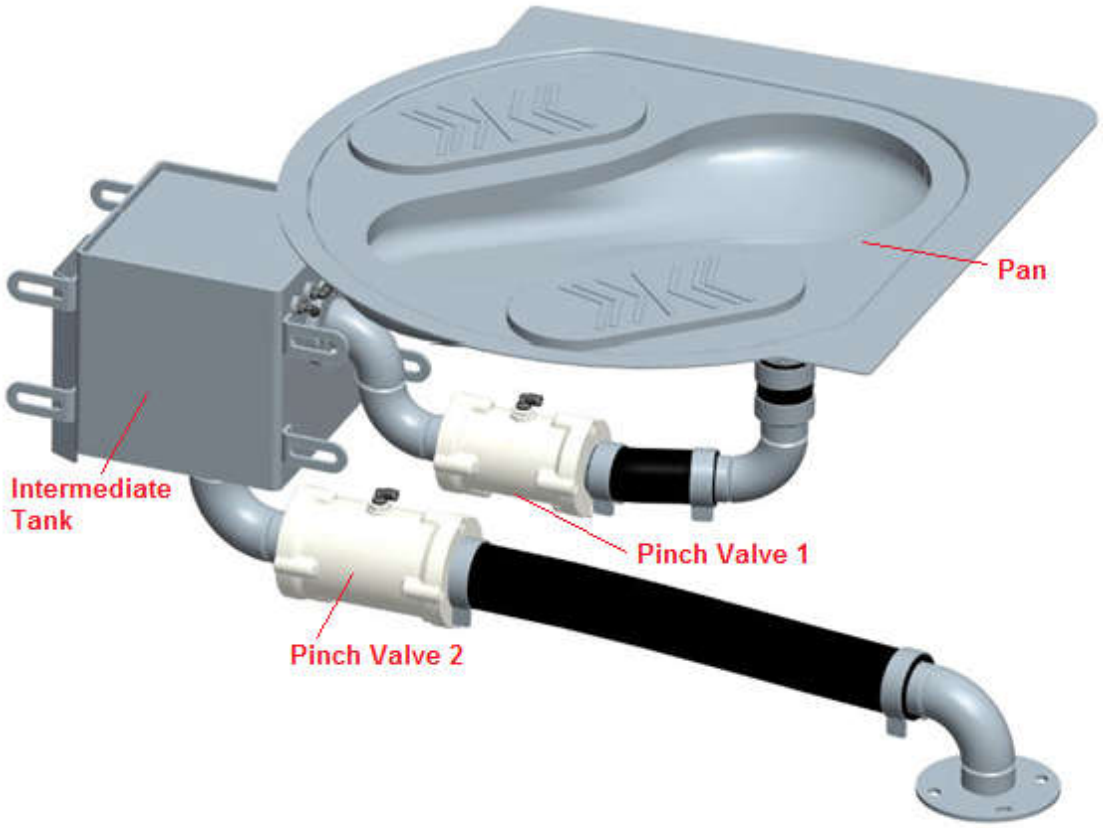
HARD REVERSE MODE



- Controller starts the cycle.
- Pressure generation start in intermediate tank
- Inlet pinch valve open.
- Block will be removed in bowl side with full pressure.

Note:-Pan has to be covered for safety reason.

OPERATION OF VACUUM EVACUATION SYSTEM
HARD REVERSE MODE



Hard Reverse Mode

- When SW1, SW2 & SW4 switch press simultaneously for 3 seconds, Controller waits for confirmation of Hard reverse mode operation.
- After that if we press SW3 switch on controller, Soft Reverse Mode initiate to clear the blockage to retention tank.
- As blockage is in between pinch valve, and not clear from soft reverse mode, Hard Reverse mode can be used to troubleshoot the blockage problem.
- During this Hard Reverse mode (pushing blockage towards pan / bowl), some precautions are taken like cover the pan for safety reasons.
- Pressure generation starts in intermediate tank and push with pressure towards pan.
- During this, pinch valve 1 opens only and pinch valve 2 is closed at that time.
- Block will be thrown in pan/bowl side with full pressure and any obstacle will be cleared instantly.

BASIC FEATURES OF MICROPROCESSOR CONTROLLER

CONTROLLER DISPLAY FAULTS THROUGH SCREEN

Our Controller show the following warnings / information on the display.

- No Air
- No Water
- System errors (flooding in pan)

Spare List

Main Spare

1	Microprocessor Controller
2	Pump Assembly
3	Pinch Valves
4	FRL Assembly

Regular Spare

1	Solenoid Valve Assembly
2	Spray Nozzle
3	Sensors
4	NRV ½”
5	Ejector Assembly
6	Air Distributer (3/6 Way)
7	Push Fittings
8	Pneumatic Pipes

ADVANTAGES

- Use very less water (0.5 to 0.7 L)
- It takes very less water to clean the bowl for the next person
- Our toilet system is of robust design, safe, simple to operate and easy to understand by the users.
- The toilet system is rugged, reliable and require minimum maintenance.
- USB based Microprocessor Controller
- Our toilet system meet the following objectives:
  - Clean, odour-less, hygienic and aesthetically pleasing toilet.
  - No discharge of waste.
  - No spillage of waste on the bogie parts, under gear or track.

Thanks To All