Broom Engineering
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Vacuum Tanker Operating & Maintenance Manual

Abstract

This document outlines the hardware utilised for a vacuum tanker, including operating instructions and the recommended factory maintenance protocol

Author:

Craig W. Tresise (BIng Mech. Eng.)

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1. Description

The system incorporates a B-range vacuum exhauster, directly coupled to a drive, not to exceed 1500 rpm, designed to negatively pressurise a vessel to a maximum of -65kPa. The system includes all necessary vacuum accessories to protect the exhauster and ensure that the system operates efficiently, mitigating down-time.

2. Component List

Please refer to the item numbers indicated in the figures to identify the component(s) in the list(s) to follow.

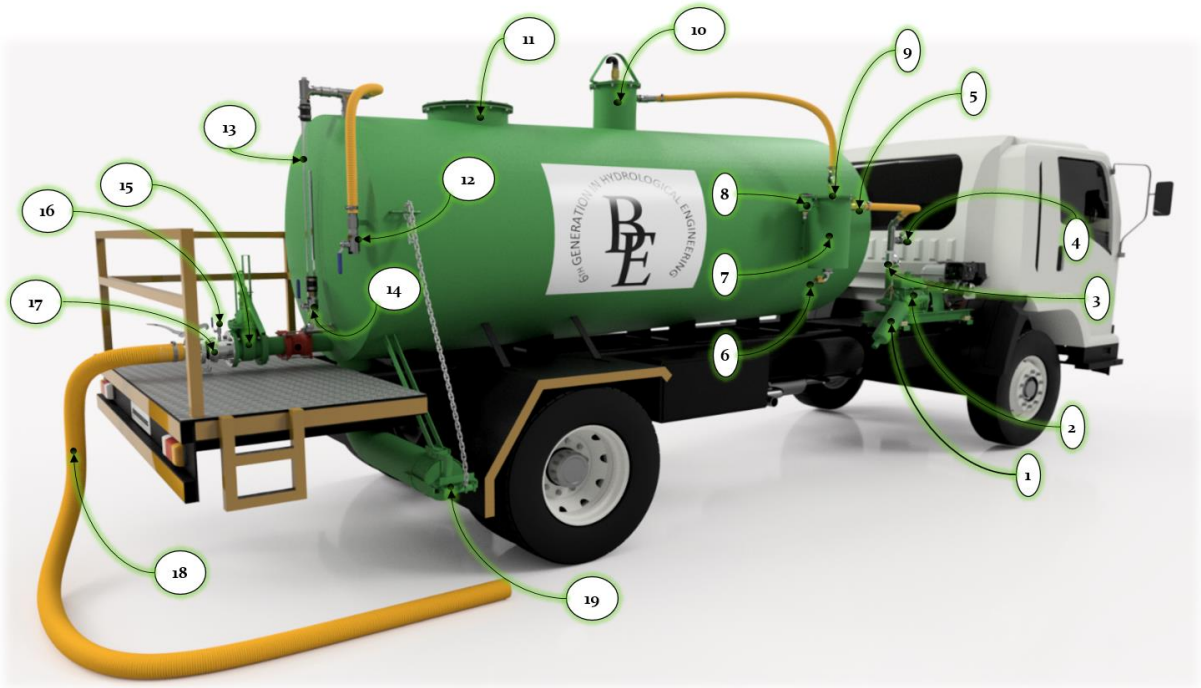


Figure 1: List of Components [1-19]

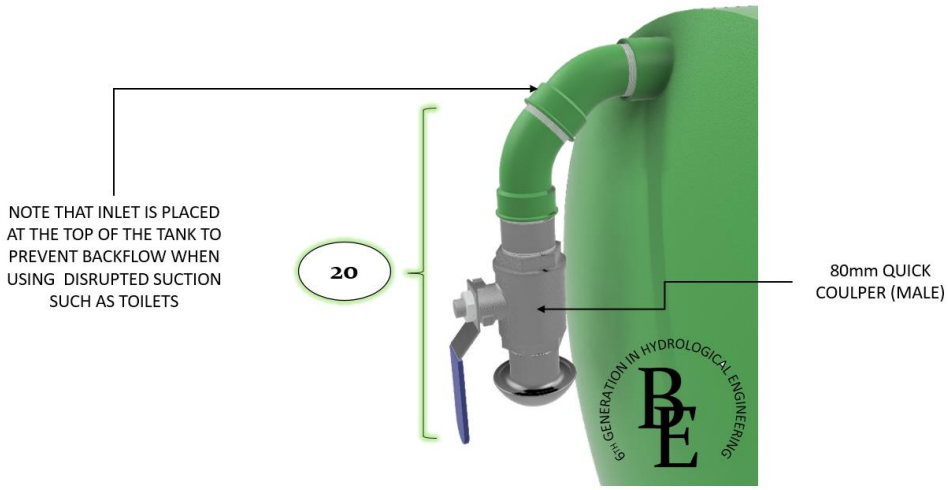


Figure 2: List of Components [20]

Table 1: Item List One Information

ITEM NO.	CODE	DESCRIPTION	FUNCTION
1	EXSIL	Silencer	Lowers the decibels produced by the vacuum exhauster.
2	B35	B35 Vacuum Exhauster	Broom Engineering manufactured vacuum and low-pressure exhauster.
3	IS40	Inline Strainer	Strainer consists of a 1mm perforated screen to prevent debris from entering the vacuum exhauster.
4	40UBV	Unloader Ball valve	Valve utilised during the start-up and shut down procedure to remove load from the exhauster and safeguard vacuum equipment.
5	NRV40	Non-Return Valve	Swing-check non return valve isolates vacuum in the pressure vessel once system drive is shut down.
6	25AD	Auto-Drain/Drain	Allows water and other condensed effluent to drain from the moisture separator once vacuum has been broken in the pressure vessel. (Image illustrated not supplied by Broom Engineering).
7	MSEP	Moisture Separator	Accumulates moisture during operation, acts as a condenser to water vapour. Prevents accumulated water from entering the vacuum exhauster.
8	VCV25	Vacuum Control Valve	Safety hardware limiting system pressure to -65kPa (recommended maximum pressure for vacuum exhauster to prevent overheating)
9	VACGG	Vacuum Gauge	Vacuum indicator ranging from 0 to -100kPa
10	FSV	Snifting Valve	Float operated overflow prevention valve.
11	MANHOLE	Vacuum Manhole	3CR12 vacuum manhole including forged rubber seal. (Image illustrated not supplied by Broom Engineering).
12	40VRV	Vacuum Breaker Valve	Ball valve operated to break the vacuum in the septic tank by allowing atmospheric air to enter the tank.
13	STUB501	Septic Tank Sight-Glass	Clear acrylic tube for septic level inspection. (Image illustrated not supplied by Broom Engineering).
14	BV40	40mm Emergency Shut-Off Valve	The emergency shut off valve is an installation utilised in the event that the site-glass is damaged when the tanker

ITEM NO.	CODE	DESCRIPTION	FUNCTION
			contains effluent, preventing Hazardous spillage.
15	QASV100	Quick Acting Suction Valve	The quick acting suction valve comes in various sizes (80mm, 100mm, and 150mm) depending on client requirements. Tankers ranging from 3000-15000 litres are recommended to fit a tanker with a 100mm (/or 4") valve. Larger valves are recommended for clients that require faster collections times. The valve utilises a basin when shut, mitigating damages typically present when operating with valves such as ball-valves.
16	BV10	Pipe Vacuum Breaker	Valve utilised when packing suction hose away. Removing negative pressure from the suction hose, removing effluent from the suction hose and preventing effluent spills. Essential health and safety hardware.
17	QC100	Quick Coupler Pair	Steel manufactured coupling between the quick acting suction valve and suction-hose. Highly recommended for the industrial and agricultural applications where frequent coupling is required.
18	PIPE100	100mm Suction Hose	Recommended suction hose for effluent collection involving vacuum applications. The hose has been industry proven to withstand negative pressure and sun exposure, increasing product life and mitigating plant downtime.
19	200DV	200mm Dump Valve	The quick acting dump valve is uniquely developed and manufactured for rapid septic effluent discharge. The installation of the valve significantly reduces process-time when dumping. Moreover, due to the installation, debris and residue build-up is reduced as a result of fluid flow characteristics.
20	80SMANI	Suction Manifold	The suction manifold is an assembly of components constructed for access to the top of the tanker. Unlike the quick acting

ITEM NO.	CODE	DESCRIPTION	FUNCTION
			suction valve, the suction manifold utilises a ball-valve that is assembled perpendicular to the ground, ensuring that debris does not block/or damage the valve Teflon seal.

3. Safety Considerations

As part of health and safety, it is recommended that personnel be issued the relevant personal protection gear to prevent any form of injury or illness while operating equipment. Recommended gear:

Table 2: Safety Gear Consideration

	Full overalls to prevent effluent from making contact with skin.
	Safety boots to ensure that an operator's feet are protected from heavy equipment.
	Chemical rubber gloves.
	Full-cover eye wear to prevent effluent from entering one's eyes
	Face mask to prevent inhaling of harmful particulates.

If an operator has an open-wound that is exposed to effluent, clean wound thoroughly, and consult a doctor immediately.

If an operator's eyes have been exposed to effluent, rinse thoroughly and consult a doctor immediately.

If effluent is ingested, it is recommended that the operator purge (self-induce vomiting), use charcoal tablets to aid in neutralising toxins and consult a doctor as soon as possible.

4. Operating Procedures

4.1. Start-up & Shutdown Procedure

Step 1a: Open unloader-ball-valve to the open position by turning valve handle parallel with the valve port (valve indicated in Figure 3).

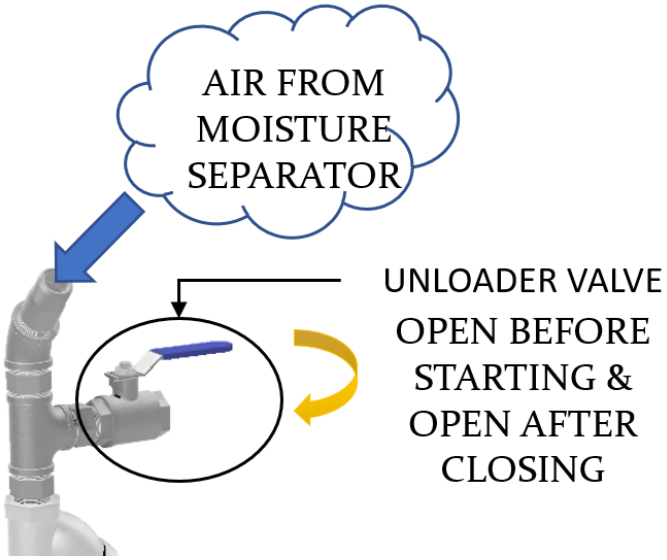


Figure 3: Unloader Ball Valve

Step 2a: Activate the system drive (hydraulic, engine, electric etc.)

Step 3a: Allow pump to run for approximately 3-5 seconds.

Step 5a: Close unloader-ball-valve (as seen in Figure 3), ensuring that the handle in perpendicular to the valve port.

Vacuum will begin to rise and will be indicated on the vacuum gauge located on top of the moisture separator as per the indicator in Figure 4.

Figure 4: Vacuum Gauge

Once pressure has reached -20kPa, an operator may begin collecting effluent as will be discussed in point 4.2.

Step 6a: Once the collection procedure has been carried out, the operator is to open the unloader ball valve as discussed in **Step 1a** to remove the vacuum-load from the exhauster prior to shutting down the system drive (as per **Step 2a**).

Step 7a: Deactivate the pump drive by disengaging the PTO switch.

If one does not open the unloader ball valve before shutting down the B-Range Exhauster pump drive, vacuum in the tank and power produced by the system drive acting in opposite directions will result in damage to the coupling, pump and engine.

4.2. Suction/Collection Procedure

As discussed in step-5a, once the unloader ball valve has been closed following the pump drive is initiation, vacuum will rise in the tank. During this time, it is recommended that the operator unload the suction-hose and couple the hose to Item-17 indicated in Figure 1.

Step 1b: Once the suction hose is coupled to Item-17 and vacuum has risen to a negative pressure of approximately -20kPa, an operator is to open the suction valve(s).

Step 2b: Carryout collection from sumps/pits, monitoring the site glass to ensure that the septic tank is not overfilled.

Once the level has reached the upper edge of the site-glass, it is recommended that an operator cease collection and empty the tank. The remaining space in the tank operates as a contingency to aid in preventing tank-overflow.

The tank is installed with an overflow prevention valve (Item-10), however should not be used as an operational stop. The overflow shut-off valve is installed as a safeguard mechanism to the vacuum equipment.

Step 3b: Stop suction by closing the quick acting suction valve(s)

Step 4b: Open the quick coupler vacuum-breaker-valve as indicated in Figure 5, allowing atmospheric ingression into the suction hose. Allow remaining effluent in the suction hose to drain prior to continuing to **Step 5 b**.

Step 5b: Disconnect suction-hose and pack all equipment away. Ensure that all valves are closed (with note on unloader ball valve) prior to driving away from the collection site.

4.3. Dumping Procedure

The collection and dumping procedure are analogous such that both utilise the same equipment with the exception of the vacuum-breaker valve on the septic tank.

Step 1c: Unload suction hose and connect it to the Quick Coupler (Item-17) as seen in Figure 1. Ensure that suction hose vacuum breaker (Item-12) is closed.

Step 2c: Place the suction hose in the dumping tank/pit.

Step 3c: Open the suction valve as indicated in Figure 5.

Quick Coupler Vacuum Breaker Valve

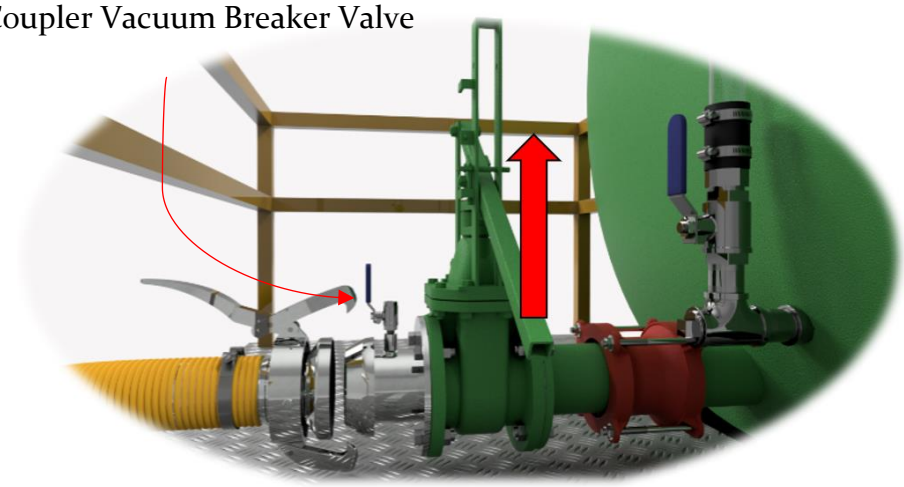


Figure 5: Quick Acting Suction Valve Operation

It is noted that there is vacuum in the septic tank is as a result of both the vacuum equipment operation and super positioned by drainage of effluent from the tank, reducing the flow rate.

Increase this flow rate by;

Step 4c: Opening the vacuum breaker valve (Item 12) indicated in Figure 1**Error! Reference source not found.**Once this valve is opened, atmospheric pressure will enter the effluent tank and the flow rate will be significantly increased.

Step 5c: Once tank is empty, close the suction valve(s), pack away the suction hose and ensure that all valves are closed prior to leaving the dumping-site.

5. Maintenance

The maintenance protocol for the system may be broken down into two categories; First: Operator-Maintenance, Second: Engineering/Cleaning Operations. Each process is time recommended; however, frequency of maintenance is subject to operating conditions and effluent.

5.1. Operator Maintenance

It is noted that the inline strainer and the oil level (in the B-Range Exhauster) are the two most essential operator maintenance criteria, if not carried out may/will lead to pump failure due to overheating (i.e. the vacuum exhauster is cooled by convective heat transfer from the outer fins and the air that passes though the exhauster's rotor cavity), if the inline strainer is not cleaned/maintained and blocks, air ceases to pass through the exhauster, subsequently causing supplementary heat retention, and resulting in component-damages and catastrophic system failure.

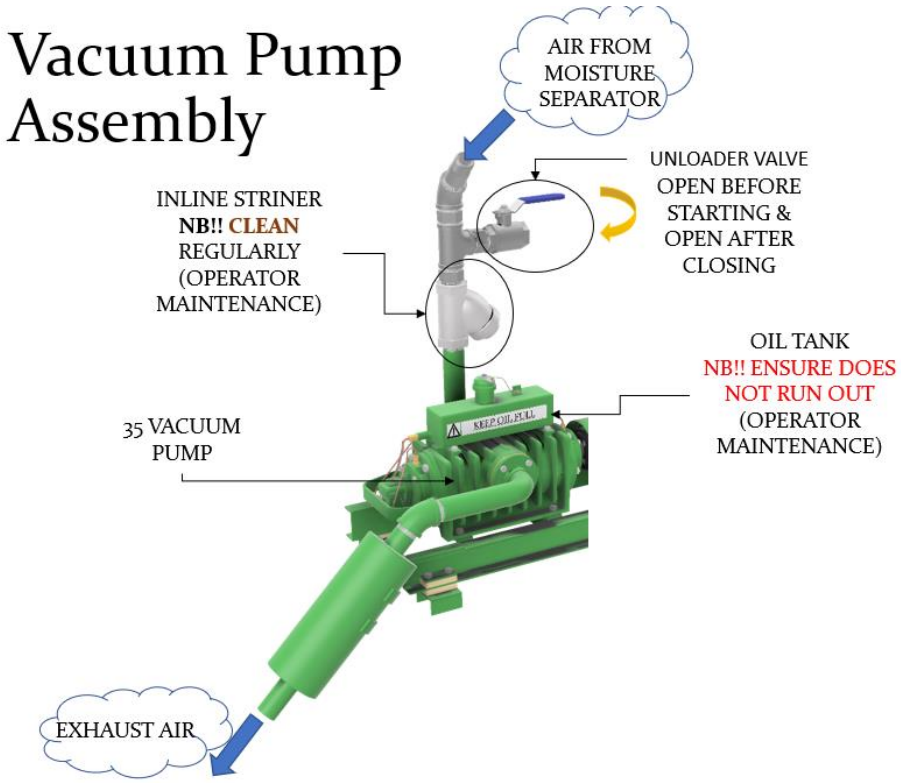


Figure 6: Vacuum Pump Assembly

The vacuum exhauster is a lost oil process, thus requires a continuous supply of oil to ensure that the bearings and internal blades of the vacuum pump remain lubricated. If there is no oil to lubricate dynamic components of the exhauster, increased friction results in additional heat and wear, causing component-damages to the vacuum pump).

Figure 6 indicates the typical arrangement of the operator maintenance parts, Table 3: discusses the protocol to take place.

Table 3: Operator Maintenance

Maintenance Item	Operation/Action	Reference Image
Inline Strainer	An operator is to open the inline strainer, remove the internal filter, clean the filter until all accumulated debris is removed, placed filter back into the strainer housing and close the strainer. *Take care not to over-tighten.* Frequency: Daily (may vary depending on effluent).	 *Figure 7: Inline Strainer*

Maintenance Item	Operation/Action	Reference Image
Oil Tank	An operator is to ensure that the B-Range vacuum exhauster **does not run out of oil** (using standard engine-oil such as 15W40). There are three holes on the internal dipstick, each indicating approximately 32 hours of operating time. Frequency: Weekly (may vary depending on effluent).	 ***Figure 8: Oil Tank***

5.2. Engineering/Cleaning Maintenance

Engineering/cleaning maintenance is considered one of the most vital aspects in sustaining a healthy vacuum plant. The hardware is designed to operate efficiently for years of service, however, due to the nature of the hazardous effluent subjected to the equipment, regular cleaning is required.

Figure 9 and Figure 10, indicate the mechanical setup of the Moisture Separator and Snifting Valve respectively. The figures indicate the items to undergo maintenance further discussed in Table 4.

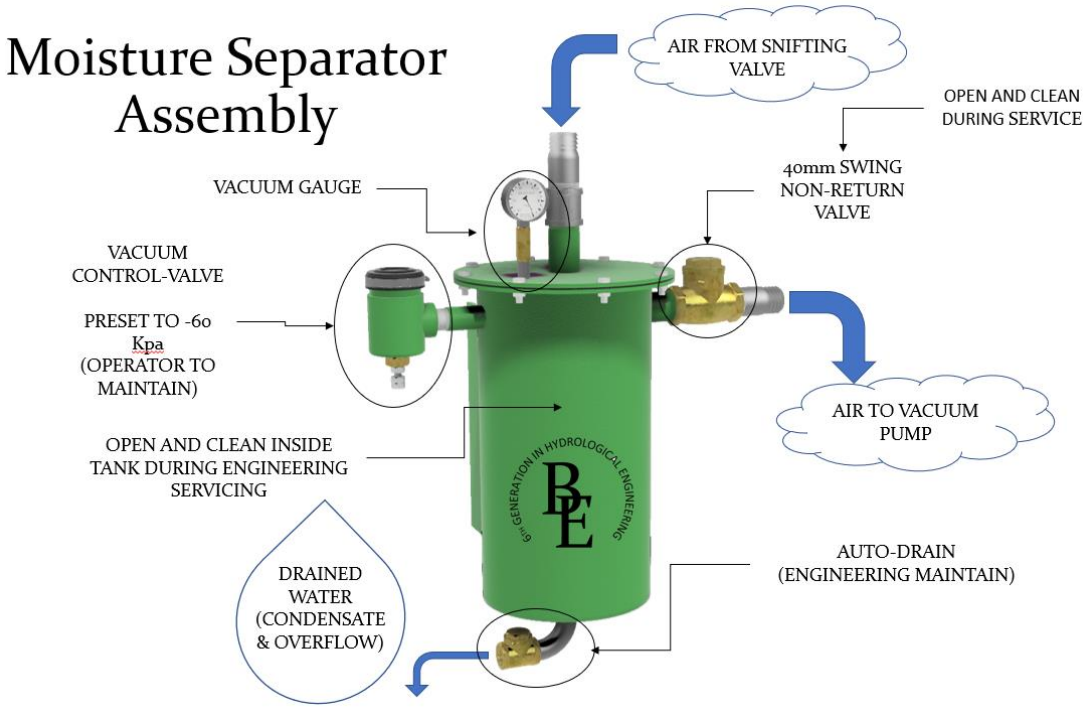


Figure 9: Moisture Separator Assembly & Related Hardware

The vacuum plant includes all the components illustrated in Figure 6,Figure 9 &Figure 10. It is essential to note that the vacuum pump operates by compressing Newtonian

fluids such as air. Thus, it is critical to ensure that none of the collected effluent makes contact with the exhauster. The vacuum plant consists of all the necessary hardware to safeguard the system. Negligence to carry out maintenance on the plant will result in system damages and consequential catastrophic failure.

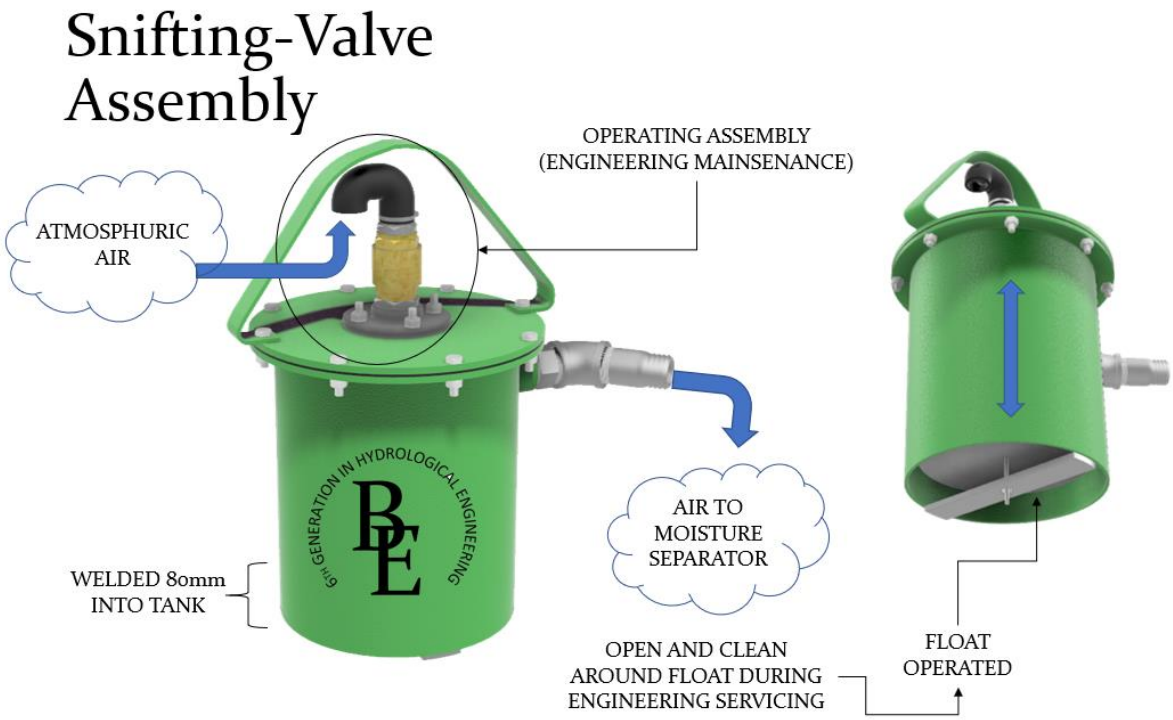
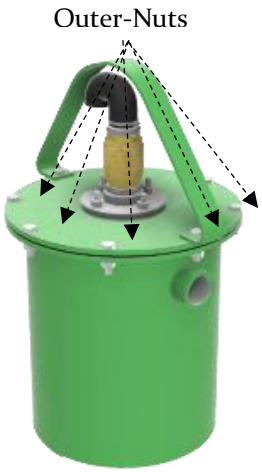
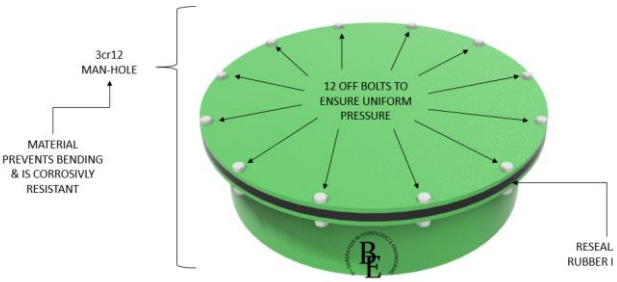
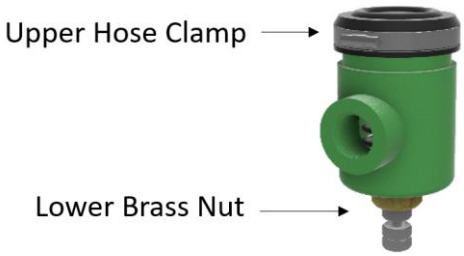
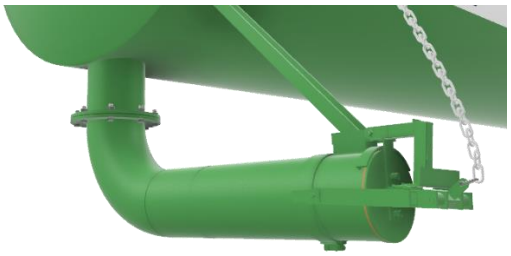


Figure 10: Snifting Valve Assembly

Table 4 Engineering/Cleaning Maintenance

Maintenance Item	Operation/Action	Reference Image
Moisture Separator	The moisture separator may accumulate small debris along the sides of the main housing. If the build-up is not removed, the functionality of the hardware is reduced and may result in fluid overflow to other related vacuum equipment. Thus, remove upper flange and clean the housing. Take care not to lose the rubber gasket. Frequency: Monthly (May vary depending on effluent)	 *Figure 11: Moisture Separator*

Maintenance Item	Operation/Action	Reference Image
40mm Non-Return Valve & Auto-Drain	Open swing-check non return valve, cleaning the rubber seat and ensure that the swing-check moves freely Frequency: Monthly (May vary depending on effluent)	 *Figure 12: 40mm Non-Return Valve*
Snifting Valve	Remove the outer nuts surrounding the Valve, lift valve out of the tank and clean around the stainless-steel float such that it is able to move freely. Do not loosen any other nuts unless required. Frequency: Monthly (May vary depending on effluent)	 *Figure 13: Overflow Stop Valve*
Septic Tank	Due to the presence of solids in septic effluent, over time the tank will accumulate a build-up of solids within the tank, reducing the collection capacity. It is recommended that the tank is opened and cleaned out using the vacuum manhole located at the top of the tank. Frequency: Bi-annually (May vary depending on effluent)	 *Figure 14: Vacuum Manhole*

Maintenance Item	Operation/Action	Reference Image
Vacuum Control Valve	Ensure that the control valve is in working order and has not accumulated solids in the housing preventing functionality. The control valve is one of the vacuum plant essential accessories such that it safeguards the vacuum vessel and exhauster. An operator is able to gain a sense of the part integrity by tugging on the brass nut located at the base of the valve, if there is no movement, it is likely that there is blockage. In the event this occurs, remove the upper hose clamp and clean the valve internals. Frequency: Bi-annually (May vary depending on effluent)	 *Figure 15: Vacuum Control Valve*
200mm Dump Valve	The 200mm Dump Valve is a rapid solution to timeously carrying out the dumping procedure discussed in section 4.3. General maintenance on the component Involves regular cleaning of the main pipeline and rubber gasket (it is essential to ensure that there are no solids or debris extruding from the main pipeline before shutting the valve as it may result in tearing of the rubber seal). In the event that the valve starts leaking, replace the rubber gasket. Frequency: Bi-annually (May vary depending on effluent)	 *Figure 16: 200mm Dump Valve*

In the event that the site glass is not indicating, or a visual blockage is present, the site-glass-assembly has been structured to allow an operator to carry out the necessary steps to remove the blockage. Figure 17 illustrates the process to follow. Fist one is to remove the upper cap and probe the blockage to the lower limit of the assembly, secondly; remove the end-cap on the lower fitting arrangement and probe the blockage into the tank.

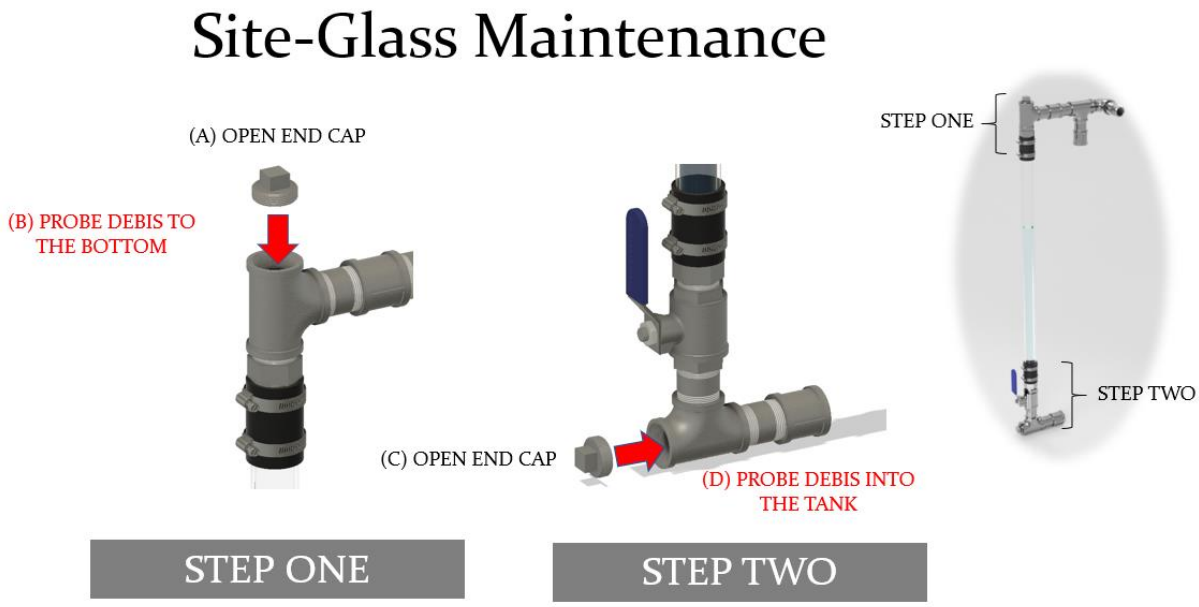


Figure 17: Site Glass Maintenance

As part of general maintenance, it is recommended that the valves and vacuum equipment are cleaned and inspected for leaks every 6 months to ensure the longevity of the system and mitigate any down time that may be experienced due to worn valves etc.

In the event that the vacuum exhauster is damaged as a result of erroneous operation, the B-Range vacuum exhausters and low-pressure compressors are fully serviceable. All parts are sold separately, mitigating downtime and ensuring effective after sales support

It is standard to use an overhaul kit (as seen in Figure 18) when servicing the vacuum exhauster.

Figure 18: Vacuum Exhauster Overhaul Kit

Training on the servicing is offered free of charge at the Broom Engineering factory in Strydom Park (South Africa)

6. Trouble Shooting

In the event that your exhauster seizes or is exhibiting unusual behaviour, Figure 19 indicates and series of possible causes to vacuum exhauster's malfunction. If the issue is not listed in the diagram, it is recommended that you contact your local supplier for more information.

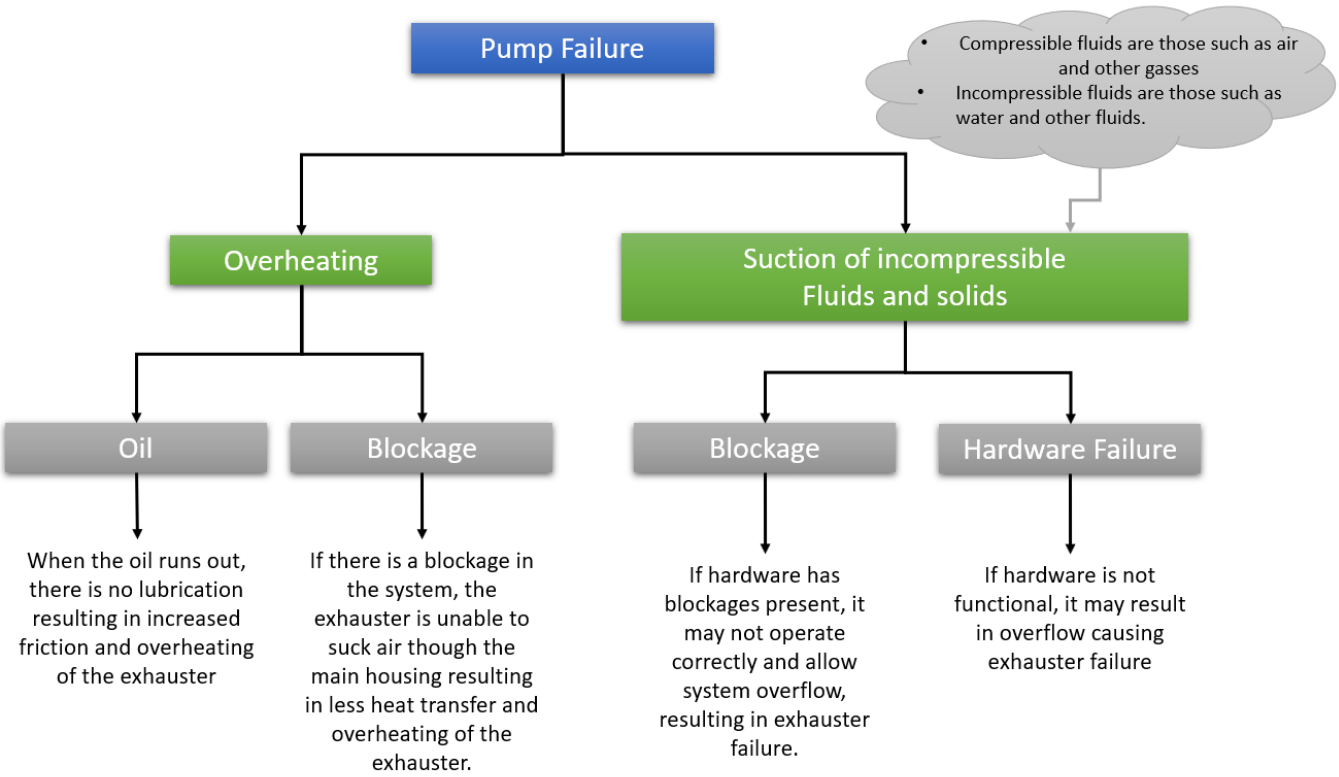


Figure 19: Trouble Shooting Flow Diagram

6. Service Log

Part(s) Serviced	Notes
	Checked By: _____ Date:_____
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7. Notes

Broom Engineering
Since 1976

Address:
25 Susan Street,
Strydom Park,
Randburg, 2169
South Africa

Tel: +27 11 792 1828