



Airvac

The **world leader** in vacuum sewer collection technology.

Vacuum 101

An introductory
guide to
vacuum sewer
collection
systems



A brand of
Aqseptence Group

What is a Vacuum Sewer Collection System?

A vacuum sewer collection system is a mechanized method of transporting wastewater. Differential air pressure creates flow rather than gravity or pressure. Essentially, a vacuum sewer collection system is a vacuum-assisted gravity sewer system.

Vacuum sewer collection systems require a vacuum station similar to a gravity lift station or pumping station. Unlike a lift station, vacuum pumps maintain vacuum on the collection mains. To maintain this vacuum, a valve at each sewage input point seals the system. The valve opens automatically when a given quantity of sewage accumulates in a collection sump. This valve is entirely pneumatic in its control and operation. Differential pressure between local atmospheric pressure and the vacuum pressure provides the thrust needed for liquid transportation.

Vacuum sewer collection systems are applicable when these conditions exist:

- Failing septic tanks causing pollution.
- At least 25 connections. We also have systems serving more than 10,000 connections!
- Primarily residential connections. Commercial connections are also possible.
- Private developments.
- Flat topography or moderate elevation change.
- Subsurface difficulties to overcome including high groundwater table, sandy and unstable soils, rock, restricted construction conditions, and sensitive eco-systems.



**For a quick
overview video**

Scan the QR Code
with your mobile device.

Why Use a Vacuum Sewer Collection System?

Vacuum Sewer collection Systems are:

Cost-effective, Efficient and Reliable

Airvac Vacuum Sewer Collection Systems are clean, efficient, easy to maintain, easy to install and typically less expensive than other collection systems. It is a proven technology with a long history of success and reliability.

Environmentally Friendly

Our completely closed vacuum collection system prohibits the infiltration and inflow of groundwater from the valve pit to the vacuum station, protecting our environment from exfiltrating wastewater. It is one of the most environmentally friendly solutions available.

Safe for Operators

With an Airvac Vacuum Sewer Collection System, operators are not exposed to raw sewage or work in confined areas, minimizing their risk of exposure to viruses, bacteria, parasites, or harmful gases such as methane and hydrogen sulfide. With our newest technologies, they also experience noise and heat reduction at the vacuum pump stations. This provides them with a more safe and comfortable work environment.

Less Disruptive to Communities

The fast and simple excavation required for an Airvac Vacuum Sewer Collection System creates shallower trenches, uses smaller diameter pipes, and smaller excavation equipment. Roads can remain fully or partially opened, creating far less disruption to your community than traditional gravity sewers. You will experience significantly reduced restoration, construction, and energy costs as well.

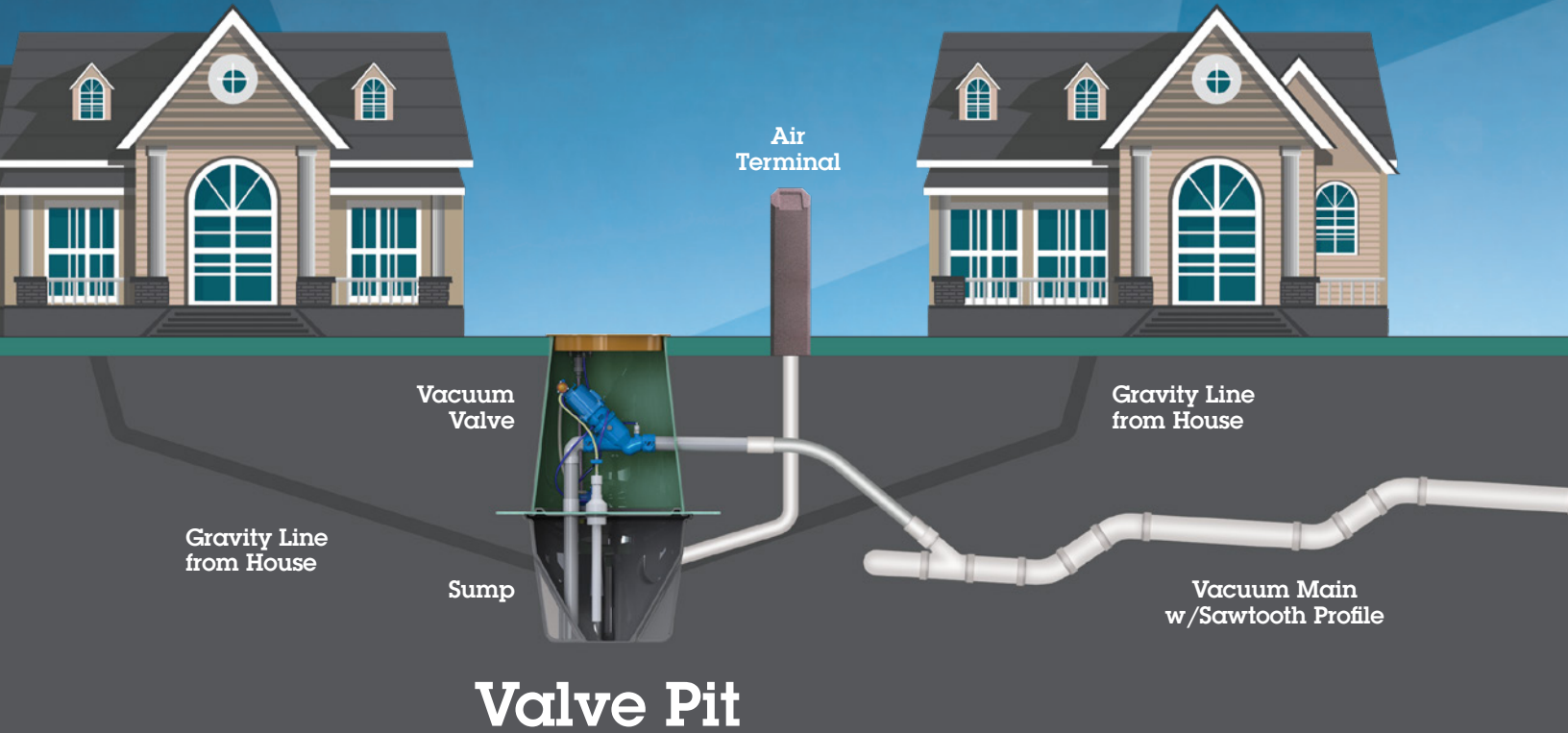
Severe Weather Ready

Because vacuum valves are pneumatically operated, the only source of power required for an Airvac vacuum sewer collection system is at the main vacuum station. Every Airvac vacuum station has a permanent back-up generator or a hook up for a portable generator, so power outages are never an issue.



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How does an Airvac Vacuum Sewer Collection System Work?

1

A traditional **gravity line** carries wastewater from the customer to an Airvac **valve pit** package.

2

The Airvac **vacuum valve** opens when 10 gallons of sewage collects in the sump and then differential pressure propels the contents into the **vacuum main**.

3

Wastewater travels at 15 to 18 fps in the **vacuum main**, which is laid in a sawtooth fashion to ensure adequate vacuum levels at the end of each line.

Vacuum Station



Our completely closed vacuum sewer collection system prevents infiltration and inflow of groundwater from the valve pit to the vacuum station, protecting waterways from exfiltrating wastewater.

4

Vacuum pumps cycle on and off as needed to maintain a constant level of vacuum on the entire collection system.

5

Wastewater enters the **collection tank** and fills to a predetermined level.

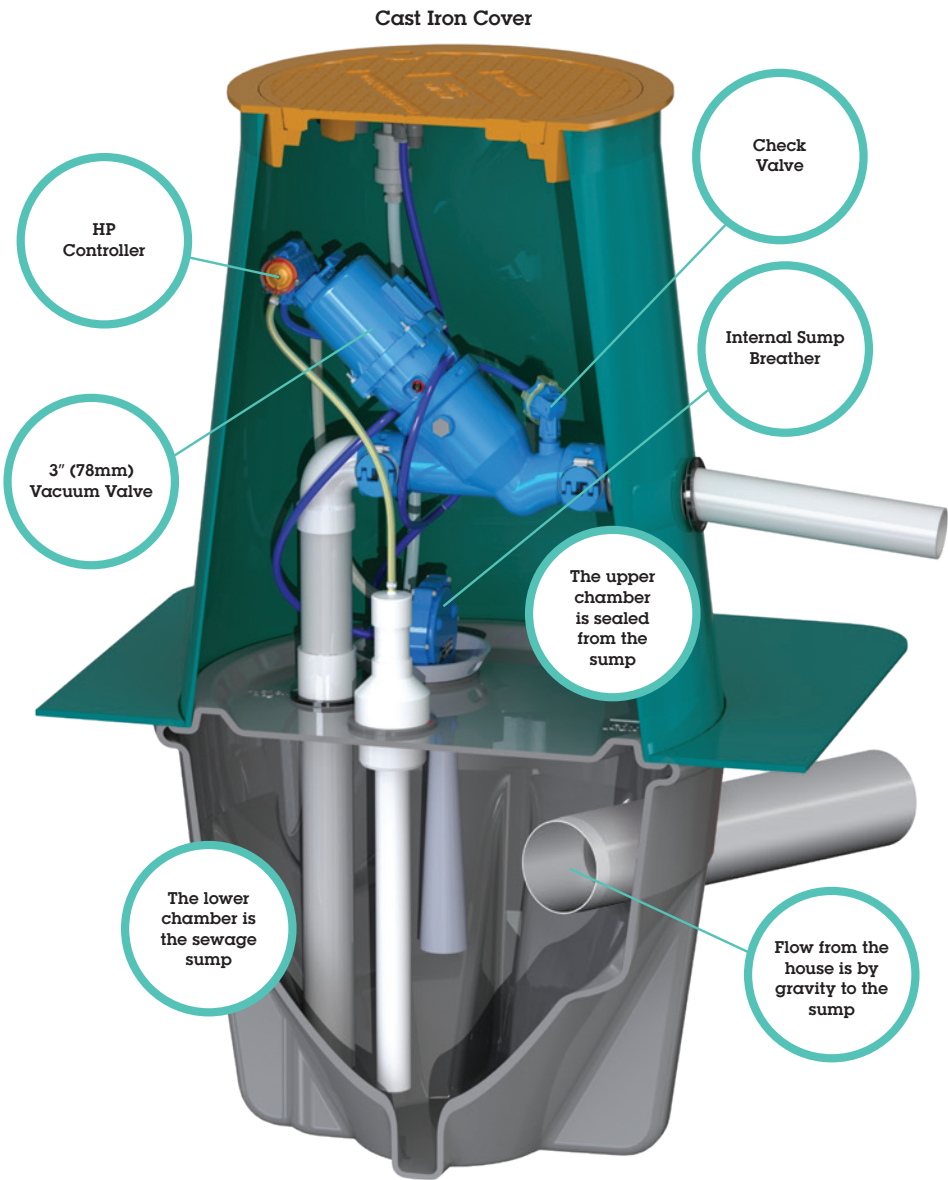
6

Sewage pumps transfer the contents to the treatment plant via a force main.

The Valve Pit

The Airvac valve pit provides the interface between the vacuum collection system and the house. The top chamber of the valve pit houses the Airvac vacuum valve and the bottom chamber is a sewage sump into which the gravity lateral from the house connects. The two chambers are sealed from each other, preventing maintenance personnel from being exposed to raw sewage.

Each valve pit can accommodate sewage for up to four homes, although the most common configuration is one valve pit serving two adjacent houses. No special plumbing fixtures are required by the homeowner and it is pneumatically operated so no electricity is required at the valve pit.



H-20 traffic rated

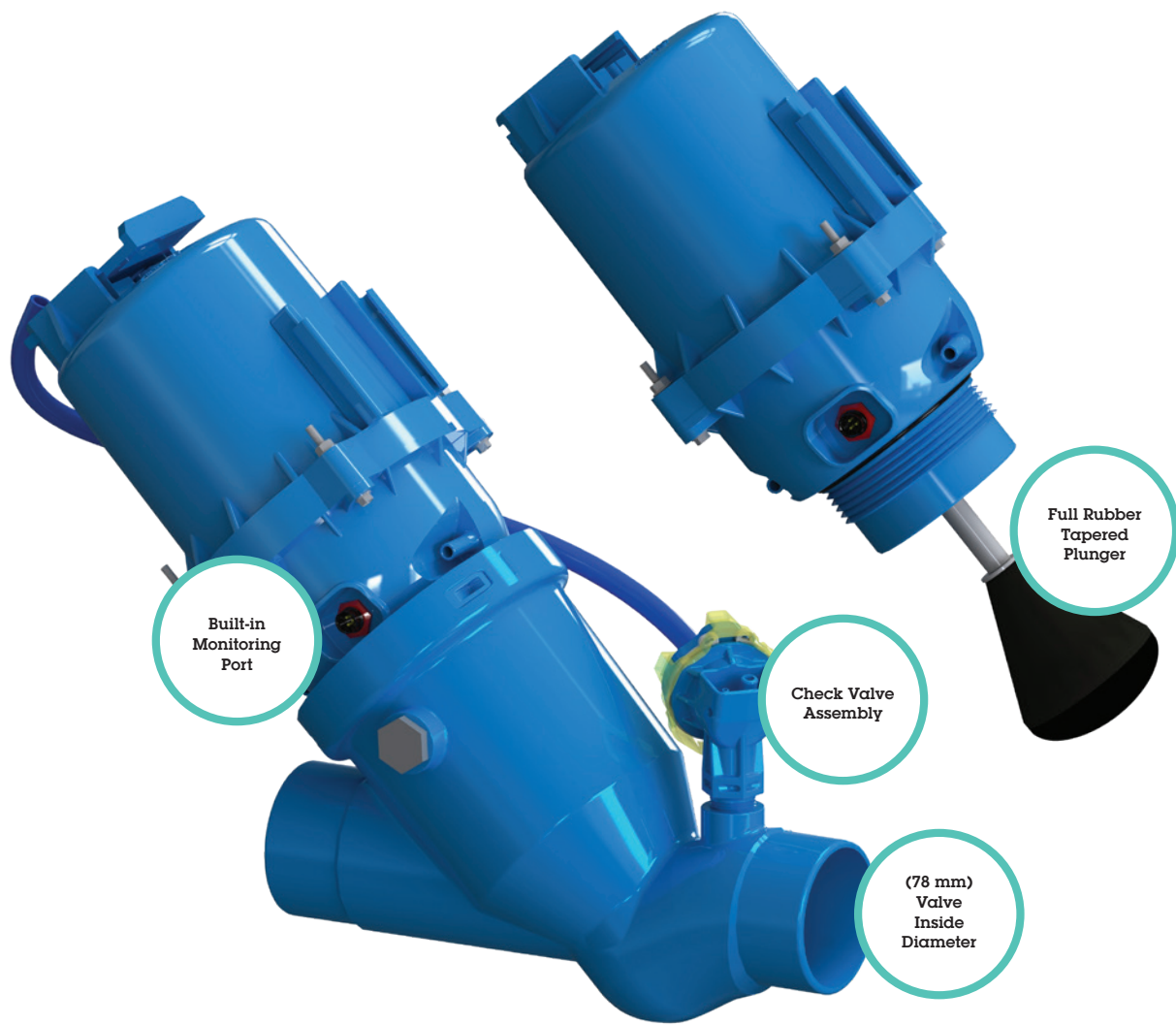
The 3" (78mm) Vacuum Valve

The Airvac 3" vacuum valve is vacuum operated on opening and spring assisted on closing. System vacuum ensures positive valve seating. The valve has a 3-inch full-port opening designed for handling 78mm solids, is made of glass filled polypropylene, and has a stainless steel shaft, delrin bearing and elastomer seals.

The 3" (78mm) vacuum valve is equipped with a rolling diaphragm-type vacuum operator and

is capable of overcoming all sealing forces, and opens using vacuum from the downstream side of the valve. All materials of the valve are chemically resistant to normal domestic sewage constituents and gases.

Vacuum valves are also available in 1.25", 1.5", and 2" models, which can be used for specific applications.

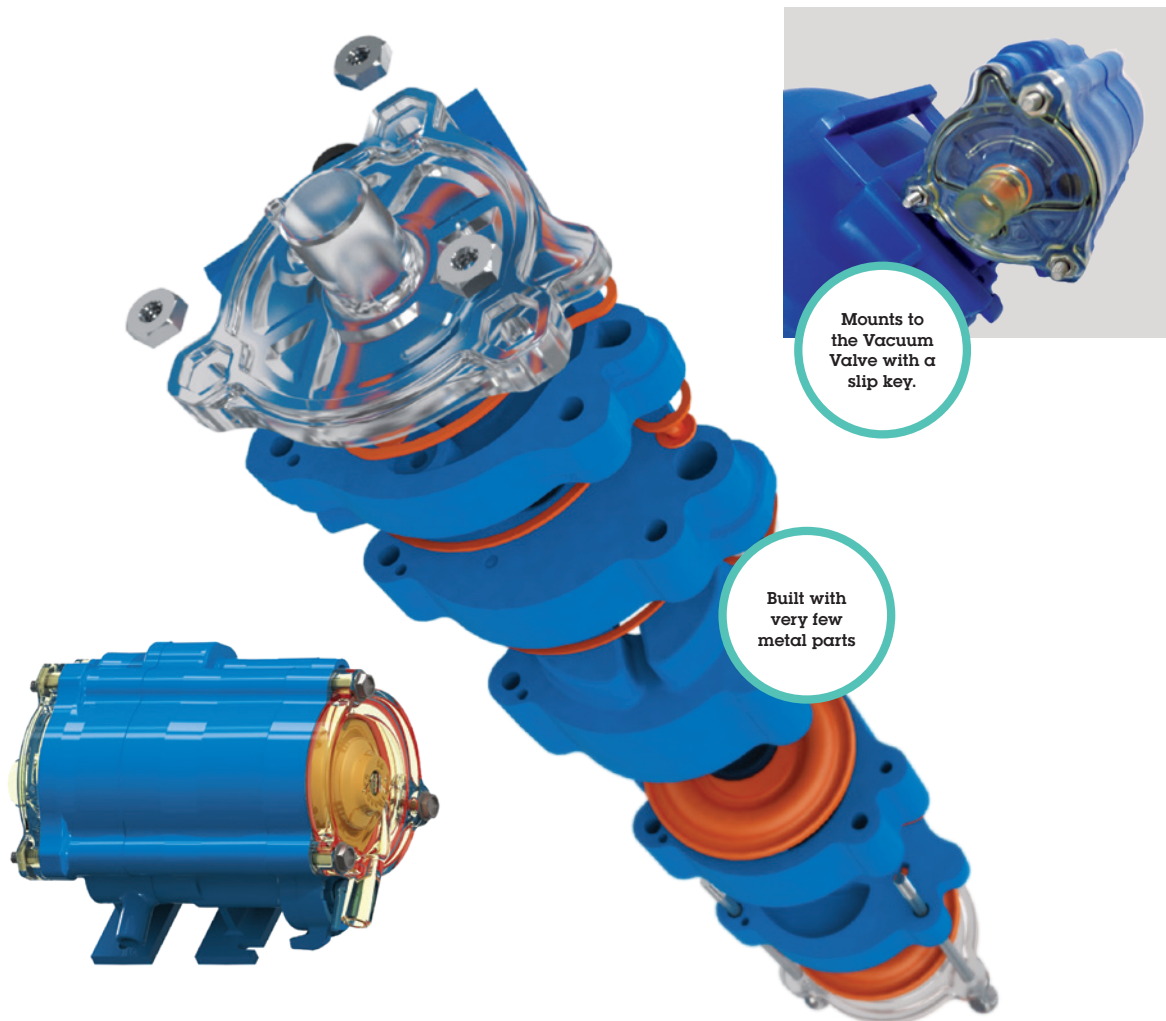


The HP Controller

The Airvac valve pit was designed so that a very repeatable, specific amount of liquid is withdrawn each cycle. This in turn helps control the Air to Liquid (A/L) ratio ensuring proper system operation. The HP Controller is the key component of the Airvac 3" vacuum valve that provides this function. The HP Controller is chemically resistant to sewer gases and is capable of operating when submerged in water.

The HP Controller relies on three forces for its operation: pressure, vacuum, and atmosphere.

As the sewage level rises in the valve pit sump, it compresses air in the sensor tube. This pressure initiates the opening of the valve by overcoming spring tension in the controller and activates a three-way valve. Once opened, the three-way valve allows the controller to take vacuum from the downstream side of the valve and apply it to the actuator chamber to fully open the valve. After the preset time period has elapsed, atmospheric air is admitted to the actuator chamber permitting spring assisted closing of the valve.



Mounts to the Vacuum Valve with a slip key.

Built with very few metal parts

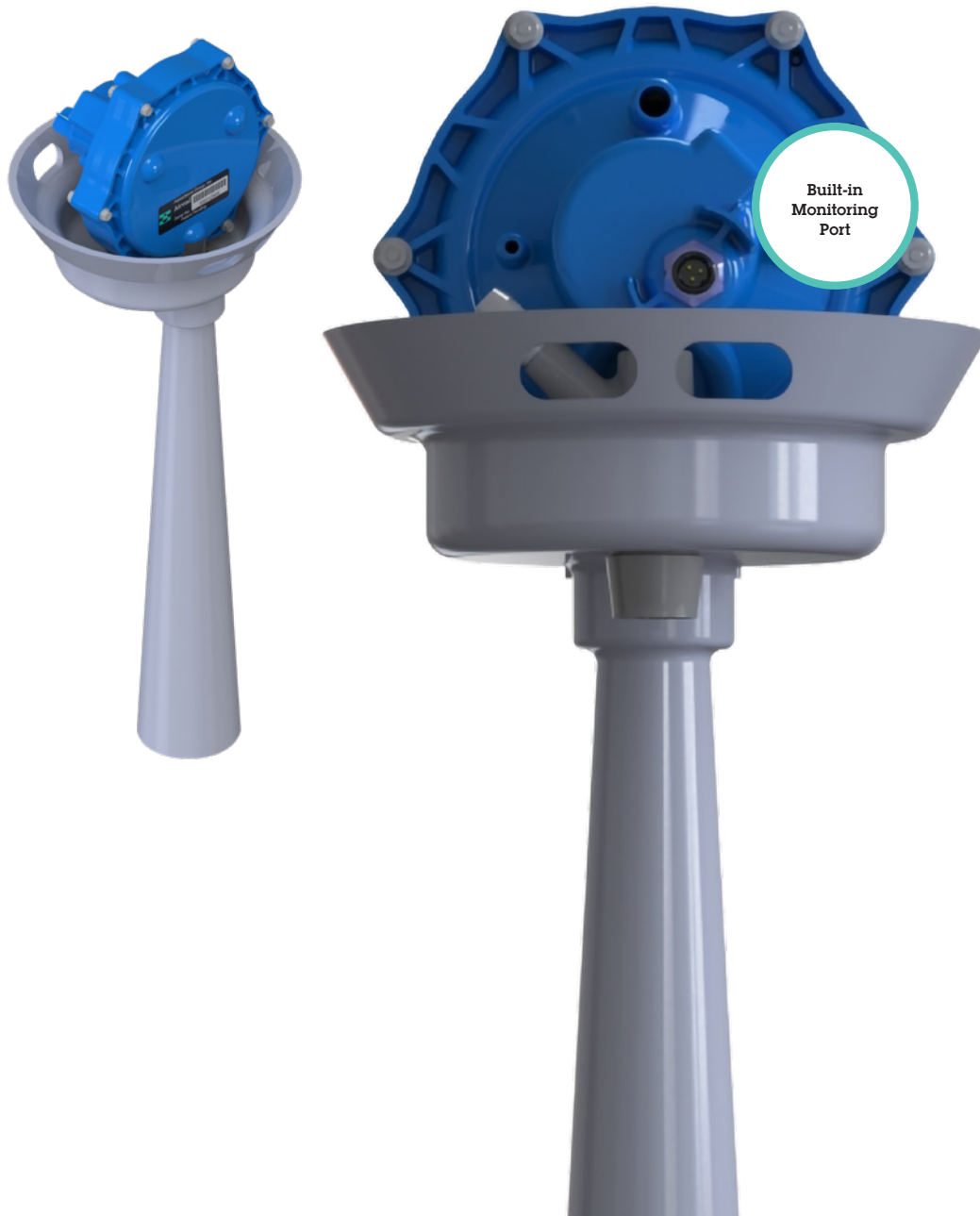
The Sump Breather

The Sump Breather operates through the use of a diaphragm that reacts to the breather pipe pressure. The sensor pipe pressure ranges from 0" (sump empty) to 6" (level where valve normally cycles).

When sewage level becomes abnormally high, the sensor pressure continues to rise. When 22" of pressure is present, the diaphragm will seal off the ports of the sump breather, protecting the

controller from water and moisture damage. An internal switch will activate to provide a high sewage sump level signal for monitoring. As a result, high sewage sump floats are not required.

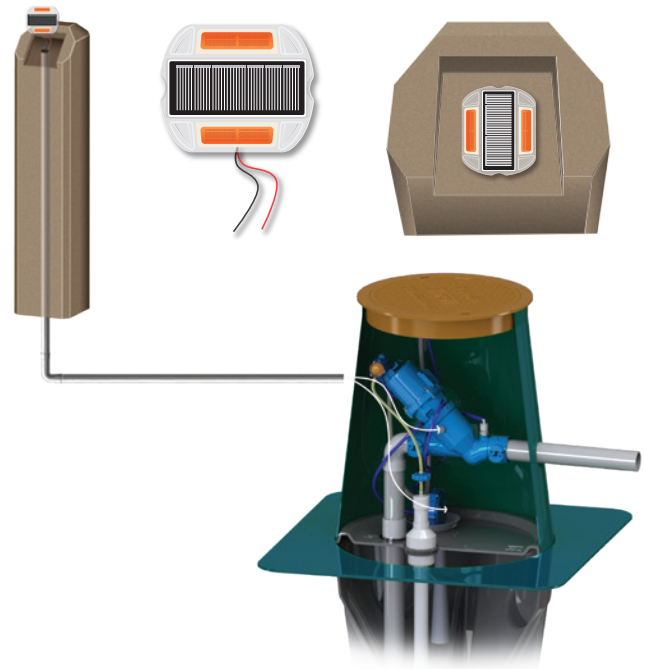
When the system operation problem is corrected, the valve will cycle, and the sewage sump will be emptied. The sensor pipe pressure will drop to 0" allowing the valve and controller to return to normal operation.



The Air Terminal

The air terminal provides the system with a source of atmospheric air, which is necessary for liquid transport. Airvac's 6" air terminal consists of a molded housing that is placed on 6" piping connected directly to a valve pit sump. The air terminal was designed to look like other utility boxes/structures typically seen in rights-of-way. The air terminal is supplied by Airvac and is installed by the contractor during the construction phase as part of the valve pit installation.

A solar light monitor can be mounted on an air terminal and connects to the internal breather and the vacuum valve. The monitor can signal a high sewage sump level via the breather or a valve failure via the vacuum valve. The light is easily visible from a long distance, avoiding the need for operators to physically check every vacuum valve in the system.



A solar light monitor is mounted on the air terminal and connects to the internal breather and the vacuum valve.

Vacuum Mains

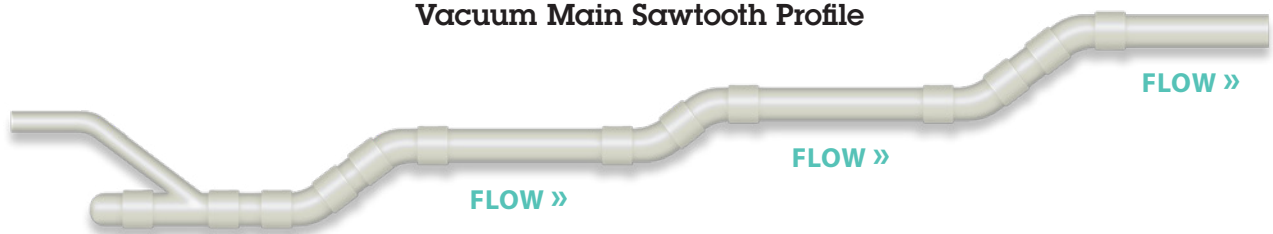
Traditional gravity sewer system installations can be very disruptive to a community, often shutting down roads completely for long periods of time.

Vacuum mains use small diameter pipes installed in shallow, narrow trenches (usually 3 to 6 ft below the surface). Because of these factors, the mains are typically installed adjacent to the pavement. This results in significantly reduced construction costs, road restoration and time savings.

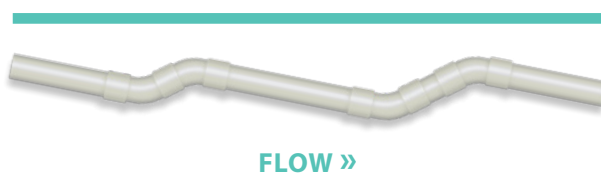
Airvac's fast and simple excavation requires not only smaller trenches, but smaller excavation equipment as well. Roads can remain fully or partially open, creating far less disruption to the people in your community.

The sawtooth profile of the vacuum main is the industry standard for vacuum sewer systems. It was originally patented by Airvac in 1979. It ensures adequate vacuum levels are maintained at every point along the line.

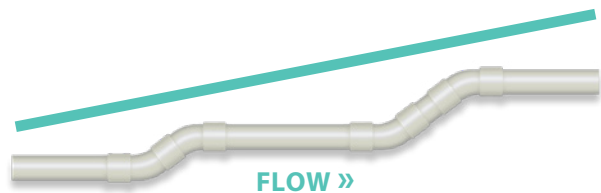
Vacuum Main Sawtooth Profile



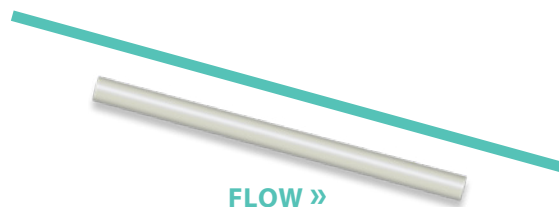
Level, Uphill & Downhill Transport



Level – use "lifts" to maintain same elevation.



Uphill – space lifts closer together.



Downhill – follow ground slope.

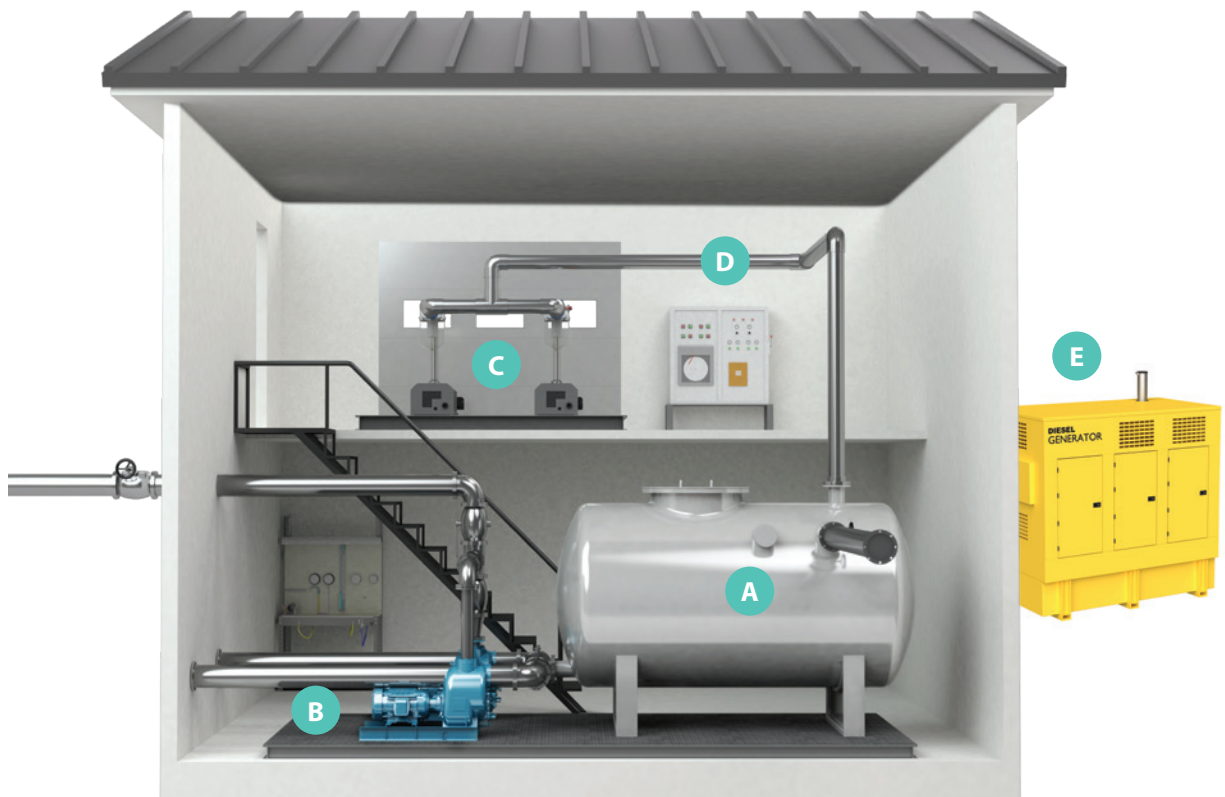
The Vacuum Station

A vacuum station is the heart of a vacuum sewer collection system.

Major components include a **collection tank** (A), **sewage pumps** (B), **vacuum pumps** (C) and a **control panel** (D). The vacuum station skid is housed in a protective structure and a **standby generator** (E) keeps the vacuum system in operation during extended power outages.

Sewage enters a collection tank and discharge pumps transfer the sewage through a force main to the treatment plant. Vacuum pumps create negative pressure on the collection tank which is then transferred to the entire piping network via the vacuum mains.

A vacuum station is about the size of a large shed and can serve houses up to two miles away.



Airvac offers several types of vacuum station equipment packages designed to accommodate a wide range of customer needs including the Airvac PacVac and various Airvac Engineered Custom stations.

Vacuum Station Models

Airvac vacuum station models are ideally suited for small to medium-sized projects serving less than 550 connections and/or peak flows less than 350 gpm. Generally, the mechanical and electrical components are located on skids including the vacuum pumps, sewage pumps, collection tank and control panel. The skids are housed in a prefabricated building that can be supplied by Airvac.

An engineered custom vacuum station is ideally suited for larger systems with more than 550 connections and peak flows greater than 350 gpm but can be used with smaller systems as well. With an engineered custom vacuum

station, Airvac provides all of the internal components on a skid(s) which are housed in a building custom designed by an engineering firm. Prefabricated options are also available. The Airvac skid(s) is typically housed in a two story structure with the vacuum pumps and control panel located on the top floor and the collection tank and sewage pumps on the lower floor.

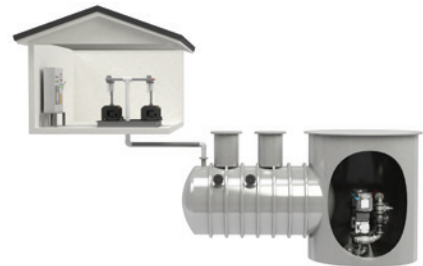
For customers who need an inexpensive, small vacuum station for an initial phase of a larger system, Airvac also can house the vacuum station in a shipping container and make this available on a short term lease basis.



PacVac 1



PacVac 2



PacVac 3



Type 360



Container Station

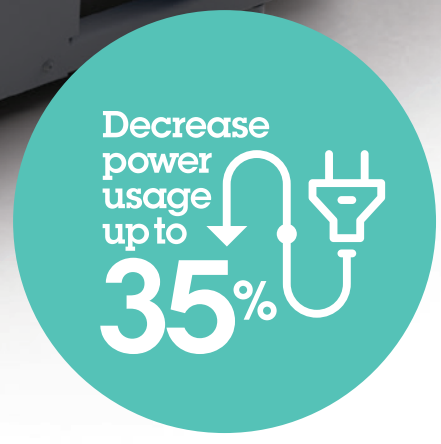
Vacuum Pump Modulation

Modulation is a patent pending program logic that improves the manner in which your vacuum system functions. Previous designs required vacuum pumps to turn on at 16" Hg and off at 20" Hg regardless of the situation within the vacuum system.

The modulation sequence controls the speed of the vacuum pumps to maintain a tighter vacuum range and speeds up and slows down depending on the demand of the vacuum system.

It is unusual for the pumps to ever operate at full speed.

Since the pumps are not turning on and off as frequently, it also significantly reduces the overall power consumption and creates less heat and noise.



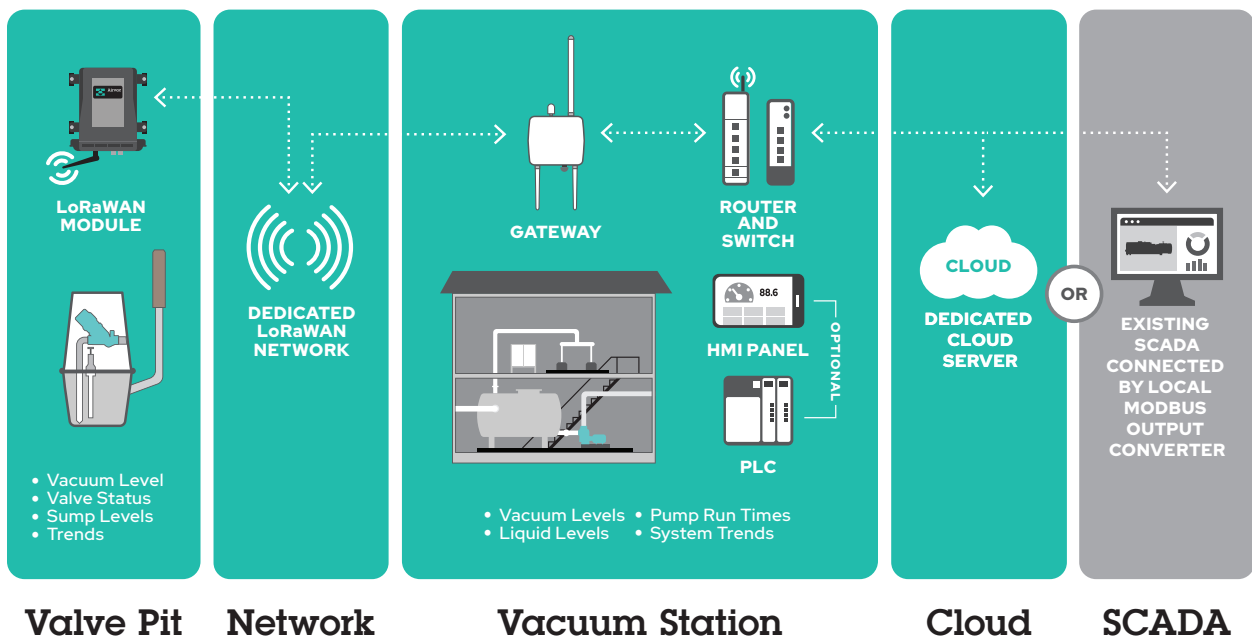
Wireless Monitoring

The Airvac Wireless Valve Pit Monitoring System is a wireless system that transmits valve pit and vacuum main operating data back to our dedicated central scada system, which is typically housed within the vacuum station. With this system, the operating personnel can see exactly how each valve pit is functioning in real time. In addition, all pertinent data from each valve pit is collected and saved to allow for analysis and adjustment if necessary.

A wiring harness is installed in the valve pit and connects to a cable running to the air terminal. A wireless radio unit is installed in the air terminal or in a utility box next to the pit. It is programmed to monitor valve opening and closing operations and monitors liquid levels in the holding sump. The pit radios used are the latest design, longest range, lowest power consumption models available. Signals are collected by the wireless unit and transmitted at set intervals.

Batteries were selected for the wireless radio unit that are tolerant of low temperatures and meet the long life requirements of the application. Battery conserving methods are also used without sacrificing the ability to receive alarms.

The "trend" feature tracks the operation of each valve pit and notifies the operator of imbalances within the system. This notification allows the operator to proactively address potential problems before they occur. An additional feature is the ability to pinpoint a problem when it occurs. An alert will be sent to the operator and the exact location of the failure will be identified. This results in quicker operator response time, fewer homeowner disruptions and lower operation and maintenance costs.



Frequently Asked Questions



Is there an industry standard for vacuum sewers?



The Water Environment Federation manual "Alternative Sewer Systems, MOP FD-12" contains extensive information regarding the planning, design, construction, operation, and maintenance of vacuum sewer systems. This manual is the industry standard for alternative sewer systems. In addition, states like Florida have created design review checklists for vacuum sewers, ensuring that systems are designed to meet their standards.



In order to design a properly operating system, should design flows be estimated as accurately as possible, and a detailed route survey be performed?



To design any collection system, design flows must be estimated as accurately as possible. For gravity, a detailed route survey must also be performed.



Vacuum systems cannot be easily expanded to serve additional homes, correct?



The expandability of a vacuum system is a function of many factors: flow, pipe length, pipe volume, hydraulic considerations, etc. Each system is different. Some systems have an inherent reserve capacity; some must have the reserve capacity designed in. In most cases, using some common sense while doing the line layout and the station component sizing, one can easily build a reserve capacity of 50 - 100%, with only a minimal increase in upfront cost (5-10%).



Are vacuum sewers operation and maintenance intensive?



A frequently held misunderstanding is that vacuum systems are inherently maintenance intensive. Experience has not supported that opinion. Properly designed vacuum systems, operated by qualified personnel, are relatively easy to maintain.

Do vacuum pumps run 24 hours a day to keep vacuum on the system?

Vacuum pumps do not run continually. The typical vacuum station is designed so that the vacuum pumps operate about 4-6 hours a day.



Are replacement parts expensive?



The small parts of the vacuum valve and controller, which are subjected to the most wear, are very inexpensive. A vacuum valve and controller can be rebuilt for about \$50-\$70, and takes less than 1 hour to complete. Recommended rebuild frequency is 15 years for the valve and 10 years for the controller.



Because this type of technology is less widely used, is operating history information and overall reliability of the system more difficult to predict?



With more than 450+ Airvac vacuum systems in the Americas, and nearly 1,000 systems worldwide, operating data is plentiful. Numerous case studies have been published over the past 20 years which illustrate the continuing advancements in the technology and how vacuum sewers can be considered as reliable as any other collection system.

Frequently Asked Questions



Are vacuum sewers only used in small communities?



Early vacuum systems were used in small communities with 75 to 500 connections. As time has passed, systems have gotten much larger. In fact, Airvac has several systems serving 10,000+ homes. These systems typically involve multiple vacuum stations. As a rule, a single vacuum station can serve as many as 2,000 connections.



Do vacuum systems require highly skilled operators?



Any water or sewer utility worker can be trained to operate a vacuum system. Factory training by Airvac, including hands on experience with the vacuum valve and controller, is usually all that is needed.



Should lines that are not used year-round (such as for seasonal homes), be flushed out periodically?



Vacuum mains are designed to carry 1/3 sewage and 2/3 air. The pipe between the vacuum valve pit and the vacuum main only contains sewage when the valve fires. Designed with a downward slope, it then empties by gravity. During time of non-use, there is nothing in these lines.

As for the mains, unless an entire section is seasonal, there will be some valves operating on each main line. A timing mechanism in the vacuum valve controller can easily be adjusted to hold the valve open longer resulting in more movement of the sewage.



Since vacuum sewers are mechanized, are they unreliable?



Early (1970's, early 1980's) vacuum systems were not without their problems. However, component improvements, design advancements, and experience with the technology, have resulted in systems that are consistently reliable.



Does vacuum need to be constantly maintained in the line in order for the system to work?



Some of this was true in the older vacuum sewer systems. Smaller diameter pipes and smaller vacuum pumps were used, making the early systems a little more sensitive to malfunctions due to the limited vacuum reserve in the pipelines and slower "vacuum recovery" times due to the smaller vacuum pumps used in that era.

Present day vacuum systems use larger diameter pipes and larger vacuum pumps than the earlier systems. This results in more pipe volume, more vacuum reserve, and quicker vacuum recovery. The net result is that a leak or malfunction now has less effect on the overall system. Typically, this results in increased pump run time until corrected, but service to the customer remains uninterrupted.

Additionally, designers have learned to use "zones" created by multiple mains that enter the vacuum station. Any abnormality in one zone can be isolated, thereby having no effect on the rest of the system.

About Airvac

Airvac's Mission

Our mission is to create effective and intelligent technologies, providing our customers with the most sustainable and eco-friendly solutions.

We empower our team members to grow and succeed, to believe in themselves, thereby releasing their full potential.

Airvac is:

A Global Company

There are more than 450+ Airvac vacuum systems in the Americas, and nearly 1,000 systems installed worldwide including North America, South America, Europe, Africa, Middle East, Asia, and Australia.

Focused on Innovation

When it comes to innovation in the vacuum sewer collection market, Airvac is second to none. As a pioneer of vacuum sewer technology, we have over twenty patented industry firsts. Our focus is to not only improve our products, but to advance vacuum technology worldwide.

Customer Centric

Airvac is not only focused on making superior products, but also on developing long-term customer relationships. We do this by providing support and service every step of the way, including assistance with the planning, design, construction, and operation of your vacuum sewer system.

Airvac offers multiple services to keep your system running at optimal performance.

O&M Services

On-Site Airvac Trained Technicians operate your system 24/7, 365 days a year.

Annual Service Agreements

Customized service levels based on your needs for service by a Factory Certified Airvac Technician. Options include hours of coverage, response time, and any applicable parts discounts.

Block Hour Services

Choose the amount of hours pre-paid to utilize at your discretion at your site.

System Site Surveys

One day in-depth analysis of your system: evaluation of performance of the vacuum system (vacuum station & valve pits) and documented recommendations of operational improvement measures.

Regional Training Classes

Held at your site with focus on operator training and review of current parts and technology.

PM Services

Offered as Annual, Bi-Annual or Quarterly. Complete documented evaluation, adjustment, and recommendations for operation, repair or replacement of components. (Parts excluded)

Quarterly Service Package Specials

(Contact Airvac Service Department for details).

Airvac App

Contains troubleshooting videos, product data sheets, and other useful tools. Available for all mobile devices in the App Store or Google play. (free of charge)

Operator School

Offered monthly in Rochester, IN (free of charge).

Natural Disaster Prep Program

Minimize potential issues or downtime due to major weather events. Our documented preventative maintenance procedures were specifically created for preparing your system and your staff for these critical times.

Discover Better.
1-800-AIRVAC9

or visit airvac.com
info.airvac@aqseptence.com

We provide FREE cost estimates & system layouts.



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