Introduction to
Supermarket Vacuum Condensate Drainage Systems

by AcornVac, Inc.

What is Vacuum Drainage?

Vacuum Condensate Drainage Systems are simply a viable alternative to underground piping that uses the combined energies of vacuum pressure and gravity for the collection and disposal of condensate drainage from refrigerated display cases.

Why Choose Vacuum Drainage?

Vacuum drainage systems offer supermarket organizations a number of benefits:

- Vacuum drainage systems eliminate the need for costly underground drainage piping in the sales area.
- Vacuum drainage systems work in concert with the new "open" architectural store environment where electrical and refrigeration services are brought to display cases from overhead. Drainage can now follow these services, allowing for unprecedented flexibility in store layout.
- Vacuum drainage systems are completely adaptable to last minute merchandising changes.
- Vacuum drainage systems easily accommodate seasonal display requirements.
- New construction projects can be completed faster, saving construction costs and allowing a facility to be brought online in a more timely fashion. Often, projects can be completed during inclimate weather because the facility can be closed before the weather conditions prohibit construction.
- Vacuum drainage systems create a cleaner environment and reduce health hazards associated with gravity drains.
- Vacuum drainage systems allow existing buildings with limited drainage to be developed for supermarket use when traditional trenching and underground piping upgrades are cost prohibitive because of:
  - ► Structural limitations (post tension slab foundations for example)
  - ► Restrictive site issues (bedrock, inappropriate inverts, historical building categorization, etc.), or
  - ► Embedded contaminants in the floor (asbestos).
- Because trenching is eliminated, store remodel activities are less expensive, safer, more sanitary, and take less time.
- Vacuum drainage systems are self venting. Trap primers and vent stacks are not required.
- Vacuum drainage equipment can be capitalized and taken with the owner if the facility is abandoned.
- Hundreds of vacuum drainage systems are in operation around the world and are accepted by most code authorities. Also, Vacuum Systems are included as a viable drainage solution in the latest edition of the IPC and IAPMO.

How Does it Work?

A Vacuum Drainage System consists of three basic components, 1) a vacuum generating station that is typically located near a facility's refrigeration equipment, 2) a piping network that allows for transport of condensate from the cases where it is produced to the vacuum generating station, and 3) vacuum interface components that isolate the vacuum piping network from the condensate collection devices near the cases and allow condensate to be removed.

Vacuum Generating Station

Referred to as the "Vac Center", the vacuum generating station includes vacuum pumps to create a useful vacuum source and storage tanks that collect and discharge the waste into the facilities' sewer main through a code compliant air gap.

Operation of the pumps, collection tanks, historical data recording, and alarm reporting is fully automated by controls provided with the Vac Center. The vacuum pumps run only on demand, and full redundancy is always provided.

Piping Network

The piping network for a vacuum drainage system is maintained under continuous vacuum and is generally fabricated out of PVC, Copper, or other smooth bore, non-porous material. The network consists of risers which transport the collected waste vertically from the case, sink, or fixture to horizontal mains and branches located in the overhead space which lead to the Vac Center. The mains and branches are sloped at a rate of 1/8" per foot toward the Vac Center and thus, for the most part, waste travels by gravity to the Vac Center, just as is does in traditional underground drainage piping.

A major benefit of this technology to the designer, installer, and user, compared to traditional gravity-only drainage is the ability of the vacuum piping to be routed around obstacles, and to allow slope recovery if the slope from the point of collection to the Vac Center cannot be maintained at the 1/8" per foot recommendation. This is done by creating traps in the running branches and mains which are cleared by differential pressures that exist between the entry point of the vacuum system (cases and fixtures) and the Vac Center during a waste extraction cycle. The vacuum that is used to lift the collected waste from the case or fixture to the overhead main is also used to overcome elevation changes in the horizontal piping network.

Vacuum Interface Components

At the heart of a vacuum drainage system are the vacuum interface components that allow condensate to be efficiently collected and transported to the Vac Center. These components include a temporary collection vessel (Accumulator) which is located underneath or near the case, a vacuum interface valve (Extraction Valve) which separates the vacuum in the piping network from atmospheric pressure surrounding the Accumulator, and a control device (Controller) which determines when the vacuum interface valve should be opened to remove the condensate from the Accumulator.

Importantly, the Extraction Valve is a "normally closed" device which eliminates any possibility of cross contamination

between the case and the drainage piping.

When the Controller determines that condensate is present, it opens the Extraction Valve, exposing the Accumulator and its contents to the vacuum pressure. The difference between the vacuum pressure in the piping network and surrounding atmospheric pressure causes air to enter the Accumulator, mixing with the condensate, and transporting the resultant emulsion to the overhead main. The extraction cycle lasts approximately 2.5 to 3.5 seconds.

With the AcornVac system, the Controller, which determines if waste is present and opens the Extraction Valve, is designed to operate only if sufficient vacuum pressure exists to completely remove the accumulated condensate. This feature acts as additional safeguard to insure that the piping network cannot be open to the public area if the system is not capable of removing the waste.

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Q: Since the drainage piping is in the ceiling space, does the Accumulator act as a trap; that is to say, does it keep water in it higher than the drain outlet of a case? Can waste backup into a case?

A: No. The accumulator is separated from the overhead piping by the normally closed Extraction Valve and is equipped with at least one, and in most cases multiple air intakes that are always located below the exit height of the case drain connection. Should the Accumulator overfill for any reason, water will spill out of the air intake and on to the floor, just like gravity drainage systems do when they become clogged.

Unlike gravity systems however, the area underneath the case is never exposed to sewer waste because the Accumulator and associated piping are connected to the Vac Center which discharges via an air gap into the facilities sewer lines away from the retail space. There is no possibility of cross-contamination between the sewer main and the vacuum drainage system.

Furthermore, in the unlikely event that an accumulator would overfill, the effect is localized to the specific case(s) to which it is connected, and only the most recent defrost accumulation is spilled. In a gravity system by contrast, if the pipe blockage is in the underground piping network, all floor sinks upstream of the blockage will flood. And the waste that exits the floor sink, that was previously isolated from the public area by underground traps, will have been mixed with any residue or bacterial growth that exists in the piping and be present on the floor beneath the case.

Although spillage will not directly contaminate the case(s) with either system, any contaminates in the collection device (Accumulator or underground piping) will be discharged onto the floor under the case; an area that is notoriously difficult to clean. Any contaminates deposited under the case are consequently exposed to the areas trafficked by the general public and employees of the supermarket.

The NSF recently conducted tests of gravity versus vacuum drainage systems in similar settings and have concluded that the vacuum drainage technology produces significantly fewer microbiological contaminants than a gravity system under equivalent circumstances.

As a final safeguard against flooding, the vertical risers always enter the overhead mains and branches from above. Thus, it is virtually impossible for any residual waste in the horizontal piping network to return to the accumulator.

Q: What happens if the vacuum piping network develops a leak?

A: Since the piping is maintained under a continuous vacuum, any leaks that might develop will draw air INTO the pipes, preventing the condensate from leaking out.

Frequently Asked Questions

Accepting that problems can occasionally develop with any mechanical system, the Acorn Vac Center is equipped with several alarm features that help alert maintenance personnel of any leaks that might develop in the vacuum piping network.

- ► For small leaks that lead to frequent pump cycling, an alarm will be generated indicating "Too Many Vacuum Pump Starts per Hour".
- ► For moderate leaks that might keep a pump running continuously, an alarm will be generated indicating that the "Vacuum Pumps have run too long".
- ► Should a major leak occur which causes the vacuum pressure to drop below minimum safe levels, the Vac Center will generate a "Low Vacuum Pressure" alarm and, most often, the leak can be heard by store personnel.

Since the vacuum piping network exists in the overhead structure, finding and correcting vacuum system leaks is easily accomplished. By comparison, leaking pipes in an underground system may go undetected for years, possibly contaminating the surrounding area or water table.

Q: What about a catastrophic piping failure, say pipe breakage due to an earthquake?

A: Unlike underground piping, a catastrophic piping failure, regardless of the cause, will be immediately identified and easily repaired.

Q: Since the system uses electrically operated vacuum pumps, what happens if power fails?

A: Most facilities add the Vac Center to their standby generating system. In fact, Acorn Vac offers a number of control features and hardware options to accommodate the unique needs of standby generator power sources.

If the facility does not have a generator, or chooses not to add the Vac Center to the standby power source, the drainage system is simply not available until normal power is restored.

For condensate applications this could mean that some of the initial defrost water that occurs during a power outage might end up on the floor adjacent to the Accumulator. However, since most refrigerated cases are also not added to the standby power generator, the defrost activity will only occur once until normal power is restored.

Q: Can the AcornVac system accept large water flows associated with cases wash downs?

A: Yes.

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Q: Can the AcornVac system handle sinks as well as condensate?

A: Yes.

Q What happens when debris gets into the system (peas, corn, plastic wrappers, ties, and general organic matter)?

A: Debris typically found in condensate and gray water drainage equipment do not effect the performance of the vacuum drainage system. In fact, items that would typically block a gravity drainage system will pass directly through the vacuum piping network to the Vac Center collection tanks. Vacuum drainage systems virtually eliminate clogged piping.

Q: Are spare parts available or should the store carry spare parts themselves?

A: All parts are supplied by AcornVac and are available for immediate shipment. However, a local factory certified maintenance contractor will stock a quantity of repair parts for emergency purposes.

Q: How fail-safe is our system? Is there any redundancy built-in?

A: The AcornVac system is designed to provide complete redundancy on all primary Vac Center components. This includes dual collection tanks and multiple pumps to ensure that the system can continue to operate so long as electrical power is available.

When the Vac Center is operating on an emergency power generator, it is designed to switch the pump control strategy to a method that is most compatible with this power source. For those facilities with generators that have marginal capability for starting induction motor loads such as a vacuum pump, we offer electronic motor starters which minimize the inrush current of a pump as it is being brought on-line.

Q: What are the recommended maintenance requirements?

A: The primary service requirements would be at the Vac Center. The vacuum pumps are equipped with a small cartridge filter that we recommend be changed every twelve months. The pumps also have a cooling coil that should be cleaned once a year.

The AcornVac vacuum interface components have been tested to well over three million cycles without failure. These components have no regular required preventive maintenance. Should a problem occur with either a Controller or an Extraction Valve, the component is designed to be easily removed and replaced.

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Q: Is the system odor free?

A: Yes. Any gasses or odors which might exist in the Vac Center collection tanks are discharged when the tank is drained, and any gasses or odors that might exist in the piping network are contained therein by the normally closed Extraction Valve and removed by the condensate extraction process.

Q: Does the system have a problem with sudsing detergents used in cleaning procedures?

A: No.

Q: A store does not have a dropped ceiling and the roof joists are well above 22'. Can the risers be higher than 22'?

A: Yes. However, the system must be engineered considering all load factors including case wash down, stair lifts, fixtures or sinks tied to the system, the required highest riser height, the size of the store, and requirements for future expansion. Call the AcornVac Engineering Department for design assistance.

Q: Where are the controller, valves, check valves, etc. made?

A: All vacuum parts are made in the USA.

Q: Does the vacuum system need vents (roof penetrations)?

A: No, the vacuum system does not need vent stacks. Air removed from the piping network by the vacuum pumps becomes the vent for the system.