

# Plumbing Engineer®

A TMB Publication

## Vacuum Plumbing and Waste Drainage Systems

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In today's business environment, selection and design of the proper emergency drench equipment system is critical to maintaining the appropriate level of workplace safety. One of the key components is the responsibility of the owner/employer to know the hazards in their workplace. Not only does this knowledge apply to determining what type of emergency drench device is best suited for the hazard, but in many cases the owner/employer must know how to properly and legally dispose of the contaminated flushing fluid after it is used to drench the affected person. Depending on the type of hazardous substance involved, local, state or federal statutes may affect the disposal of this waste flushing fluid.

An open gravity drain to the sewer system has long been used as a way of disposing of contaminated fluids from a shower or eyewash. In locations where no drain was available, the waste fluid was simply mopped up and thrown out into the environment. As more regulations govern the retention and disposal of contaminated flushing fluid, finding alternate means of capturing this used fluid have become necessary. One of the most effective alternatives is a vacuum and waste drainage system. This system provides a means to capture the contaminated flushing fluid and deposit it into containment vessels with no possible exposure or leakage into the public water system.

What is a vacuum plumbing and waste drainage system? Vacuum drainage systems, a viable alternative to gravity drainage, use the combined forces of atmospheric and vacuum pressures to move waste water from its point of origin to sanitary waste lines or to containment vessels, without requiring under-slab waste piping.

Vacuum waste drainage system operation is based on the use of differential air pressure to transport waste in a piping network, which is maintained under vacuum pressure of approximately 16 -18 in Hg. The waste is transported from its point of origin, which is at atmospheric pressure, through a vacuumized waste-piping network, to a central collection point, which is also under vacuum pressure. Waste is temporarily held at this central collection point before being discharged to the facility's sanitary waste line or containment vessel. The differential pressure that exists between the vacuum pressure in the system and atmospheric pressure at the point of origin is what transports the waste into the system and to the central collection point.

A vacuum drainage system is an engineered system consisting of three basic components:

1. A vacuum generating and temporary waste collection center

2. A vacuum drainage piping network
3. Vacuum valve and control components used to isolate the vacuum piping network from atmospheric pressure and to collect waste at its point of origin

In emergency drench equipment drainage applications, the Vac Center consists of waste collection tanks, vacuum pumps and system controls that automate the operation of the system. While the vacuum pumps are always available to run,



*A typical Vac Center, including vacuum pumps, system controls and waste collection tanks, designed to discharge rinse water to sanitary sewer mains or containment vessels for controlled waste disposal.*

they operate only as required to maintain a suitable vacuum pressure inside the vacuum drainage-piping network, which is continuously monitored by a vacuum pressure transducer. The size of the Vacuum Center waste collection tanks and vacuum pump capacities are based on the drainage requirements of the specific facility; however, it is important to note that sizing of both components is always based on providing full redundancy in system capacity.

The second component in an efficient vacuum drainage system is the vacuum piping network. To ensure efficient system operation, several details are given consideration when planning the piping layout for each project. Differential air pressure is employed to transport waste into the drainage system, thereby making it important that the internal surfaces of the piping are smooth and non-porous. For this reason, the

# Waste Drainage

vacuum waste piping network is typically specified with PVC, copper or stainless pipe with approved DWV waste fittings, allowing for smooth transition of waste through the piping network.

The piping network consists of a connection to the collection point at the individual shower or eyewash fixture and of the vertical and horizontal piping needed to transport the waste from the point of use to overhead branch and main waste lines that lead to the Vac Center. Routing of branch and main waste lines are made to promote the forward movement of waste toward the Vac Center. Strategic placement of swing check valves in the waste piping network prevents any possible backward movement of waste flushing fluid.

While vacuum drainage systems employ the interface of vacuum and atmospheric pressures for the transport of waste, wastewater movement through the overhead horizontal portions of the piping is made via the combined effects of differential air pressure and gravity. Horizontal vacuum waste piping is typically sloped at 1/8" per foot; however, unlike gravity drainage piping, there is no requirement for continuous slope. Space loss due to slope can be "made up" with offsets in the horizontal piping, thereby minimizing the space required to accommodate long runs of waste piping and allowing the piping to be routed around obstacles such as beams and duct work, providing greater flexibility in drainage layout and design.

The vacuum pressure in the piping network is separated from atmospheric pressure at the waste collection vessel serving the emergency fixture by means of vacuum valve and control components. These components include the following: an intermediate waste collection vessel, known as an Accumulator; a normally closed interface valve, known as the Extraction Valve, which separates atmospheric pressure at the Accumulator from vacuum pressure in the piping network; and a Controller, which operates the Extraction Valve.

Contaminated fluid from the emergency drench equipment drains via gravity into the Accumulator. As the Accumulator fills, a passive sensor port designed to trap atmospheric pressure between the Accumulator and Controller becomes sealed off. As waste continues to rise within the Accumulator, the pressure within the sensor port continues to rise, exerting a pressure of a 1"- 3" water column on the Controller. This pressure causes the Controller to open the normally closed Extraction Valve, allowing atmospheric pressure to enter through the Accumulator, aerate the collected waste and move it from the Accumulator into the waste piping network. The Extraction Valve remains open until contaminated flushing fluid is cleared from the Accumulator. As mentioned earlier, once waste is in horizontal branch and main lines routing to the Vac Center, it moves

via gravity, but is assisted along the way via differential air pressure introduced with subsequent activations of the Extraction Valve(s).

Once the waste fluid has reached the Vac Center, it is temporarily held before being automatically discharged to either a containment vessel or, if possible, to a municipal sewer connection, thus allowing for controlled waste disposal.

## Practical use and application

From an applications perspective, because vacuum systems allow drainage to be provided anywhere within the facility without requirement for floor trenching, emergency drench equipment can be placed wherever necessary without concern for wastewater cleanup or for damage associated with equipment use or testing.

The flexibility of the waste piping network to run vertically as well as horizontally, through space limited areas, without requirement to plan around obstructions, provides tremendous benefit in facilities where relocation of emergency equipment is required due to manufacturing concerns requiring regular changes in layout.

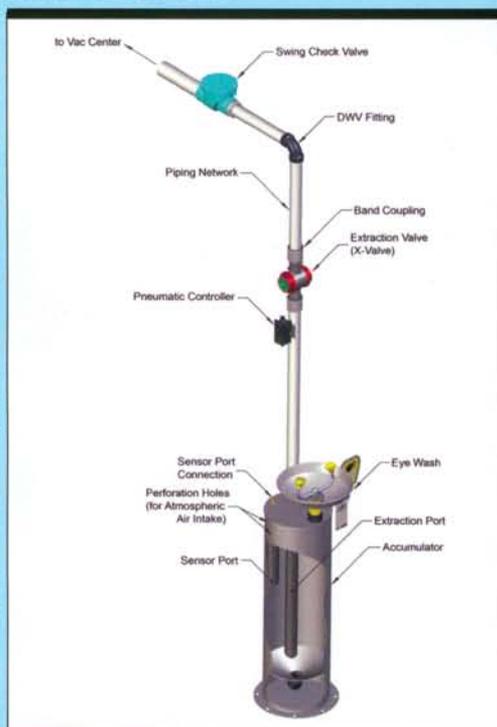
By isolating the contaminated fluid and depositing the collected effluent into a containment vessel for later disposal, vacuum drainage systems offer the opportunity to create a cleaner, safer environment and to reduce health hazards associated with cleanup and disposal of hazardous residual waste. Moreover, since air

can leak in but waste cannot leak out, ex-filtration of hazardous waste effluent into the environment is also eliminated.

Vacuum systems can also represent an economical solution for waste system renovation within a facility where existing gravity drainage inverts are difficult to maintain due to unfavorable site conditions such as bedrock or coral, or structural conditions such as post-tension slabs, grade beams and water vapor seals, which limit excavation or penetrations beneath the slab. In addition, because these systems are self-venting, there is no need for the vent stacks or expensive roof penetrations typically associated with gravity drainage systems.

Vacuum drainage systems are not new technology, but rather represent an emerging technology offering several practical applications as well as health and safety benefits to shower and eyewash equipment drainage. ■

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*An emergency eyewash with optional integral accumulator and vacuum drainage valves and piping*