

PASSIVE SUB-SLAB VENTILATION TECHNOLOGY INFORMATION SHEET

Passive mitigation system (no electric fan)



This Interstate Technology & Regulatory Council (ITRC) technology information sheet describes passive sub-slab ventilation (SSV) systems for mitigation of vapor intrusion (VI). Passive venting systems differ from SSV systems in that the former are not electrically powered and rely on temperature and pressure differences between the building and atmosphere to induce airflow. A brief overview, along with advantages and disadvantages, is provided below.

Overview

The goal of a passive SSV system is to vent to the exterior atmosphere contaminant vapors that have accumulated beneath a structure. Combined with a passive barrier, contaminant vapors are captured and rerouted through a passive venting system to prevent contaminant vapors from entering the building and accumulating within the indoor air environment.

Passive SSV systems rely on wind effects, thermal effects, and pressure differences to induce airflow. This airflow moves contaminant vapors, which may accumulate beneath a building, through vents to the atmosphere. The amount of venting attributed to natural airflow and the resulting vapor concentrations below the passive barrier depend on site-specific conditions and the resistance of the venting material or the subsurface to airflow. A passive venting system is most easily installed prior to building construction. While effective passive venting systems have been designed for existing structures, their effectiveness relies on the presence of a permeable subsurface layer and the ability to install an adequate network of conveyances for venting along with an adequately sealed floor slab. Passive venting of existing structures is often limited by the permeability of the sub-slab materials and the lack of a perforated pipe or vent strip conveyance system. Therefore, passive venting is most commonly used in new construction. A typical way to vent sub-slab soil gas in new construction is using a perforated ventilation network, consisting of pipes or low-profile vents that run beneath the slab and direct the vapors to a centrally located plenum box or pipe header. Another effective SSV option is an aerated floor void space system (VSS); details of a VSS are provided in the [Aerated Floor Void Space Systems Technology Information Sheet](#).

Existing structures may be retrofitted with passive venting systems using vertical vent points installed through the floor slab or by installing a network of horizontal vent piping trenches constructed beneath the existing floor slab. This approach requires modifications and repairs to the existing concrete floor slab.

Passive SSV systems are generally used in conjunction with passive barriers. The venting system reduces contaminant concentrations in soil gas beneath the barrier and the potential impacts of vapor migration through barrier conduits into a building. Passive barriers improve the capture efficiency of a venting system by eliminating airflow between the interior of the structure and the vented space (see the [Passive Vapor Intrusion Barriers Fact Sheet](#)). Passive barriers also prevent vapor entry when passive venting systems are not evacuating air from the sub-slab environment (e.g., during high atmospheric pressure or when there is little to no airflow). When passive venting systems are used in conjunction with passive barriers, the collective systems are referred to as passive sub-slab vapor intrusion mitigation systems (VIMS). Some passive venting systems are designed to introduce ambient air into the network to dilute contaminant vapor concentrations prior to discharge to the atmosphere. This is accomplished by installing dilution header pipes that collect ambient air from areas outside of the contaminant zone or building envelope. Inclusion of dilution piping is more common in passive vent systems for new construction where more space is available to install the dilution pipe headers.

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Passive SSV systems differ from sub-slab depressurization systems (described in the [Sub-Slab Depressurization Technology Information Sheet](#)) in that passive systems may not create a measurable or consistent pressure differential across a slab. Performance metrics should focus on evidence of airflow in the vent and riser piping rather than pressure measurements. Measurement and evaluation of vapor-phase contaminant concentrations in the sub-slab and indoor air environments are other performance metrics used to evaluate the efficiency of a passive VIMS.

Following system installation, post-installation verification should be conducted to document that flow is not obstructed through the system. Refer to the [Post-Installation Vapor Intrusion Mitigation System Verification Checklist](#) for a complete list of system construction and operational parameters to monitor following installation. Operation and maintenance of a passive SSV system is generally limited to periodic verification of flow through the riser pipes and monitoring. Refer to the [Vapor Intrusion Mitigation System Operation, Maintenance, and Monitoring Fact Sheet](#) and the [Vapor Intrusion Mitigation System Operation, Maintenance, and Monitoring Checklist](#) for more information on operation, maintenance, and monitoring of passive SSV systems

Components

The basic system components are shown in [Figure 1](#) and [Figure 2](#). Passive SSV systems for new construction consist of a network of horizontal vent piping surrounded by a layer of permeable fill material below the concrete slab or foundation of a building. The vent piping may consist of perforated pipe or low-profile venting material, which is a highly permeable strip of geotextile matting ([Figure 3](#)). The lateral vent pipes or low-profile vent material are connected to vertical vent piping that routes contaminant vapors through the building to the atmosphere. The fill material surrounding the vent piping or low-profile venting below the concrete slab must be permeable enough to allow for adequate flow of air and contaminant vapors into the horizontal vent piping or low-profile vent material.

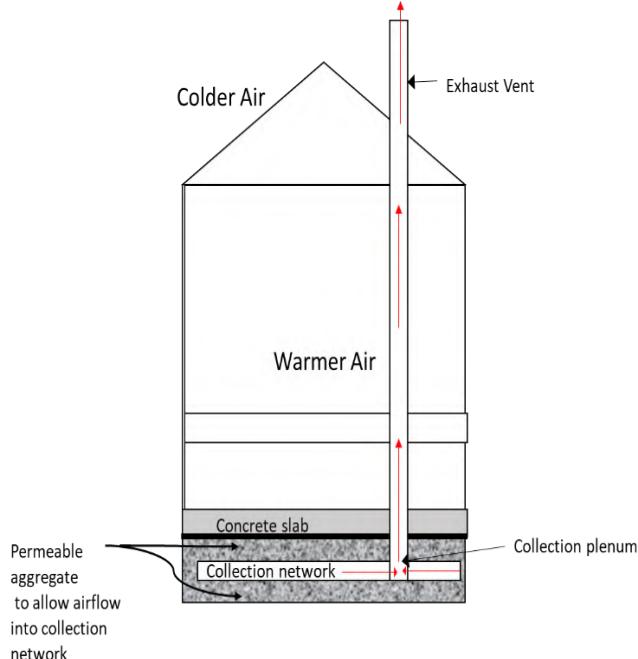


Figure 1. Passive mitigation system components. Airflow is greatest during colder weather when less-dense warmer air rises through the vent pipe. Some systems will use individual collection sumps in lieu of a collection network.

Source: S. McKinley, used with permission.

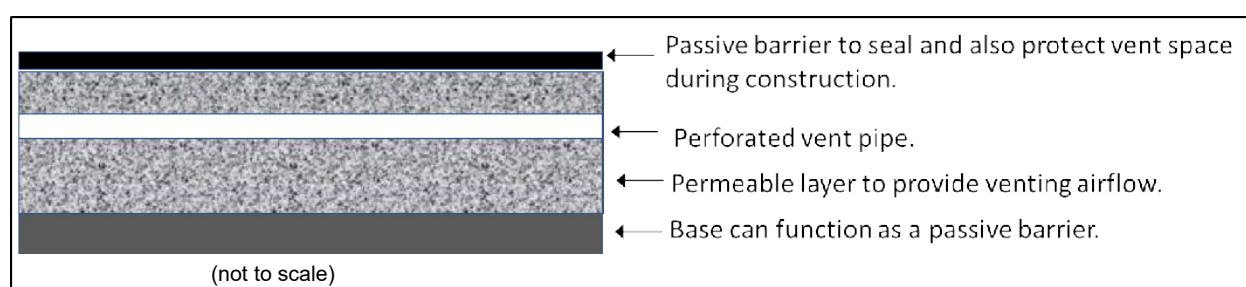


Figure 2. To be effective, passive venting systems need a high-permeability layer to promote airflow and an impermeable barrier to provide a seal between the vent and the slab.

Source: S McKinley, used with permission.

Pressure differences and airflow rates within a passive vent system will be dramatically lower and more inconsistent than in an active system with a fan. Therefore, passive systems require a well-connected network of slotted or perforated piping or low-profile vents, a permeable sub-slab layer to allow airflow into the piping, a competent seal between foundation and walls, and a competent slab to minimize leakage. Compared to an active system, passive systems may require multiple collection points, a more extensive horizontal network of vent piping, and a collection plenum or header to be effective. The basic system components include the following:

- A high-permeability material is used beneath a competent slab or barrier (e.g., AASHTO M 43 No.57 or 67 stone) ([Figure 2](#) and [Figure 3](#)).
- The venting network consists of slotted/perforated collection pipes, low-profile vent material, or aerated mats beneath the slab; Schedule 40 polyvinyl chloride (PVC) or standard dimensional ratio (SDR) 35 slotted or perforated (factory- or field-drilled) pipe is typically used for vent piping ([Figure 4](#)).
- The collection plenum box is typically constructed of hollow concrete blocks turned on their sides with an empty space in the center. It vents the sub-slab collection system to the outside atmosphere through a vertical riser. A pipe header can also be used to connect the vent piping to the riser ([Figure 5](#)).



Figure 4. Photograph of mitigation system piping.

Source: A. Rodak, Duncklee & Dunham, used with permission.



Figure 3. Photograph of a low-profile vent and vent pipes.

Source: CETCO.



Figure 5. Photograph of a header for mitigation system piping.

Source: Duncklee & Dunham, used with permission.

- Exhaust vent(s) are riser pipe(s) that extend through the slab, roof, or wall of the structure to the outside. Most of the riser pipe length must be in a conditioned area so that the warmer air inside the pipe will rise through the structure and vent the subsurface air through thermal venting (see [Figure 1](#)).

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- Design components, such as fans and associated controls, can be used to upgrade to active mitigation if necessary (see the [Sub-Slab Ventilation Technology Information Sheet](#)).

Advantages

Passive SSV systems offer several advantages:

- Users avoid long-term costs for mechanical part maintenance and operation.
- They have energy-efficient function (i.e., green and sustainable technology).
- This type of system does not rely on a power source for continuous operation.
- Depending on the permeability of subsurface soil, passive SSV systems can often capture vapors over a large surface with minimal pipe coverage area.

Limitations

Compared to active venting, passive systems may not be able to reduce concentrations of sub-slab soil-gas COCs to less than regulatory screening or indoor air quality levels over the same time period. Other limitations of passive SSV systems include the following:

- They may show reduced performance, when compared to active systems, due to the absence of an electrical fan or blower to induce continual airflow and by stack effects that are more influential in cooler weather periods.
- Effective coverage area of each riser pipe may be limited. Passive venting systems tend to breathe in and out, and therefore vapors cannot travel great distances without the use of an electrical fan or blower.
- Performance may depend on the integrity and life of the seal above the SSV system.
- Performance may be affected by building foundation settlement.
- The presence of concrete footers or sub-slab wall extensions may require additional vent piping.
- Some states may not allow passive venting systems.
- An effective system may require a larger number of riser pipes than active systems.

Special Circumstances

- A high water table or an impermeable subsurface may limit venting effectiveness and prevent use.
- Isolated areas under elevated or noncontinuous slabs should be addressed by placing adequate gravel below these areas and adding additional ventilation pipe to the passive venting system.

Occupant, Community, and Stakeholder Considerations

It is essential to develop and implement a site-specific community involvement plan that addresses how to win trust and gain access to properties, communicate risk to potentially exposed individuals, and minimize the disruption of people's lives and businesses. For more details, see [Chapter 3: Community Engagement](#).