This document references Chapters and Sections from the ITRC Vapor Intrusion Technical and Regulatory Guidance, and Fact Sheets and Technology Information Sheets from the ITRC Vapor Intrusion Toolkit, published January 2026. These resources can be accessed at: **https://itrcweb.org/vapor-intrusion-toolkit**.

PASSIVE VAPOR INTRUSION MITIGATION SYSTEMS FACT SHEET

Introduction

Passive mitigation of the vapor intrusion (VI) pathway involves interception, dilution, diffusion, or diversion of soil vapor entry into a building without the use of mechanical means. These systems physically block the entry of vapors into a building and/or rely on natural mechanisms, such as chemical diffusion and thermal- or wind-induced pressure gradients to divert vapor-forming compounds (VFCs) and soil vapor around the building (e.g., to a vent riser). Passive mitigation systems require a high degree of documentation during the installation process and the establishment of planning methods that will confirm the system's effectiveness, such as using surrogates and tracers (e.g., smoke testing). This document introduces the three most common categories of passive mitigation technology—passive barrier systems, passive venting systems, and building design—and explains instances where such systems can be installed (e.g., new construction, existing buildings).

Mitigation technologies presented here assume that the primary means for contaminant vapor entry is via advection rather than diffusion.

Passive Mitigation Types

This fact sheet and associated documentation focuses on three general categories of passive mitigation technologies:

- Common passive barrier systems
  - Composite Membranes (CM)
  - Single-Sheet Membranes (SSM)
  - Epoxy Floor Coatings (EFC)
- Common passive venting systems
  - Passive sub-slab venting
  - Aerated floor Void Space Systems (VSS)
- Building design approaches
  - Raised foundations
  - Vented garages

Common Passive Barrier System Technologies

This section provides a summary of the common passive barrier system technologies that are typically employed, focusing on passive barrier technologies designed for use in subsurface-to-indoor air chemical VI applications, which are different from vapor barriers, a commonly used term in the construction industry. "Vapor barrier" is the term most associated with thin plastic membranes (e.g., 6–15 thousands of an inch [0.001 inch is known as 1 mil]) that are used to mitigate moisture transmission through concrete. Vapor barriers used in standard construction practices are not typically designed to mitigate chemical vapor transmission (NJDEP 2021).

Composite Membranes

(See also the **Composite Membranes Technology Information Sheet**.)

The primary component of a CM passive barrier system is the spray-on asphalt latex material. These materials are water based, free of VFCs, and used in combination with other layers to create a barrier to advective flow and diffusive transport of VFCs. A typical CM passive barrier system consists of a base layer, a spray-applied asphalt latex, and a cap sheet. CMs can be modified to site-specific goals by changing one or more of the components to achieve site-specific performance criteria. For the base layer and protective cap sheet, the materials would not classify as a single-sheet membrane as defined below, but they can incorporate the same materials. For added chemical resistance and increased durability, SSM as defined below can be incorporated into composite systems.

CMs adhere directly to concrete and penetrations without the need for additional system components for fastening. The ability of CMs to adhere to most substrates makes it ideal for sealing to penetrations and to wall terminations. The key differences between CMs and SSMs are the robustness of the system and the ability to withstand the construction process without damage.

Single-Sheet Membranes

(See also the **Single-Sheet Membranes Technology Information Sheet**.)

SSMs are composed of one or more materials that are applied in sheet form and seamed together in the field to achieve a uniform barrier. Historically, these membranes have consisted of high-density polyethylene (HDPE), but variations such as linear low-density polyethylene (LLDPE) are also available. New variations of SSMs now exist that incorporate materials such as ethylene vinyl alcohol or metalized films to decrease the permeability to VFC flux through these materials. These membranes can also incorporate protective materials to increase durability; examples include geotextiles and reinforcement grids. The thickness of SSMs typically ranges between 20 and 60 mils. The key to these SSMs is the seal of the seam, which can be accomplished through heat welding, spray-applied material, or tapes.

Epoxy Floor Coatings

(See also the **Epoxy Floor Coatings Technology Information Sheet**.)

EFCs can be used for a variety of industrial, commercial, and residential applications. EFCs can be applied to the surface of concrete slabs in existing buildings and new construction. EFCs are most often used to protect existing concrete surfaces or provide a decorative finish; however, EFCs can also be applied to existing concrete slabs as a passive barrier system.

When applied, the epoxy cures by a chemical reaction that changes the material from liquid to solid. During the conversion from a liquid to a solid state, EFCs become highly adhesive, which allows EFCs to bond with the concrete floor to seal porous concrete. EFCs can be strong, durable, and chemically resistant to VFCs. As a result, EFCs can reduce the potential for advective and diffusive transport.

Common Passive Venting Systems

This section provides a summary of passive venting systems that are often employed in conjunction with one of the three common passive barrier system technologies described above.

Passive Sub-slab Venting System

(See also the **Sub-slab Ventilation Technology Information Sheet**.)

The goal of a passive sub-slab venting system is to vent contaminant vapors to the exterior atmosphere and prevent accumulation beneath a building. Combined with a passive barrier system, contaminant vapors are blocked and rerouted through a passive sub-slab venting system to prevent contaminant vapors from accumulating beneath the slab and migrating into the indoor air environment.

Passive sub-slab venting systems rely on wind effects, thermal effects (also described as the stack effect), and pressure differences to induce airflow and transport contaminant vapors from beneath a building to the atmosphere through discharge vents. A passive sub-slab venting system is most easily installed prior to building construction. Successful passive sub-slab venting systems have been designed for existing buildings; however, their effectiveness relies on the presence of a subsurface permeable layer or venting system media and adequate access to allow for the installation of a substantial venting network. Venting system media can include gravel, perforated pipes, low-profile geocomposite strips, or combinations of these materials. Perforated pipes are typically used for comparatively longer distances rather than low-profile geocomposite strips; this determination should be considered during the design phase of the project. The venting system should generally underlie the entire vapor barrier between foundation elements.

Aerated Floor Void Space Systems

(See also the **Aerated Floor Void Space Systems Technology Information Sheet**.)

Aerated floor VSSs are concrete slabs with a continuous void space beneath the slab that can be used for passive and active sub-slab venting or depressurization in lieu of a sand or gravel venting layer commonly associated with traditional mitigation systems. Because the void space has very low resistance to air flow, vacuum levels and air exchange rates in the void space are generally higher and more uniform than in sand or gravel layers. Aerated floors are typically constructed using proprietary plastic forms that are placed on the subgrade prior to pouring of the concrete slab to create an open void space below the slab. Aerated floors can be used in either active or passive mode, depending on the degree of venting or depressurization needed to mitigate VI. Generally, these systems do not employ the use of barrier system technology due to the presence of the void space and plastic forms below the slab. Therefore, sealing of floor penetrations, slab joints, and other potential subsurface-to-indoor air transport pathways with caulking, pipe boots, or similar mechanisms is an important design consideration for a VSS. Aerated floor VSSs are most applicable to new construction, although aerated floors can also be used for complete floor replacement or placed over existing slabs if a higher finished floor elevation can be accommodated.

Building Design Approaches

(See also the **Building Design for Passive Vapor Intrusion Mitigation Technology Information Sheet**.)

This section provides a summary of common approaches that address VI concerns passively using building design. These common building design approaches are sometimes employed in conjunction with other passive technologies and systems detailed above or with active systems.

Raised Foundations

The primary purpose of buildings designed with raised foundations, such as buildings with block and beam construction and/or open or ventilated crawl spaces (also referred to as podium construction), is typically to prevent water vapor from entering the building. A raised foundation can also be an effective means of mitigating VI. If the raised foundation is designed with sufficient ventilation below the building, this approach can offer a sustainable, effective, and low-cost method of passive VI mitigation. This approach to passive VI mitigation is most applicable in the following contexts:

- Geographic locations where raised building foundations are the preferred building style
- Existing buildings constructed with a raised foundation
- Buildings slated for construction on contaminated sites where the potential VI risk is determined to be low
- Sites with petroleum hydrocarbons impacts.

Vented Garages

When garages are constructed below occupied spaces, venting of the garage is likely to reduce the potential for VI in overlying units by dilution of VFC concentrations below the units and by normal heating, ventilation, and air conditioning (HVAC) controls that prevent garage air (e.g., vehicle exhaust) from entering the building. In many cases, concentrations within the garage itself may be reduced below levels of concern commensurate with garage exposure conditions. Vented garages are typically constructed in urban settings on properties where a vapor source is present and space is limited, making placement of a garage under the building economically feasible.

The presence of a vented garage does not necessarily eliminate the need for other VI mitigation measures, particularly because active ventilation of garages is often triggered by carbon monoxide concentrations within the garage. Thus, the VI mitigation system designer should consider the approach to garage ventilation as part of the design process. It is worth noting that below-grade parking garages often require waterproofing to be applied to the foundation; passive barriers that also have waterproofing capabilities can be used to create additional redundancy.

Considerations for Passive Mitigation Systems

Careful consideration should be given to several factors to select, design, install, and maintain an effective passive mitigation system. The approach outlined below provides a summary of information to consider during each step in the passive mitigation process. More details regarding these factors can be found in the fact sheets listed below.

- **Design and Implementation Considerations for Vapor Intrusion Mitigation Approaches Fact Sheet**
- **Quality Assurance Considerations Fact Sheet**
- **Vapor Intrusion Mitigation Systems Post-Installation Verification Fact Sheet**
- **Vapor Intrusion Mitigation System Operation, Maintenance, and Monitoring Fact Sheet**
- **Vapor Intrusion Mitigation System Curtailment and Shutdown Fact Sheet**

These fact sheets are written to include all VI mitigation technology types and go into more detail about the considerations to be made at each point in the stepwise process and the relative impact each factor may have for each type of mitigation technology.

Design Considerations

Prior to passive mitigation system design, it is common practice to evaluate design drawings (plans) for buildings proposed for construction or to perform a building survey for existing buildings. Designing a passive mitigation system for a building prior to construction allows for a greater degree of flexibility in the selection of available passive mitigation technologies and ultimately lower installation costs when compared to retrofitting an existing building with a passive mitigation system. This is due to a greater level of control over the building construction sequence and access during installation of the mitigation system components. For retrofitting, factors such as access, accommodating the work schedules of building tenants, and structural integrity of the foundation and floor slab of existing buildings are limitations that may result in increased installation time frames and a narrower selection of cost-effective passive mitigation technologies. An explanation and summary discussion of common design considerations for passive mitigation systems is provided in the **Design and Implementation Considerations for Vapor Intrusion Mitigation Approaches Fact Sheet**. Factors considered to have a significant impact on design of passive mitigation systems are listed below.

- VI Conceptual Site Model (CSM) considerations
    - Vapor source
    - Geology and hydrogeology
    - Building conditions
- Design investigation and diagnostic testing
    - Barrier or membrane material tests
    - Building HVAC tests
- Mitigation system design
    - Design basis
    - Design layout and components
    - Stakeholder requirements
- System construction and implementation
    - System effectiveness and reliability
    - VI Mitigation System (VIMS) management and exit strategy considerations

A **Design and Implementation Considerations for Vapor Intrusion Mitigation Approaches Fact Sheet** has been created to provide a guide through the considerations relative to both active and passive mitigation strategies.

During this stage in the mitigation process, the installation and installation oversight (also referred to as construction quality assurance [CQA]) of the system should be considered as it relates to the design and the components of completing a design (e.g., implementability, permitting, construction quality objectives, etc.). Additional installation considerations are summarized in the CQA and post-installation verification process step.

Construction Quality Assurance Considerations

Following design, preconstruction planning and CQA monitoring are important considerations to support the long-term integrity of the mitigation system. Attention to these items will greatly improve the post-installation evaluation and likely lead to more successful long-term system operation and performance.

The formality of preconstruction planning and CQA during installation will depend on the size and complexity of the building and the mitigation system to be constructed.

The primary purpose of preconstruction planning and CQA of a mitigation system is to achieve the following:

- Document that the materials used in the construction of the mitigation system are consistent with the design documents and/or otherwise approved by the designer
- Inspect the installation of the VIMS components during construction for conformance to the design documents
- Provide a plan to manage unforeseen construction scenarios in collaboration with and with approval from the designer

The **Quality Assurance Considerations Fact Sheet** provides details of the above factors that could be considered for passive mitigation and includes the following:

- A more detailed overview and purpose of CQA
- Considerations for state agency–specific CQA requirements
- VIMS product manufacturer CQA requirements
- Typical CQA tasks
- CQA documentation considerations

Please also refer to **Appendix J: Vapor Intrusion Mitigation System Construction Quality Assurance Plan Outline** for a guide to developing a CQA plan.

Post-Installation System Verification Considerations

Once the passive mitigation system has been designed and installed, mitigation system verification during the construction process will be needed to document that the system is functioning as designed. Verification of system installation and effective operation may include multiple criteria. It is also important during this step, as well as in the future during operation, maintenance, and monitoring (OM&M), to validate the VI CSM for which the system was designed. Below is a summary of possible post-installation verification considerations that may be needed for passive mitigation systems.

The type of post-installation system verification testing approaches should be based upon the type of passive mitigation technology installed. For instance, smoke and tracer gas testing are appropriate for assessment of passive barrier systems and passive sub-slab venting systems and can be used to verify the integrity of the barrier (especially at locations where another roll of barrier is overlapping and sealed) and to assess the adequacy of sealing around the areas of membrane repairs, perimeter edges, and utility penetrations. Smoke and tracer gas testing may also be appropriate for assessing the adequacy of pipe-fitting connections and/or the presence of any obstructions within sub-slab venting systems. In addition to conducting smoke or tracer gas testing, coupon sampling is an important verification testing approach appropriate for membranes such as CM and SSM to confirm that the membrane integrity of the seal meets the design specification and may be required by certain manufacturers. In many situations, a passive system may be designed such that it can be made active if needed. Pilot testing of the sub-slab venting system, after pouring the concrete slab, is common to verify that an electrical fan or blower can adequately depressurize/influence the remote extents of the system for contingency scenarios in which the passive system requires transition to active operation. Time frames required for collection of system verification information vary depending upon state requirements. Check with your applicable state and/or federal regulatory agency regarding requirements for the type and time frames for collection and submittal of post-installation system verification data.

An explanation and summary discussion of common post-installation system verification considerations for passive mitigation systems are provided in the **Vapor Intrusion Mitigation Systems Post-Installation Verification Fact Sheet**. Factors considered to have a significant impact on post-installation system verification of passive mitigation systems are listed below.

- Building information and survey
- Confirmation testing
- Communications

The **Post-installation Vapor Intrusion Mitigation System Verification Checklist** provides a list of considerations when assessing which data to collect to verify whether the system is effectively mitigating the VI pathway.

Operation, Maintenance, and Monitoring Considerations

An OM&M plan provides instructions for proper system operation and maintenance required for an installed mitigation system. An OM&M plan should be prepared for each mitigation system installed, regardless of the mitigation technology implemented. The goal of OM&M is to ensure the ongoing function of the mitigation system as designed following system installation and performance verification. This goal is achieved through performing routine inspections, as well as identification and completion of system repairs due to system malfunction (i.e., system not operating to meet performance objectives) or due to system equipment life expectancy. Indoor air and/or sub-slab soil vapor testing, or other means of demonstrating continued performance of the passive barrier, may be required over time to demonstrate system effectiveness.

An explanation and summary discussion of common OM&M considerations for passive mitigation systems is provided in the **Vapor Intrusion Mitigation System Operation, Maintenance, and Monitoring Fact Sheet**. Factors considered to have a significant impact on OM&M of passive mitigation systems are listed below.

- Mitigation system operation
- Building conditions and use
- System inspections and performance metrics
- Communication and reporting

The **Vapor Intrusion Mitigation System Operation, Maintenance, and Monitoring Checklist** includes a list of questions designed to assess VIMS operation and the need for corrective actions identified during regularly scheduled VIMS inspections.

Vapor Intrusion Mitigation System Management and Decommissioning Considerations

A key concept to consider throughout the process of effective implementation of a passive mitigation technology is evaluating whether the monitoring data and VI CSM support a potential reduction in monitoring scope and/or optimization of system operation over time. In some cases, the data may even support eliminating ongoing system operation and monitoring requirements entirely. The Vapor Intrusion

Mitigation System **Vapor Intrusion Mitigation System Curtailment and Shutdown Fact Sheet** presents a framework to consider for optimizing the monitoring and operation for both active and passive VIMS based upon long-term site management objectives.

In the event the vapor source no longer poses an unacceptable risk to the receptors within the building, the VIMS may no longer be necessary. Situations may also arise when VIMS are installed out of an abundance of caution, such as presumptive mitigation to expedite property redevelopment or due to uncertainties associated with spatial and temporal variability, background sources, and/or conservative regulatory guidance. Decommissioning strategies should be considered when these types of situations arise.

The details for decommissioning considerations can be found in the **Vapor Intrusion Mitigation System Curtailment and Shutdown Fact Sheet**. It may be appropriate to prepare a short work plan that outlines the decommissioning process—and the monitoring data and/or other information to support it—prior to implementation of system decommissioning efforts.

Summary

Passive mitigation involves the use of one or more technologies that limit sub-slab soil vapor from accumulating into the interior of a building without the use of mechanical means. The three general categories of passive mitigation technologies are passive barrier systems, passive venting systems, and building design approaches.

Successful implementation of passive mitigation technologies greatly depends upon the appropriateness of the system design to account for site-specific conditions. This fact sheet summarizes the many considerations that go into the design, installation, verification, and operation of each of the most common passive mitigation technologies. The details and considerations discussed above are part of a long-term plan for passive VIMS.