Post-Mitigation Verification: Confirming Vapor Mitigation System Effectiveness

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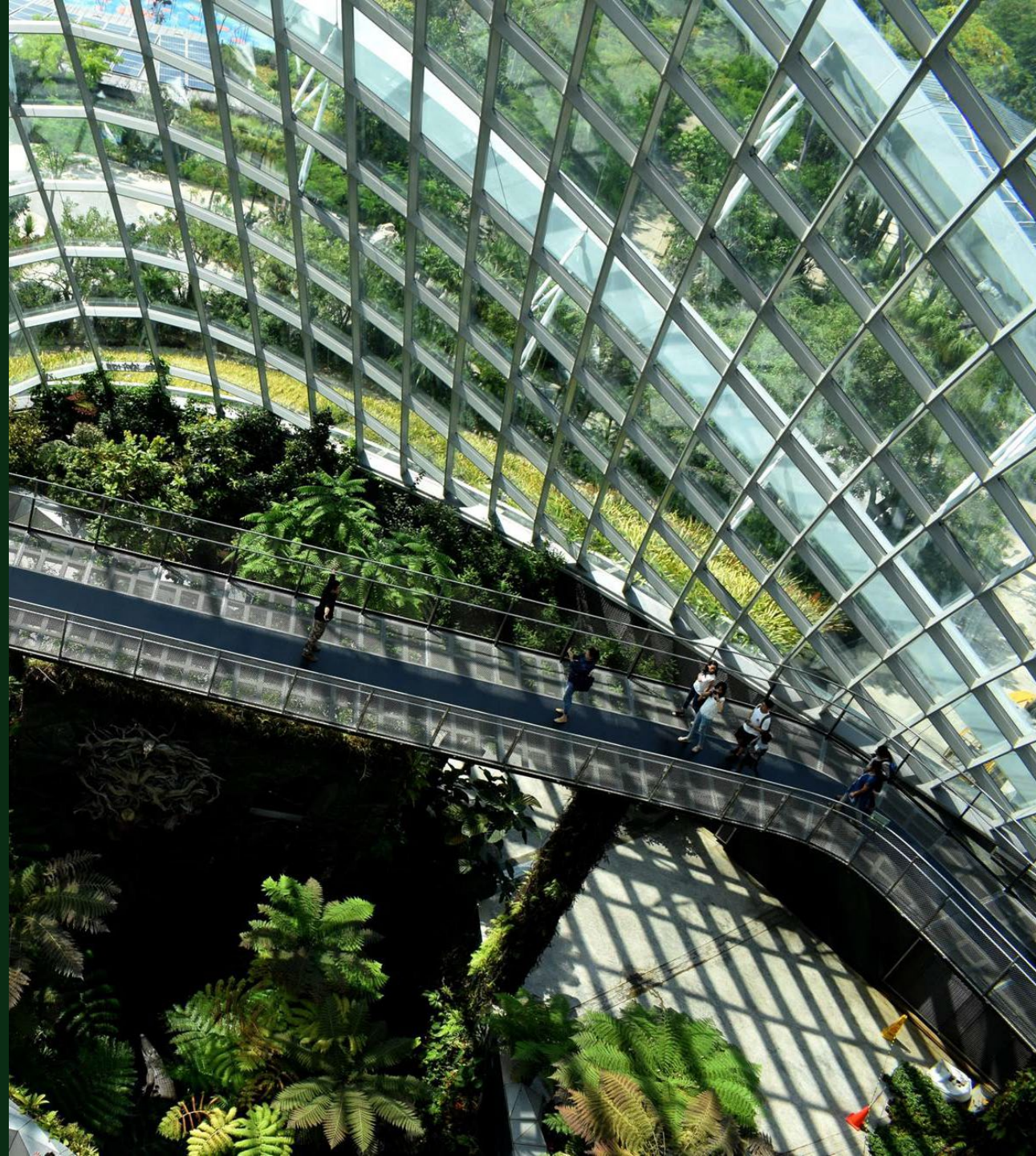
Sustainability is our business



Steps in the VIM Process

Pre-System Installation

1. Assessment of Site Conditions
2. Technology Selection
3. Develop and Document System Design

System Installation

4. Pre-construction Meeting
5. Installation
6. Installation Oversight

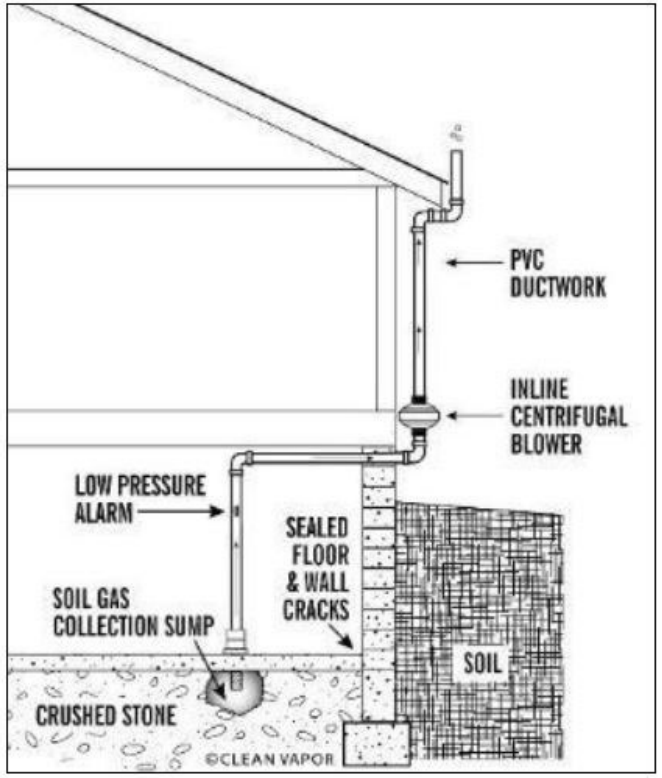
Post-System Installation

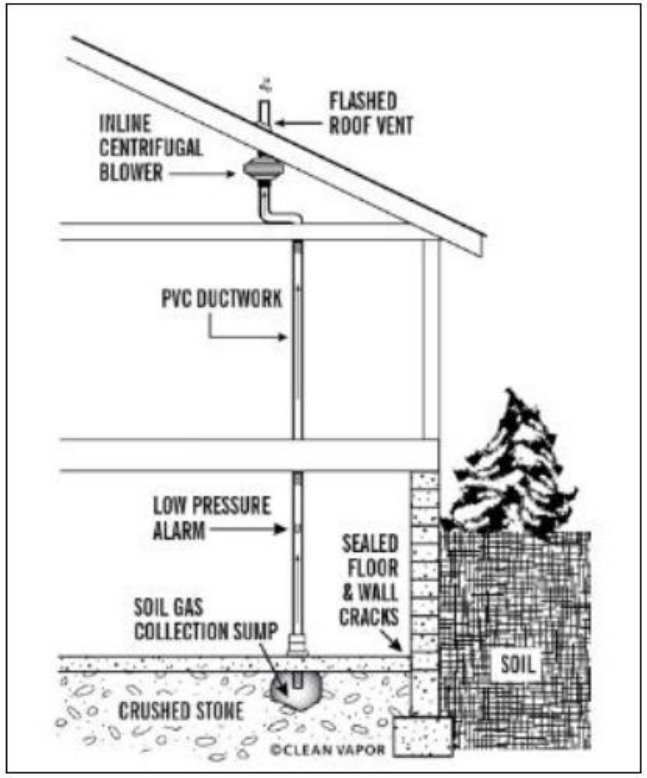
7. System Verification
   a) Inspection
   b) Verification Sampling
   c) Confirming Performance QA/QC
8. Documentation
9. Operation, Maintenance, and Monitoring

ITRC, 2022

Post System Installation Verification: Documentation

- **Post-Installation Checklists**
- **As-Built Drawings**
- **Installation Verification Data**





Vapor Barrier Design Checklist*

Note to consultant- Please fill in the blanks below and submit this checklist along with the vapor barrier design cover letter and any design drawings.

Example- Vent to roof. Vent 5-10 feet above roof or ten feet higher than ground surface if not mounted on the roof. _Meet requirement-Vent height shown in Drawing 1-2

Vapor Barrier (Cap) Design

Information on Vapor Intrusion and the need for vapor barrier can be seen in the SIRB Vapor Intrusion Policy Dated March 2007. For an example, please see Justison Landing (DE-1377) vapor barrier design drawings.

Basic Vapor Barrier Design

A barrier consists of a vapor barrier and venting system. The system should be detailed in a drawing from deepest to roof as follows:

- Vent to roof. Vent 5-10 feet above roof or ten feet higher than ground surface if not mounted on the roof.

Delaware.gov

Post System Installation Verification: Inspection

- State-Specific vs. Industry Available
- Critical Aspects of the Checklist
  - Site Conditions/COCs/Concentrations
  - System Design/Layout/Configuration
    - Variable: Active vs. Passive
  - Piping Connections & Completions
  - Blower Configuration
  - Dedicated Monitoring Probes
  - Diagnostic Testing
  - Labeling

Passive Mitigation Checklist
for
New Construction and Existing Buildings

Details and types of passive mitigation can be reviewed in the ***Passive Mitigation Fact Sheet***. The primary passive technologies that are the focus of this design checklist are aerated floors, epoxy floor coatings, passive barrier systems, and passive sub-slab venting systems. These technologies are detailed in their respective technical information sheets. This section focuses mainly on design checklist considerations for new construction. Passive mitigation systems are most commonly used within new building construction. Passive mitigation systems can also be implemented within existing buildings. For existing buildings, removal of the floor slab may be necessary to allow installation of some passive mitigation systems. Alternatively, some passive mitigation systems can be installed above existing floor slabs, such as an aerated floor, EFC, or vapor barrier membrane.

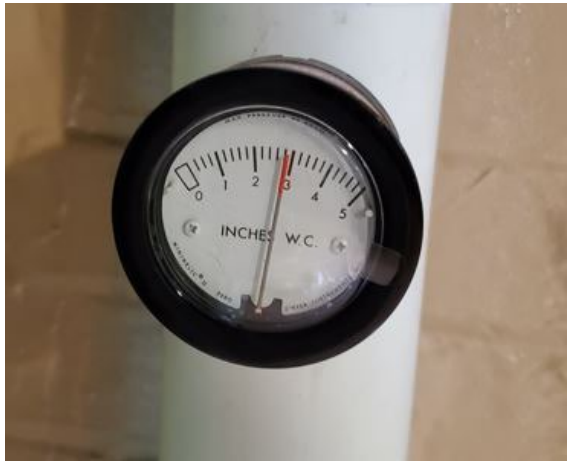
SYSTEM DESIGN AND DOCUMENTATION CHECKLISTS

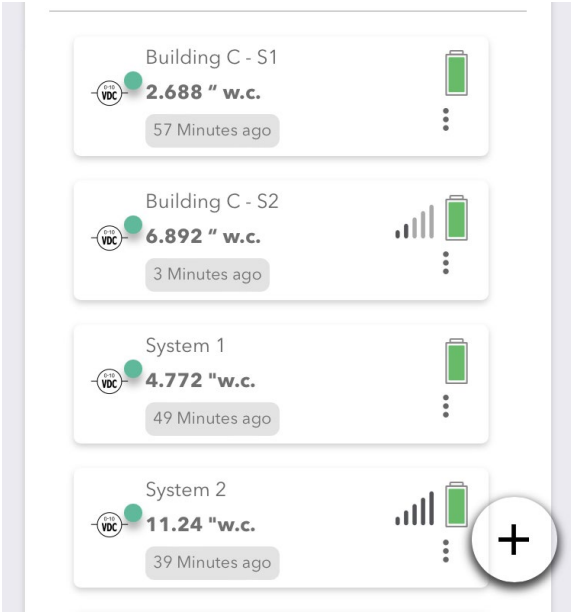
This checklist provides information necessary to proceed through the design process described in the ***Design Considerations Fact Sheet***. This checklist focuses on system design and documentation for active strategies (first portion of checklist) and passive strategies (second portion of checklist). Before completing this checklist, review and complete the ***Vapor Intrusion Mitigation Conceptual Site Model (CSM) Checklist***. Not all the information presented below is necessary to document a particular design. For example, some small residential building designs may be completed with very little predesign information and systems may be installed using only a conceptual design. The user should be able to identify which considerations best represent effective design for their specific vapor intrusion mitigation system (VIMS). If a checklist item is not applicable to the design, select "NA" for not applicable and consider documenting the rationale as an attachment to this checklist.

Active Mitigation Checklist
for
Existing Buildings and New Construction

1-Design-Considerations-VIMT_Design_Checklist-Final.pdf (itrcweb.org)

Post System Installation Verification: Inspection





Post System Installation Verification: Sampling

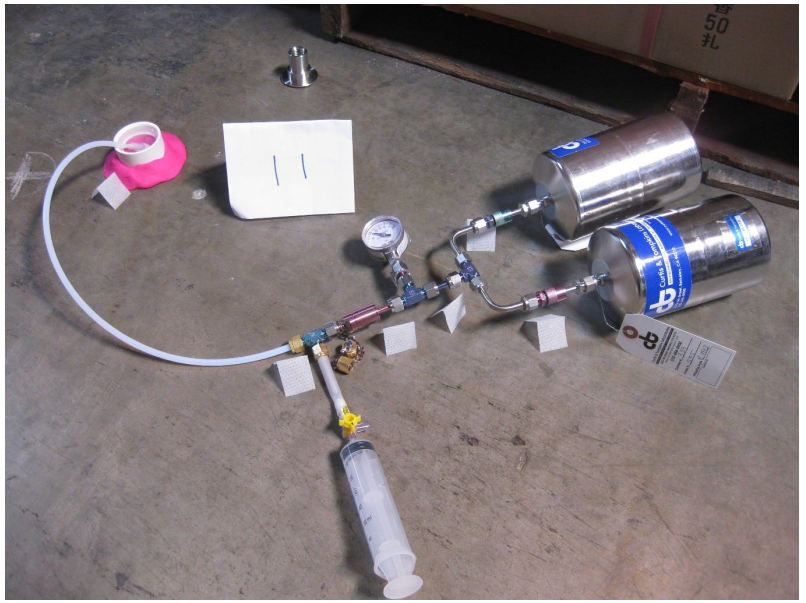
- **Analysis**
- **Field Screening Measurements**
- **Indoor Air vs. Outdoor Air vs. SS Soil Gas**
  - **Range of Time After System Installation (2-4 Weeks)**
- **Documentation of Field Conditions**
- **Effluent System Analytical**
  - **Air Permit Requirements – HAP Standards**
- **Acceptable Criteria**
  - **Periodic Sampling**
  - **1 OOM < SLs, 1 event/year**
- **Reporting Data**

According to New Jersey's 2016 vapor intrusion guidance, "*the baseline performance measurements should be collected no sooner than 30 days after the system activation, but not in excess of 60 days (Commission Timeframe). The 30-day timeframe also allows the building time to vent prior to collecting verification IA [indoor air] samples.*"

Post-mitigation sampling should focus on the chemicals that triggered the mitigation decision

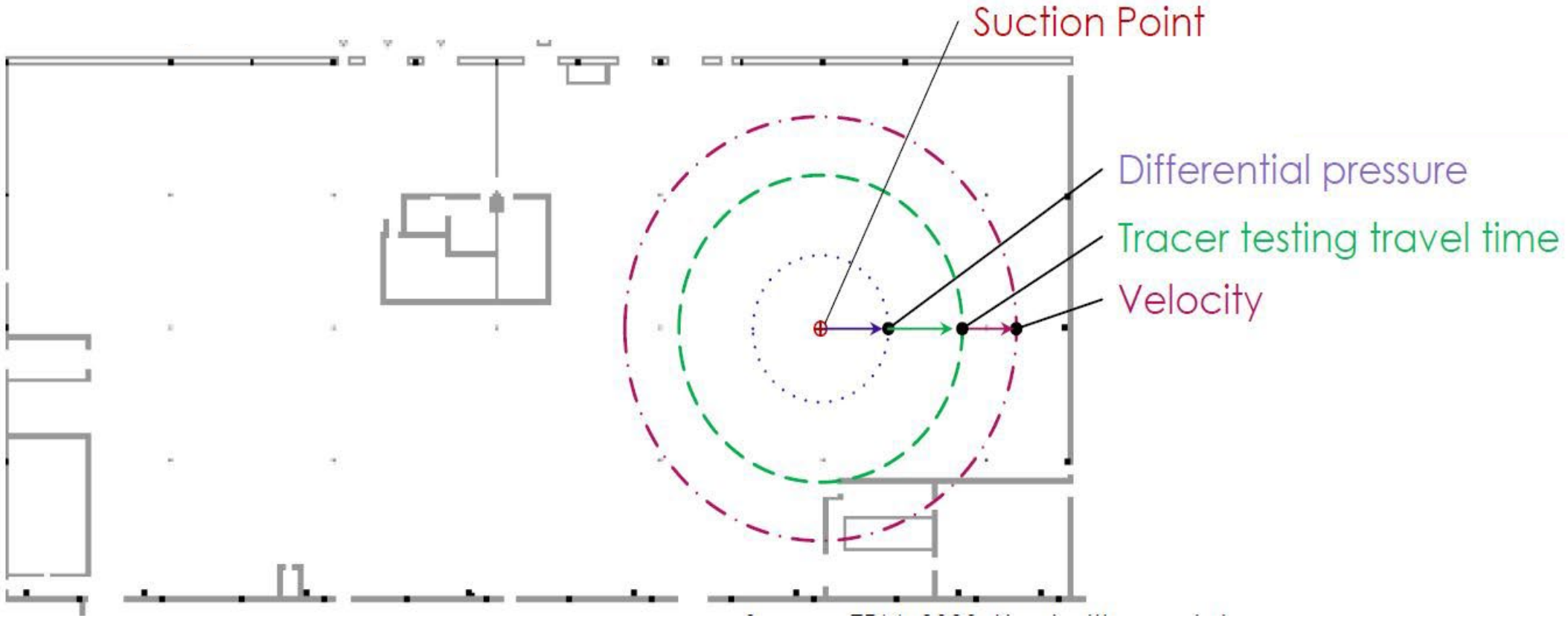
Post System Installation Verification: Confirming Performance

- Vacuum field or pressure differential across slab
- Smoke/tracer gas testing
- IA/SG Sample results
- Long-term institutional controls
- System vacuum and airflow
- Other system/regulatory-specific metrics



Source: Clean Vapor & ERM

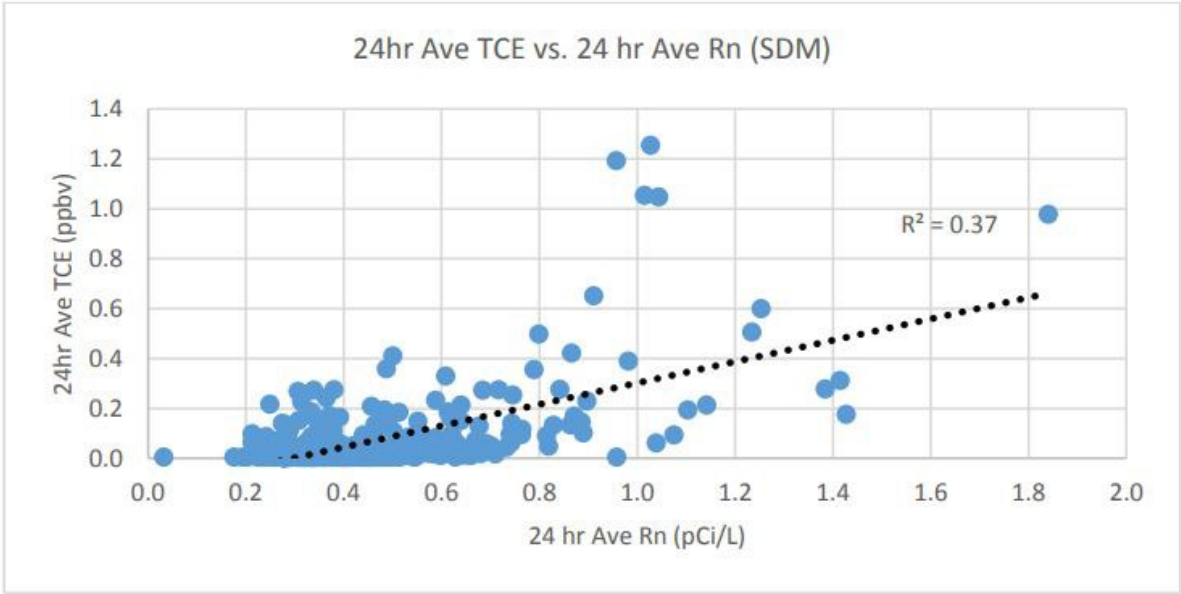
Post System Installation Verification: Confirming Performance

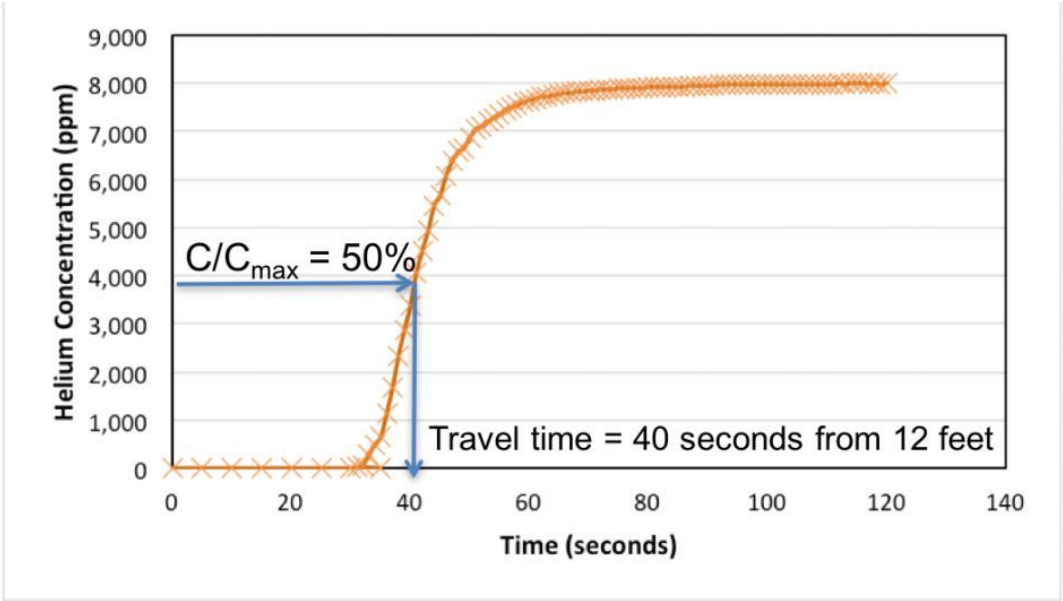


Confirming Performance through Tracers & Surrogates

<u>Common Tracers & Surrogates</u>

- Perfluorocarbons, chlorofluorocarbons
- Helium
- Radon
- Carbon Dioxide
- Formaldehyde
- Chemical Daughter Products
- Sewer Gas Indicators (atypical)





DoD Handbook FS 005 (Clu-in) & Kurtz, 2017

Post System Installation Verification: Pressure Differentials

What Metric to Use?

At a minimum, a vacuum of -0.004" of water column (WC) should be achieved throughout the area targeted for mitigation under worst-case, seasonal conditions. Sub-membrane Depressurization Systems (SMDS) are typically used for structures with crawl spaces.

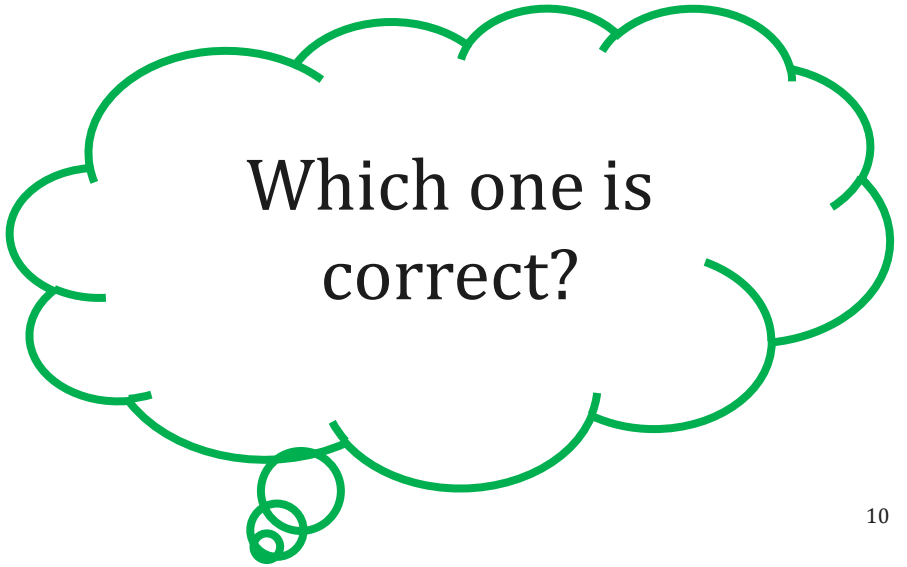
US EPA: *As a practical matter SSD systems are normally designed to achieve a pressure differential of at least 0.02 inch of water (5 Pascal), during the worst case season, to provide an adequate safety factor for long-term variations.*

OEPA: *Differential pressure gauges should be capable of reading to 1/1000-inch water column or 0.25 pascals with + 25% accuracy. There should be adequate sample ports to cover the entire floor space of the building.*

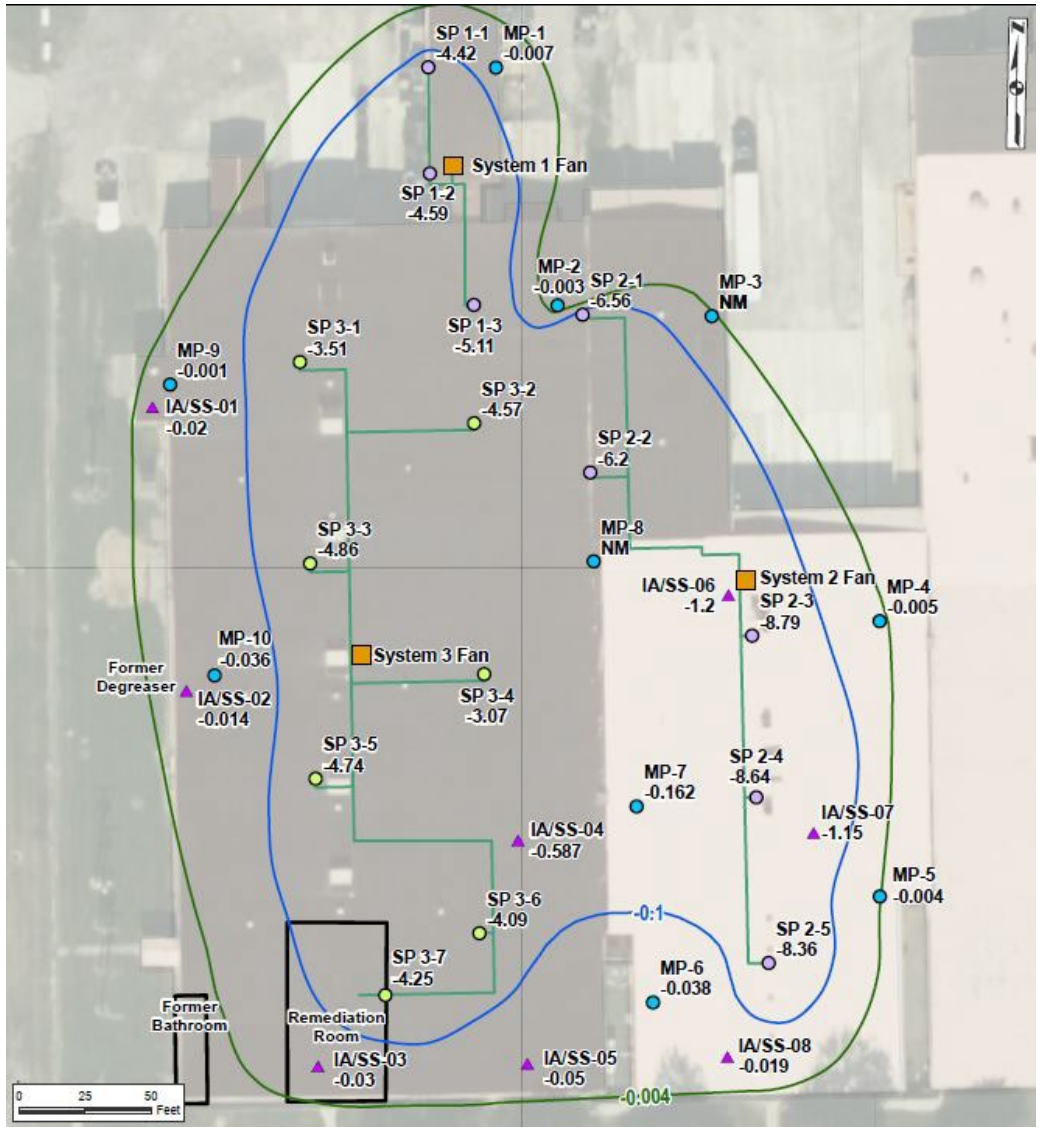
NJ: *Use subsurface vacuum measurements to confirm the pressure differential across the slab in the target area (typically entire slab but can be partial slab on large buildings). Vacuum measurements from permanent sub-slab points may be in the range of 0.01 to 0.001 inches of water (2.5-0.25 Pascal).*

TN: *A micromanometer can be used to collect pressure field measurements through permanent sub-slab monitoring points to confirm a minimum vacuum of -0.004 inches of water is being met at all monitoring point locations.*

Some states have no guidance, rendering a lines of evidence approach, so….



Post System Installation Verification: Confirming Performance



- **Pressure Differential Data Collection**
- **Vacuum Field Mapping**
- **Smoke Testing**

6.6 Monitoring Emissions

If predicted emissions for each individual COC are considered insignificant according to the definition of "insignificant activity" or "insignificant emissions unit" contained in the Division of Air Pollution Control Rule 1200-03-09-.04(2)(a)(3), then no monitoring of system emissions will be necessary.

However, if emissions for each individual COC exceed the definition of "insignificant activity" or "insignificant emissions unit" contained in the Division of Air Pollution Control Rule 1200-03-09-.04(2)(a)(3), then post-installation emissions monitoring or other COC emission treatment may be required based on the applicable TDEC regulations.

Post System Installation Verification: OM&M

- **Written OM&M Plan**
  - **Background**
  - **System inspections**
  - **Measurements**
  - **Repairs and Concrete Crack Inspection**
- **Determine acceptable ongoing performance**
  - **Active vs. Passive vs. Remediation**
- **Exit strategy**
  - **Develop plan**
  - **Estimate timeline for exit criteria**
  - **VI Source Reduction**
  - **Shutdown process**

OM&M/Exit Strategy Highest Impact (ITRC, 2020)

- System Operation – Purpose
- Building Condition & Use – Change in Use
- Building Condition & Use – Physical Modifications to Building
- System Inspection & Performance Metrics – Assessment of Performance Metrics

Post System Installation Verification: OM&M Considerations

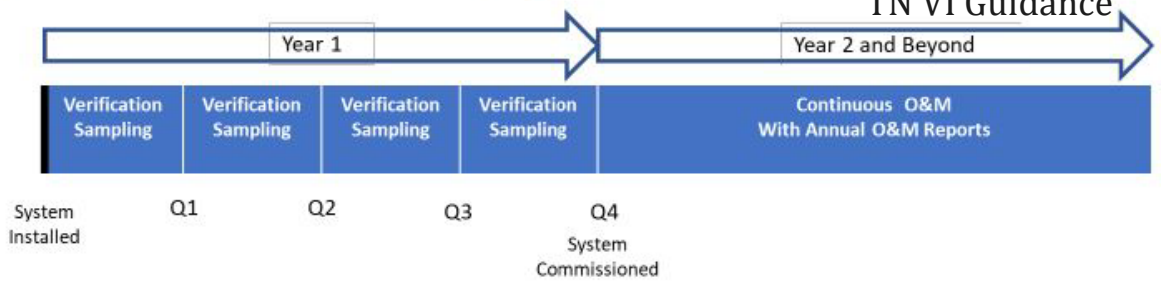
ASTM (ASTM, 2005) calls for regular monitoring and maintenance intervals and makes useful suggestions for how to select a monitoring interval (sections 6.3.8 and 8)

For example, ASTM states: “The monitoring frequency will be a function of the timeframe for possible failure of the engineering control (i.e., more frequent for an active system, less frequent for a passive system) and the relative effect of such a failure on a potential receptor (more frequent for immediate impact, less frequent for a delayed impact). D

DoR-VOAP-G-01-Vapor Mitigation Guidance-01102023

Figure 6-1 Idealized Verification Sampling and O&M Timeline

TN VI Guidance



VAPOR INTRUSION MITIGATION SYSTEM OPERATION, MONITORING, AND MAINTENANCE CHECKLIST

Scope of Checklist: The purpose of this checklist is to guide the user during the inspection of a vapor intrusion mitigation system (VIMS) to (1) verify that the VIMS is operating as designed and (2) determine if certain operation, maintenance, and monitoring (OM&M) activities are necessary for continued operation and effectiveness of the system. This checklist is intended to provide factors to consider when documenting that the VIMS is operating and is effectively mitigating the vapor intrusion pathway during the lifecycle of its operation. Not

Post System Installation Verification: Long Term Monitoring

Example: Indiana (IDEM) Vapor Remedy Selection & Implementation Guide (2019) & Risk-Based Closure Guide (2022)

Table 4-A: Inspection and Sampling Intervals

	Premitigation Indoor Air Concentration			
SGss or SGe concentration	Indoor air < IDEM published level	Published level < indoor air < 2x IDEM published level	2x published level < indoor air < 10x IDEM published level	Indoor air > 10x IDEM published level
SGss or SGe < IDEM published level	None anticipated	None anticipated	None anticipated	None anticipated
Published level < SGss or SGe < 2x IDEM published level	None anticipated	Schedule 1	Schedule 2	Schedule 2
2x published level < SGss or SGe < 10x IDEM published level	Schedule 1 OR conduct on-going sampling	Schedule 1	Schedule 2	Schedule 2
SGss or SGe > 10x IDEM published level	Schedule 2	Schedule 2	Schedule 2	Schedule 2

Table 4-B: Mitigation System Monitoring Schedule

Schedule 1	Schedule 2
Perform activities specified in Section 4.2.3.2, generally on an annual basis. Annual sampling of indoor air during winter worst-case conditions during the first, second, and fifth year, and every fifth year thereafter.	Perform activities specified in Section 4.2.3.2, generally on an annual basis. Annual sampling of indoor air during winter worst-case conditions during the first, second, and fourth year, and every other year thereafter.

Post System Installation Verification: Long Term Stewardship

- **Chemical VI Engineering Controls = Mitigation System**
  - **prevent or minimize exposure**
  - **removals or remedial actions**
- **Institutional Controls**
  - **Deed Restriction, Prospective Purchaser Agreements, Easements, Equitable Servitudes**
  - **Duration;**
  - **Land Coverage; Changes**
- **ICs/ECs Inclusive**
  - **Long Term Success & Post-Implementation Problems**
  - **Residential vs. Non-Residential**
  - **Building Parameter Changes (e.g HVAC)**
  - **Duration**
  - **Parcels**

Short Term 1 – 2 Years

Long Term 2 – 30+ Years

EPA, 2012: A Guide to Planning, Implementing, Maintaining and Enforcing Institutional Controls at Contaminated Sites

EPA, 2012: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites

ITRC, 2016: Long-term Contaminant Management Using Institutional Controls

EPA 2018: Advanced Monitoring Technologies and Approaches to Support Long-Term Stewardship

Post System Installation Verification: Long Term Stewardship (cont.)

- **Stakeholder Engagement**
  - **Regulatory Agency**
  - **On-Site/Employee Notifications**
  - **Off-Site Entities/Organizations**
- **Post System Shutdown Responsibility & Notification**
  - **Decommissioning & Post-Closure Modifications**
- **Financial Assurance**
  - **Requirement vs. Recommendation**
  - **Contemplate Before Transactions**

Thank you

For further information on this subject, please contact:

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