COMMERCIAL VI MITIGATION SYSTEMS

SUCCESSFUL STRATEGIES AND IMPORTANT LESSONS LEARNED

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NEWMOA Video Presentation
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PRESENTATION GOALS

- Present best practices of commercial vapor mitigation design and installation procedures.
- Discuss the efficacy of traditional system components.
- Present examples of design features that do not meet industry standards and how they can impact project success.

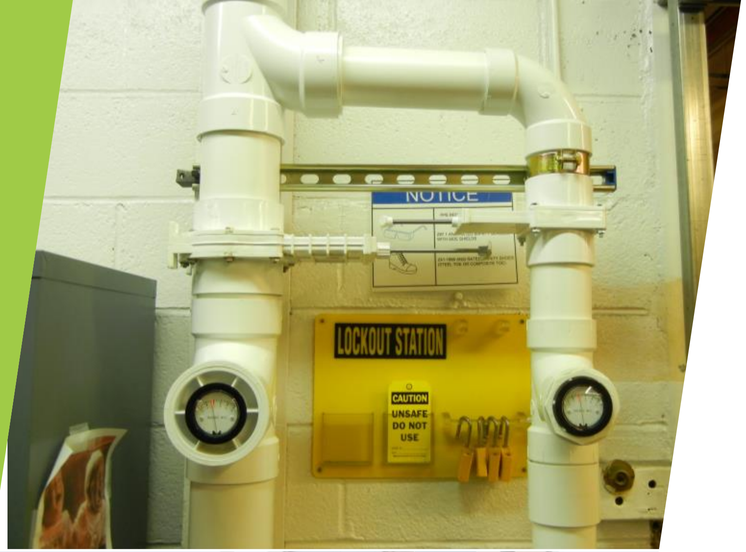
SSD SYSTEM TYPES

Passive

Active

PASSIVE SSD SYSTEMS

- Used in new construction only.
- Comprised of:
  - Vapor collection matting.
  - High quality vapor barrier.
  - PVC riser pipes to roof.
- Emphasis on:
  - Sealing possible VI entry routes.
  - Utilizing stack effect for flow in riser pipes.
- No constantly verifiable performance metrics.
- Fans can be added after construction if passive system alone proves ineffective.



ACTIVE SSD SYSTEMS

- Used in existing buildings and new construction.
- Comprised of:
  - Extraction points.
  - Conveyance piping.
  - Fan assemblies.
  - Monitoring system.
- Emphasis on:
  - Sealing existing VI entry routes.
  - Generating pressure field under the slab.
- Constantly verifiable performance metrics.
- System configuration dependent on existing sub slab characteristics.

WHERE DOES MITIGATION DESIGN BEGIN?

- Every successful project starts off at the same spot.

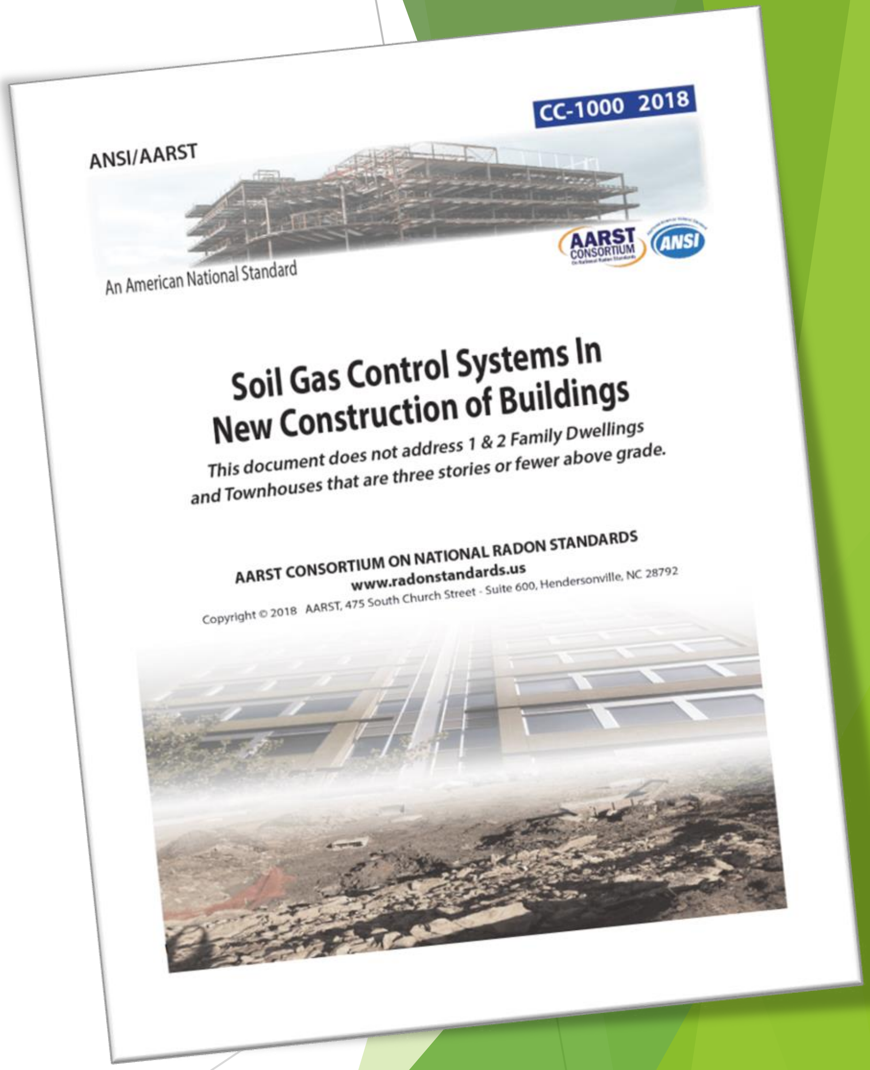
SUCCESSFUL PROJECTS START WITH STANDARDS

Mitigation standards have existed for SSD systems for over 20 years.

- ANSI/AARST Consortium
  - SGM – LB – Large Building Mitigation
  - SGM – MF – Multifamily Building Mitigation
  - SGM – SF – Residential Building Mitigation
  - CC1000 – Large Building New Construction
  - CC-AH – Residential New Construction

Standards are beneficial to everyone involved!

- Design professionals rely on them as a guide to proper installations
- Regulators use them as a ruler to measure proper design
- Clients use them to ensure they are getting the proper solution to their problem



VI SPECIFIC MITIGATION STANDARDS

Published in 2017, ANSI/AARST SGM – SF was the first standard to include Vapor Intrusion specific requirements.

- Remaining ANSI/AARST Mitigation Standards are incorporating these sections as part of their regularly scheduled maintenance updates.
  - This process should be completed by mid 2021.

SGM-SF 2017 Intr

PRACTICAL APPLICATION

Potential reduction in documentation generation by industry and corresponding review by regulators by adding requirement to design/install SSD system to applicable ANSI/AARST Standard to Michigan EGLE projects.

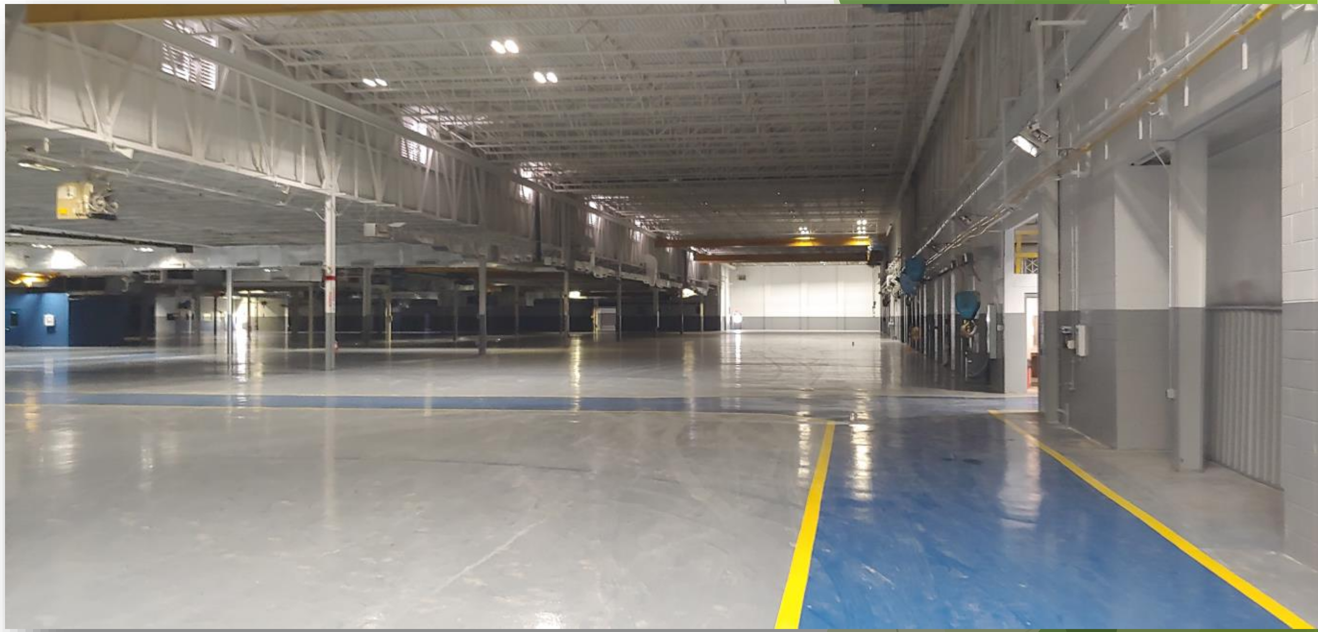

APPENDIX C.5
Checklist for Reviewing the Design of an Active Mitigation System

APPENDIX C.6
Checklist for Reviewing the Design of a Passive Mitigation System

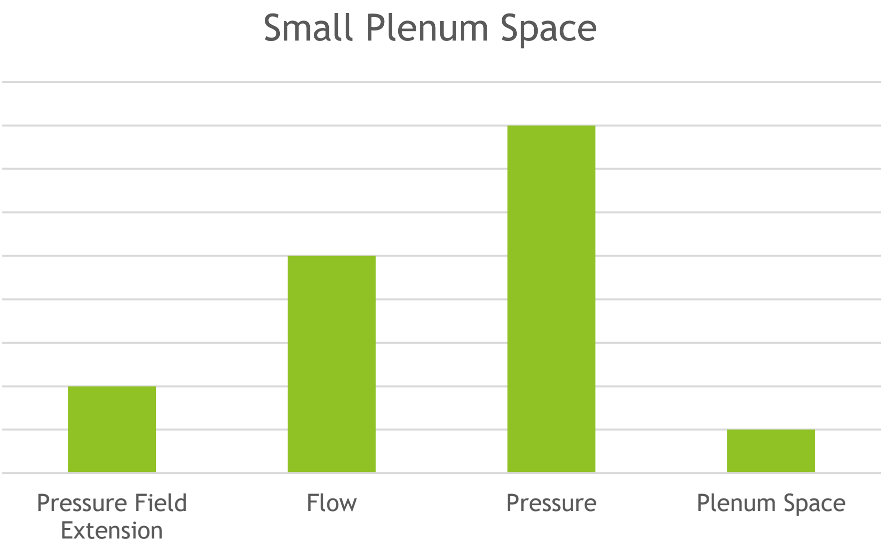
	Active System Checklist (C.5)	Passive System Checklist (C.6)
Current Number of Pages:	5	4
Current Number of Items on Checklist:	49	43
Items Eliminated by Requiring Appropriate ANSI/AARST Standard:	43	32
Items on Updated Checklist:	7	12
Updated Checklist Page Count:	1	2

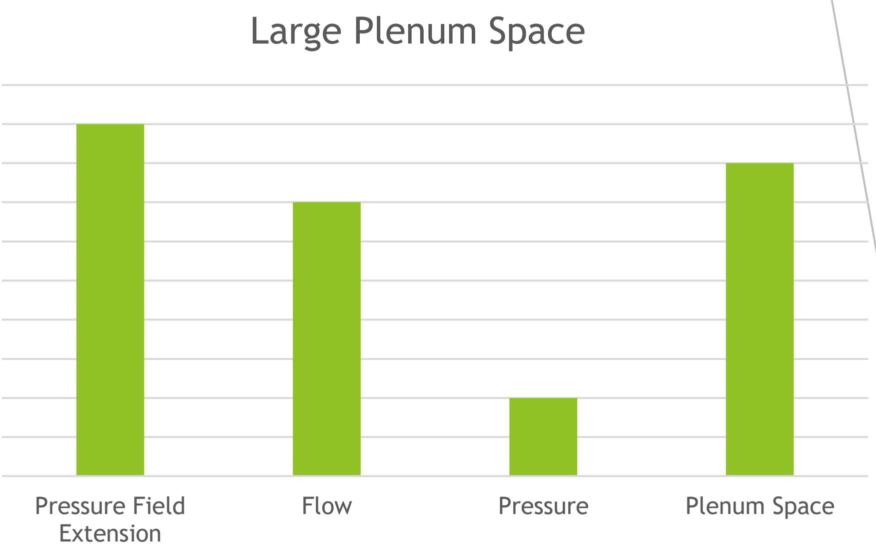
CASE STUDY

Project Location	Tennesee
Building Use	Manufacturing
Building Size	315,000 FT2
Treatment Area	22,000 FT2
Chemical of Concern	TCE
Floor Coating	New Epoxy Floor
Soil Subsidence from Slab	1"
Sub Slab Soil	#57 Gravel w Fines



4 VARIABLES OF A PILOT TEST EXTRACTION POINT



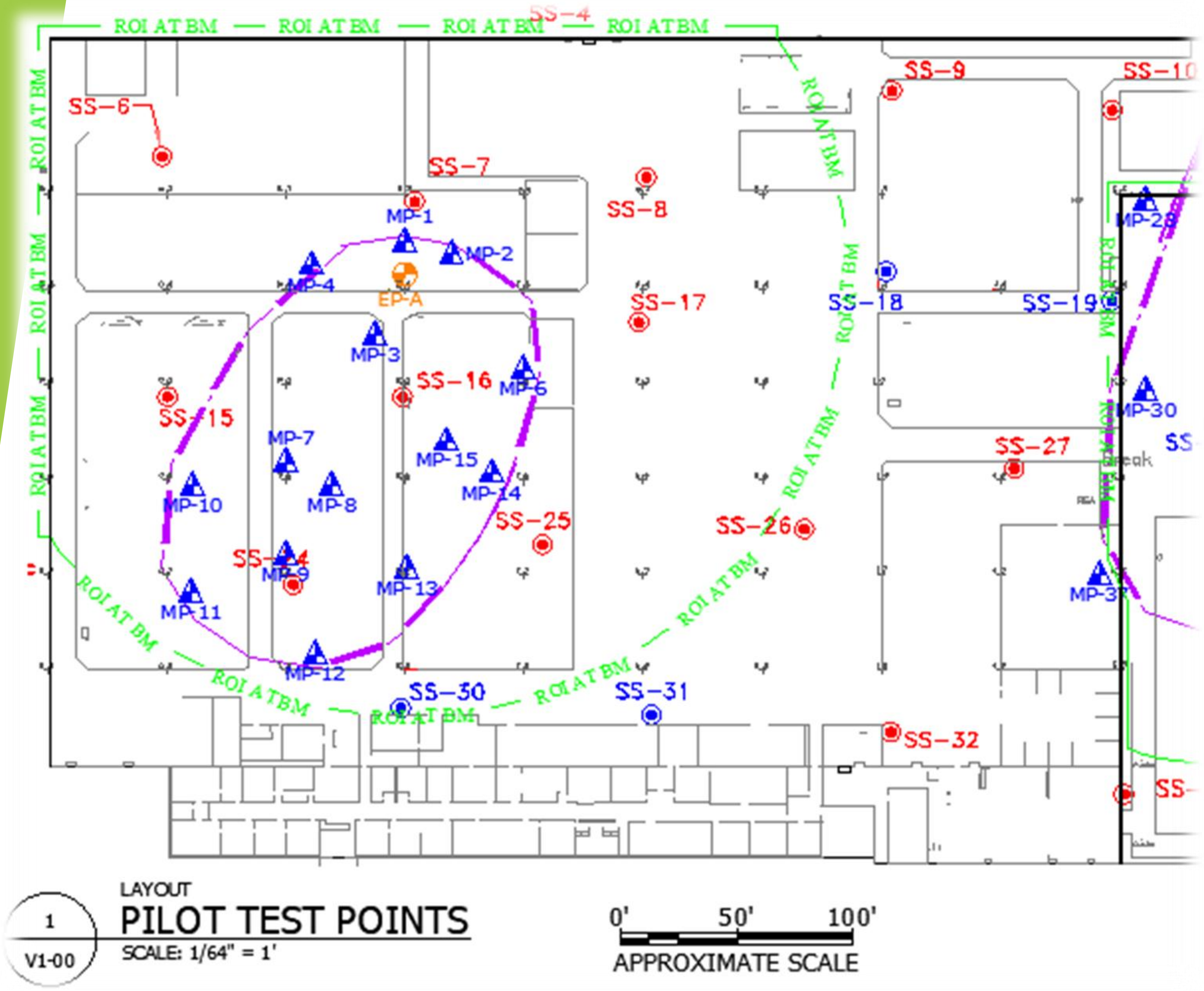


- Pressure Field Extension – Size of the area treated with each EP. Varies by EP and building design.
- Plenum Size – Size of the void space beneath the EP.
- Pressure – Amount of pressure at the EP required to maintain the benchmark pressure at the monitoring point.
- Flow – Amount of air moving from the extraction point to maintain the benchmark pressure at the monitoring point.

PROPER PILOT TEST METHODOLOGY

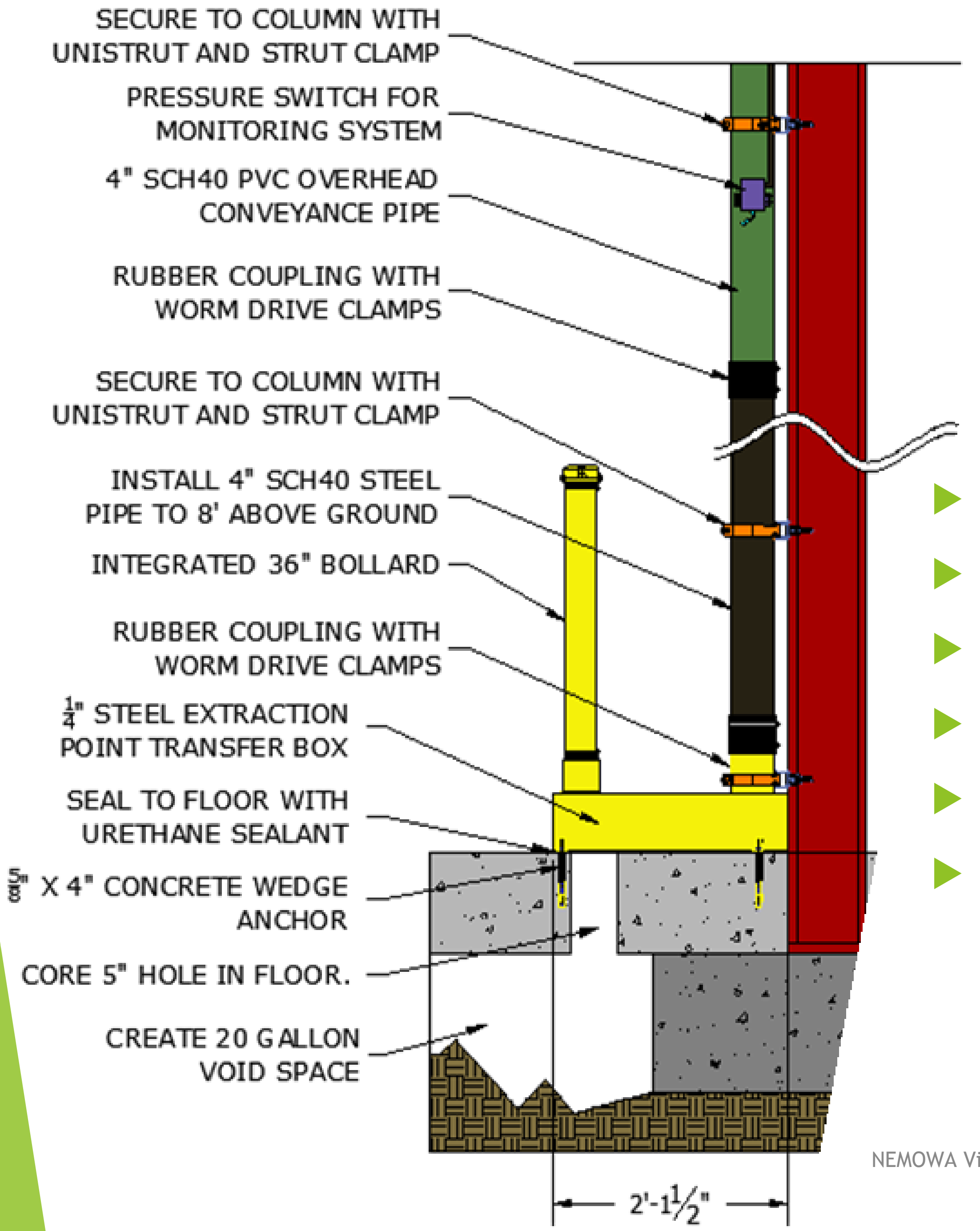
- Pressure and flow gages below valve.
- Correct pipe size.
- 5” extraction point (EP).
- Large plenum size.
- Valve to regulate pressure and flow at EP.
  - Closing the valve decreases pressure and flow at the EP and is accurately recorded on the gages.

PILOT TEST LAYOUT



									Extraction Point:	EP- A	
NOTES: Exceptional PFE at this EP. Initial test conducted with no plenum space and 3 RN-4 fans operating in series. Final balanced test performed with single RN-4 operating and inlie gate vale set at a 2.75" opening.											
Extraction Point				**Initial Test**		**Retest After Plenum**			**Balanced Pilot Test**		
Concrete Depth	6		Inches	Fan	RN-4 X 3	Fan	RN-4 X 3		Fan	RN-4 X 1	
Subsidence	1		Inches	Plenum Size	0 Gallons	Plenum Size	3	Gallons	Plenum Size	3	Gallons
Soil	#57 Stone with Fines			Operating Pressure	-11.5 "WC	Operating Pressure	-11	"WC	Operating Pressure	-1.8	"WC
				Flow	72 CFM	Flow	84	CFM	Flow	56	CFM
Monitoring Point											
Number	Distance from EP	Cross Foundation	Static Pressure	Measured Pressure	Delta vs Static	Measured Pressure	Delta vs Static	Delta vs Initial	Measured Pressure	Delta vs Initial	Delta vs Excavated
MP-1	10	No	-5	-1280	-1275	-1795	-1790	-515	-327	-515	1468
MP-2	20	No	-3	-2364	-2361	-3701	-3698	-1337	-615	-1337	3086
MP-3	30	No	-1	-1440	-1439	-2207	-2206	-767	-407	-767	1800
MP-4	40	No	-6	-423	-417	-613	-607	-190	-103	-190	510
MP-6	65	No	-3	-382	-379	-600	-597	-218	-120	-218	480
MP-7	95	No	-4	-136	-132	-223	-219	-87	-49	-87	174
MP-8	95	No	-8	-254	-246	-600	-592	-346	-115	-346	485
MP*9	129	No	-2	-124	-122	-258	-256	-134	-47	-134	211
MP-10	127	No	-5	-115	-110	-203	-198	-88	-38	-88	165
MP-11	162	No	-3	-96	-93	-196	-193	-100	-39	-100	157
MP-12	166	No	-5	-46	-41	-81	-76	-35	-17	-35	64
MP-13	125	No	-3	-208	-205	-528	-525	-320	-104	-320	424
MP-14	92	No	-9	-503	-494	-895	-886	-392	-160	-392	735
MP-15	72	No	-9	-645	-636	-1135	-1126	-490	-215	-490	920
SS-18	186	No	-1	-14	-13	-19	-18	-5	-5	-5	14
SS-30	216	No	-4	-46	-42	-82	-78	-36	-20	-36	62
SS-31	208	No	-2	-16	-14	-26	-24	-10	-7	-10	19

ASSEMBLE AN ACTIONABLE DATASET



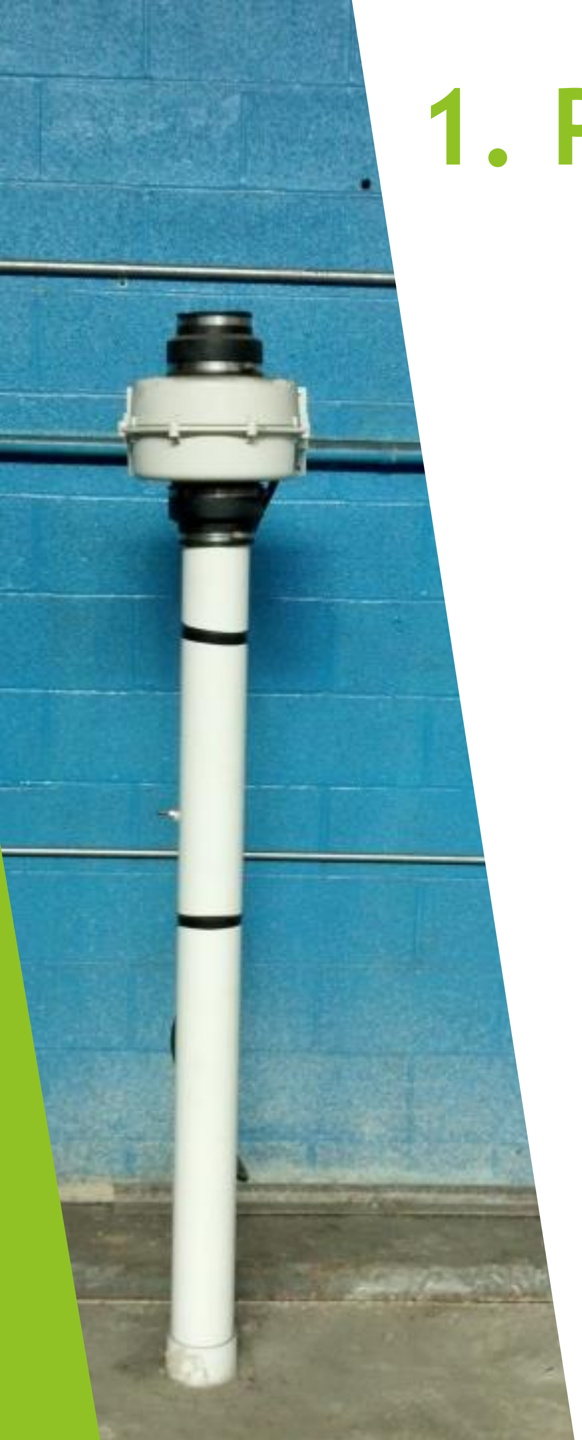
GENERATE CONSTRUCTION DOCUMENTS

- Layout drawings of system.
- Detail drawings of major components.
- Installation specifications.
- Cut sheets for all equipment.
- Project budget.
- Some regulators conduct a design review at this phase for compliance to the project standard and to ensure a successful mitigation.

INSTALLED SYSTEM METRICS

Extraction Points	1	Each
System Pressure	-5.7	"WC
System Flow	210	CFM
Power Consumption	330	Watts
Treatment Area	91,000	FT2
Installation Cost	18%	of Initial Budget
30 Year OMM Cost	$ 50,000.00	Estimated

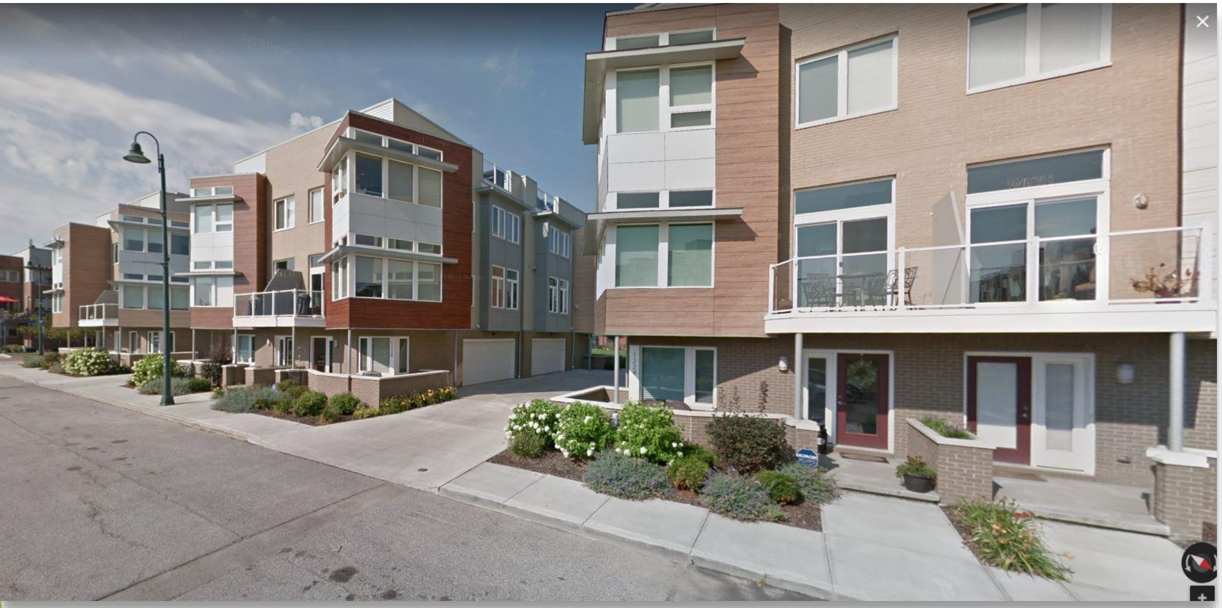
The following misconceptions and poor design choices often lead to ineffective mitigation systems.

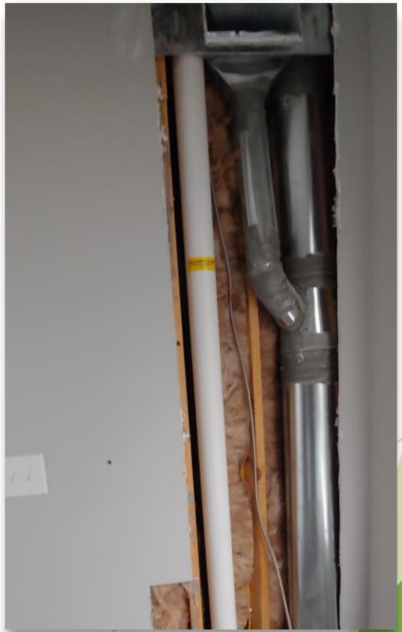


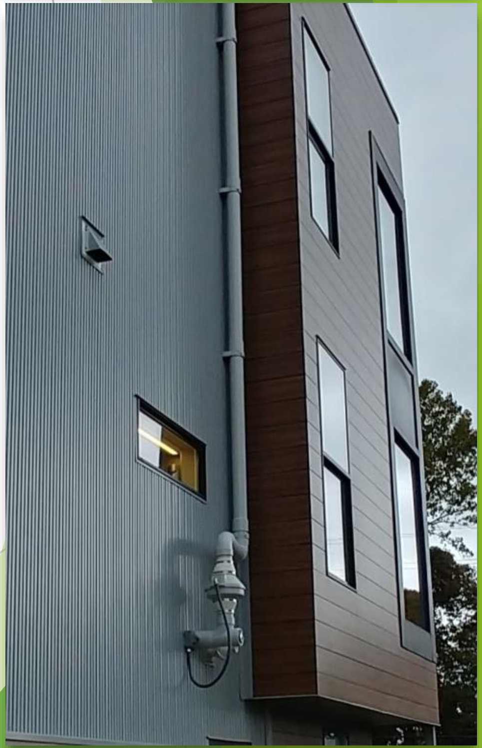
1. POST HOC ERGO PROCTOR HOC

- The Latin phrase "Post Hoc Ergo Proctor Hoc" translates roughly to "After this, therefore because of this"
- A significant portion of SSD systems are installed prophylactically due to the uncertainty in determining if a preferential pathway between the plume and the new building will exist after construction.
- During sampling, low IAQ results are typically attributed solely to the installation of the passive system. The preferential pathway is not examined.
- Failure to recognize this disconnect has led to the reinforcement of poor design choices.
- "I knew we were going to pass the IAQ tests because I wore my lucky socks when I deployed the sampling devices."

2. STAND ALONE VAPOR BARRIERS







- In a passive system, the riser piping acts as a pressure relief valve for the vapor barrier. Without this component, the barrier will eventually fail. Installing riser piping after the building is complete is expensive and invasive compared to the cost to install during construction.

EXHAUST TURBINES

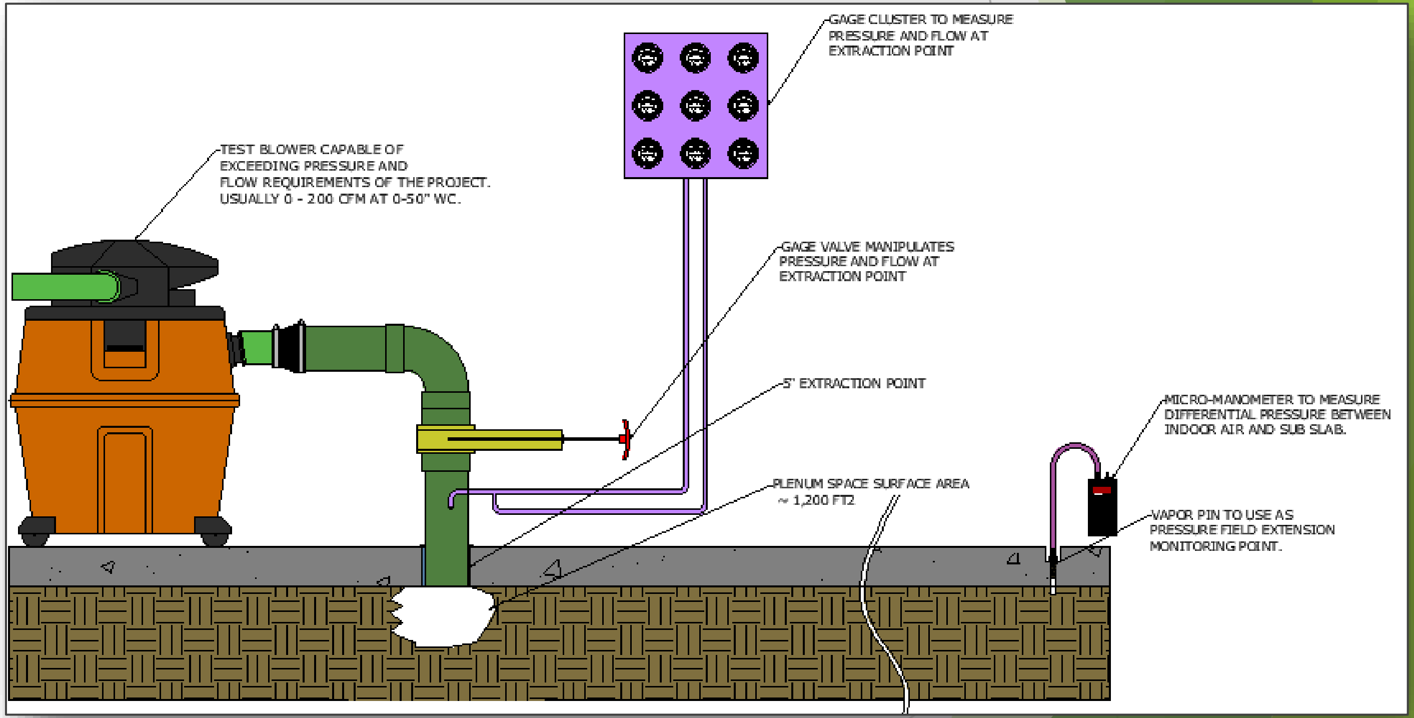
- Some regulators require turbines on the passive SSD system exhaust to enhance the effectiveness of the system.
- Unfortunately, there is very little evidence for the efficacy of these products.
- More research is needed in this area.

Turbine Performance Evaluation									
Wind Generation				Turbine		SSD Inlet Values			
Volume	Distance From Turbine	Air Speed		Rotational Speed	Runout Time after Air Removed	Max Pressure	Equivalent Pipe Length	Operating Pressure	Operating Flow
CFM	Inches	FPM	MPH	RPM	Seconds	IN WC	FT	IN WC	CFM
192	2.5	2200	25	763.9	94	0.060	10	0.014	14
							110	0.017	13
							210	0.015	12
31	2.5	352	4	122.2	92	0.015	10	0.002	2
							110	0	0
							210	0	0

PILOT TEST METHODOLOGY

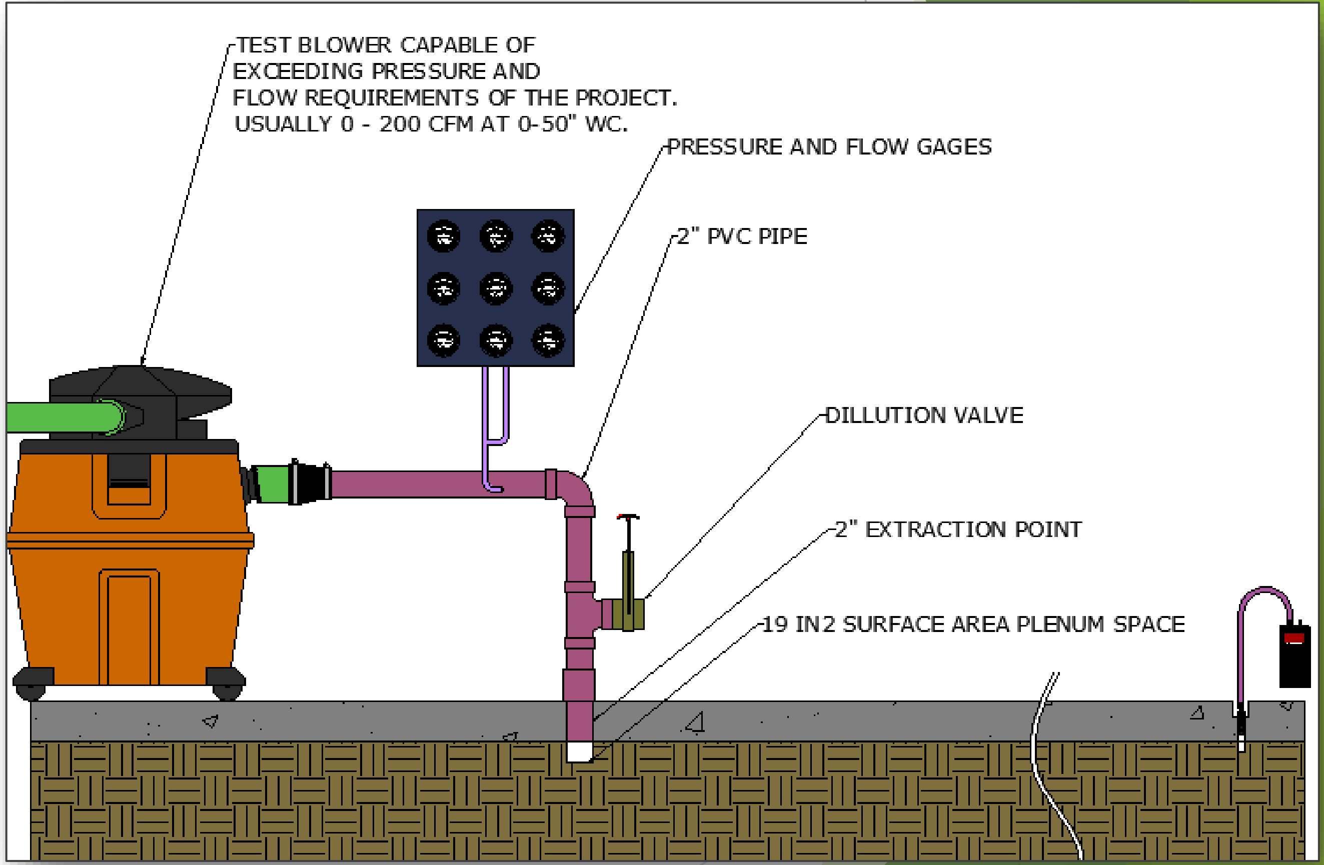
Proper setup

- Pressure and flow gages below valve.
- Correct pipe size
- 5” extraction point (EP)
- Large plenum size
- Valve to regulate pressure and flow at EP
    - Closing the valve decreases pressure and flow at the EP and is accurately recorded on the gages



PILOT TEST METHODOLOGY *Incorrect Setup*

- Valve is incorrect
  - Does not regulate pressure or flow at EP
  - **ALWAYS** produces best results when closed
- EP should be 5”
  - Necessary for plenum space creation
- Pipe size should be larger.
  - 2” pipe adds unnecessary friction to the system can limit flow rates.
- Plenum size
  - Too small to gather accurate data
- Gages measure total pressure and flow, not EP
  - Only accurate when valve is closed

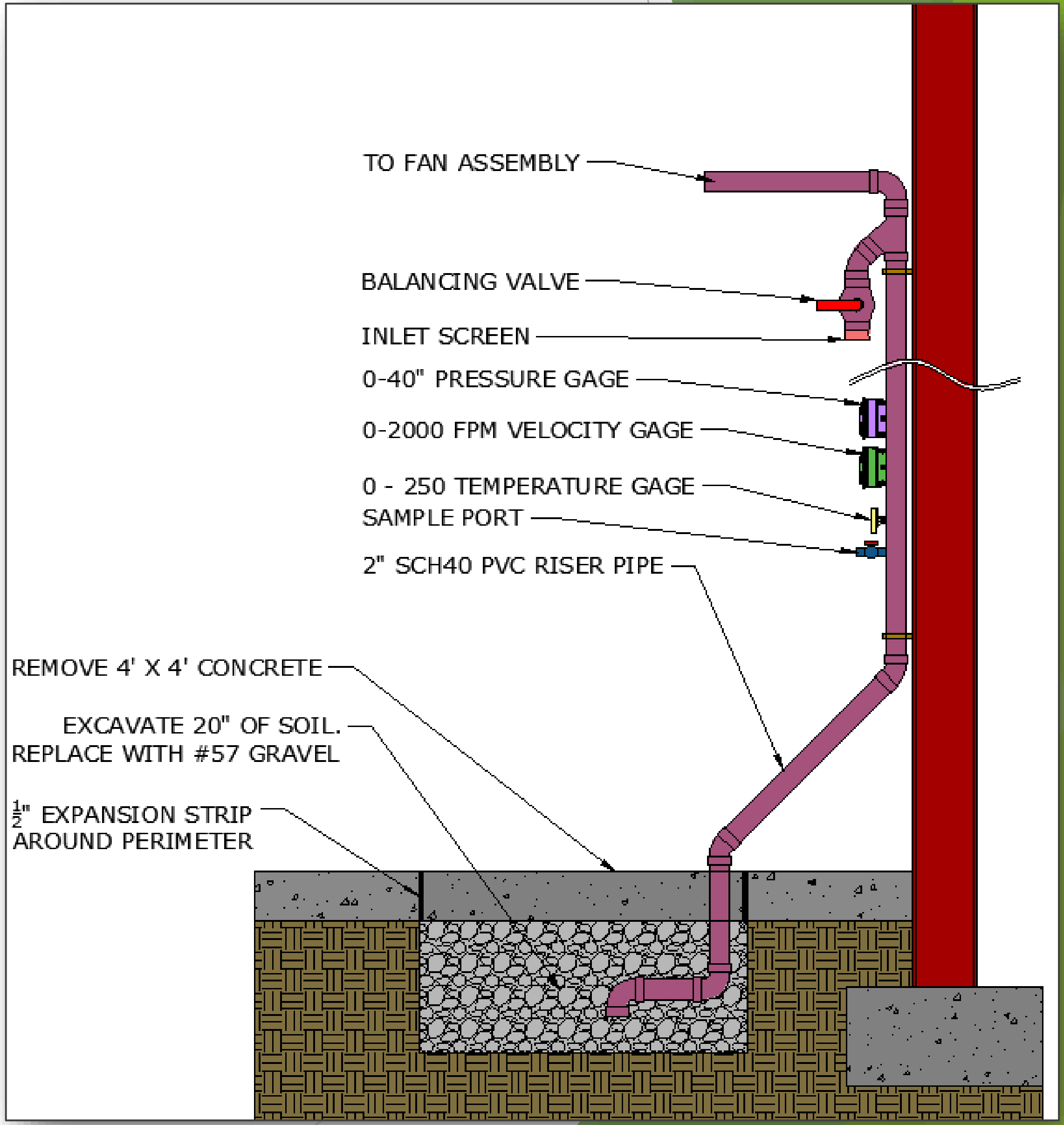


EXTRACTION POINT

Typical Flawed Example

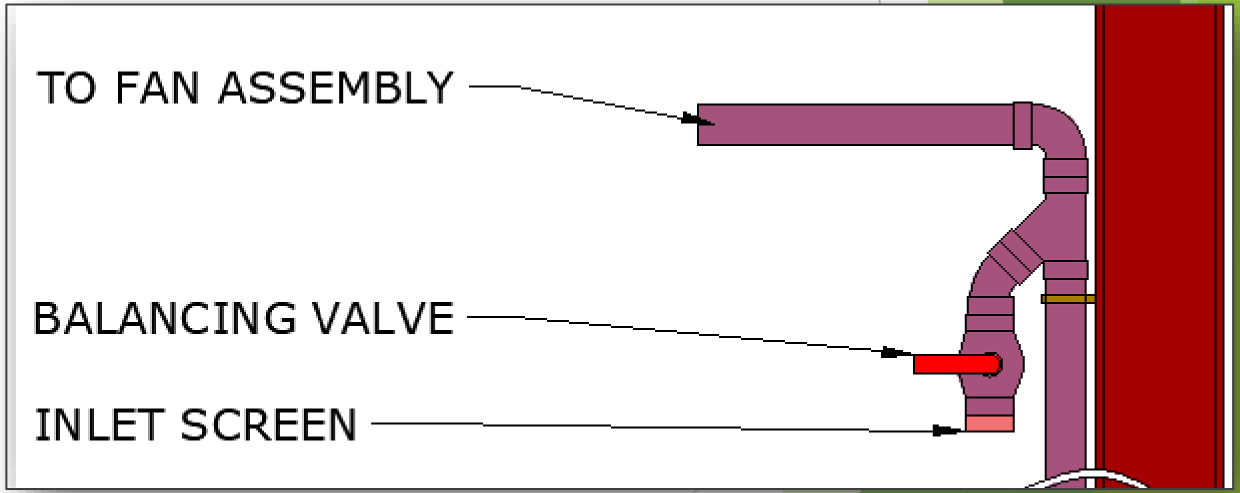
Main Components:

- 2” Conveyance piping
- Dilution valve to regulate pressure
- Gages to measure pressure, flow and temperature
- Sample port
- 16 ft2 of concrete demo
- Remove 20 ft3 of soil
- Install gravel and replace concrete



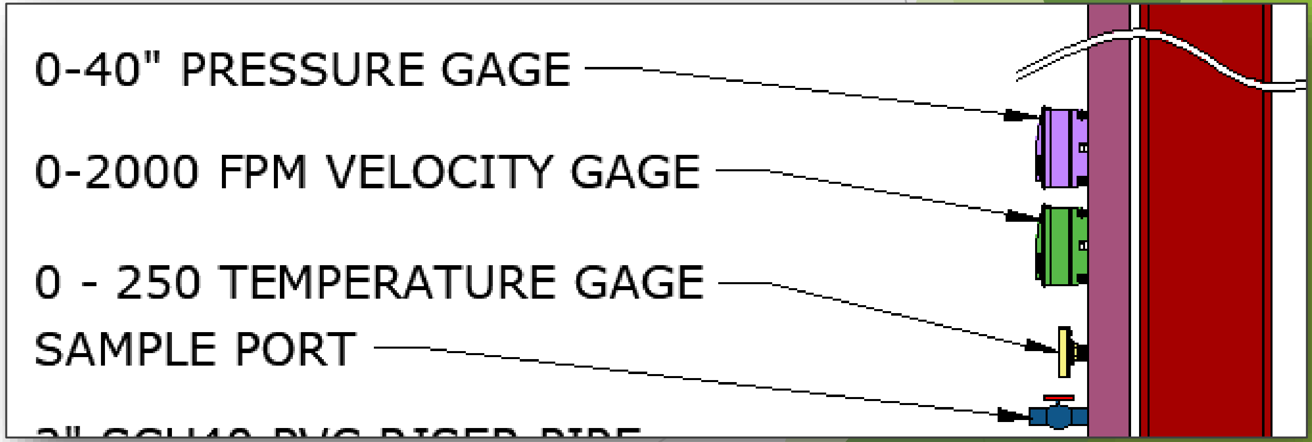
EXTRACTION POINT *Typical Flawed Example*

- Deficiencies:
  - 2” Overhead and EP piping not large enough. 3” is minimum
    - AARST/ANSI RMS LB 7.3.1 – The minimum inside duct diameter from exhaust point to soil gas collection plenum shall be equivalent or greater than the cross-sectional area of a 3” inside diameter pipe…
  - Will Cause:
    - Excessive wear on fan assembly
    - Excessive cost to operate oversized fan
    - Insufficient flow
    - Early fan failure
  - Valve location incorrect. Opening valve allows ambient air into the system
    - This method is so far outside the standards that there are no references to it.



EXTRACTION POINT *Typical Flawed Example*

- Deficiencies:
  - Pressure Gage – OK
  - Flow Gage
    - These are acceptable, but generally not necessary.
  - Temperature Gage - Used to ensure airstream does not rise to autoignition temperature of COC.
    - Naphthalene
      - Autoignition: 525 °C (977 °F; 798 K)
    - PVC Pipe
      - Melting Point: 100 °C (212 °F; 373 K)



REAL WORLD EXAMPLE

- The diameter of the pipe adds resistance to the system which must be overcome by the blower
- Let's consider a typical system with 200' of pipe
- The Pilot Test indicates total operating pressure of 1.5"WC and 100 CFM

Pipe Diameter	2"	4"
Friction Loss for 200' of pipe @ 100 CFM	39.5"	1.3"
Required System Pressure	1.5"	1.5"
Total blower pressure requirement @ 200 CFM	41.0"	2.8"

THANK YOU!

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