

Distinguishing Vapor Intrusion Sources from Background Sources of Volatile Organic Chemicals in Indoor Air Using Building Pressure Control

Presented by:

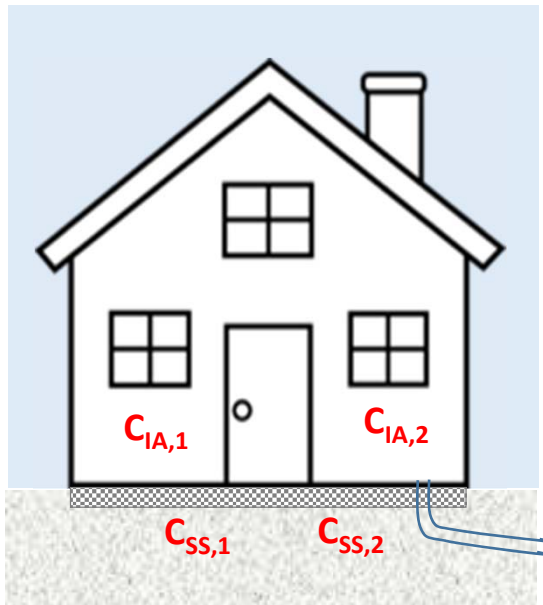
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Topics

- Conventional approach to vapor intrusion (VI) assessment
- Key factors influencing VI
- Cross-slab pressure differentials
- Building Pressure Control (BPC)
- Technology applications
- Regulatory acceptance

Conventional VI Assessment



C_{IA} = indoor air (IA) concentration

C_{SS} = subslab (SS) concentration

- Evacuated canisters



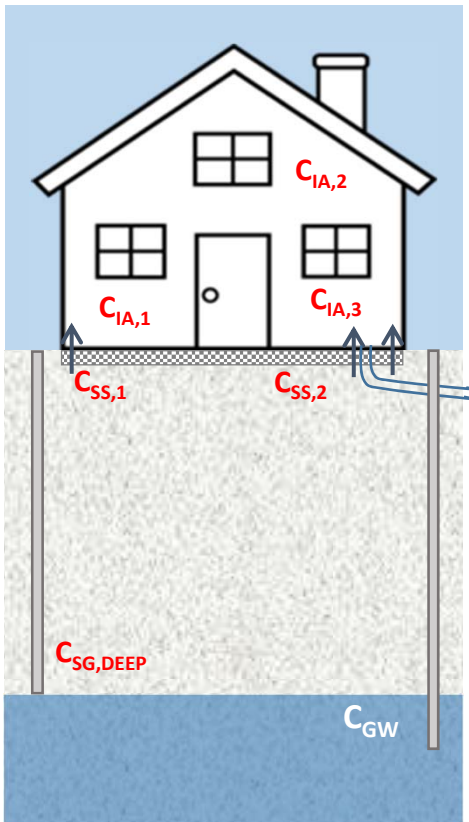
- Active thermal desorption tubes



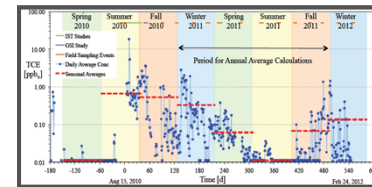
- Grab (SS) or time averaged 8-24 hr samples (IA)

How many samples? How many rounds of sampling?

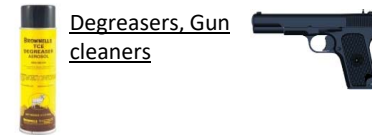
Technical Challenges



- Temporal variability in indoor air concentrations



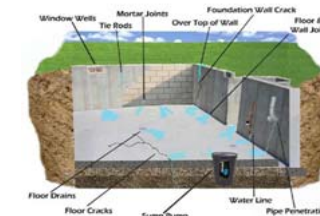
- Background sources of volatile organic compounds



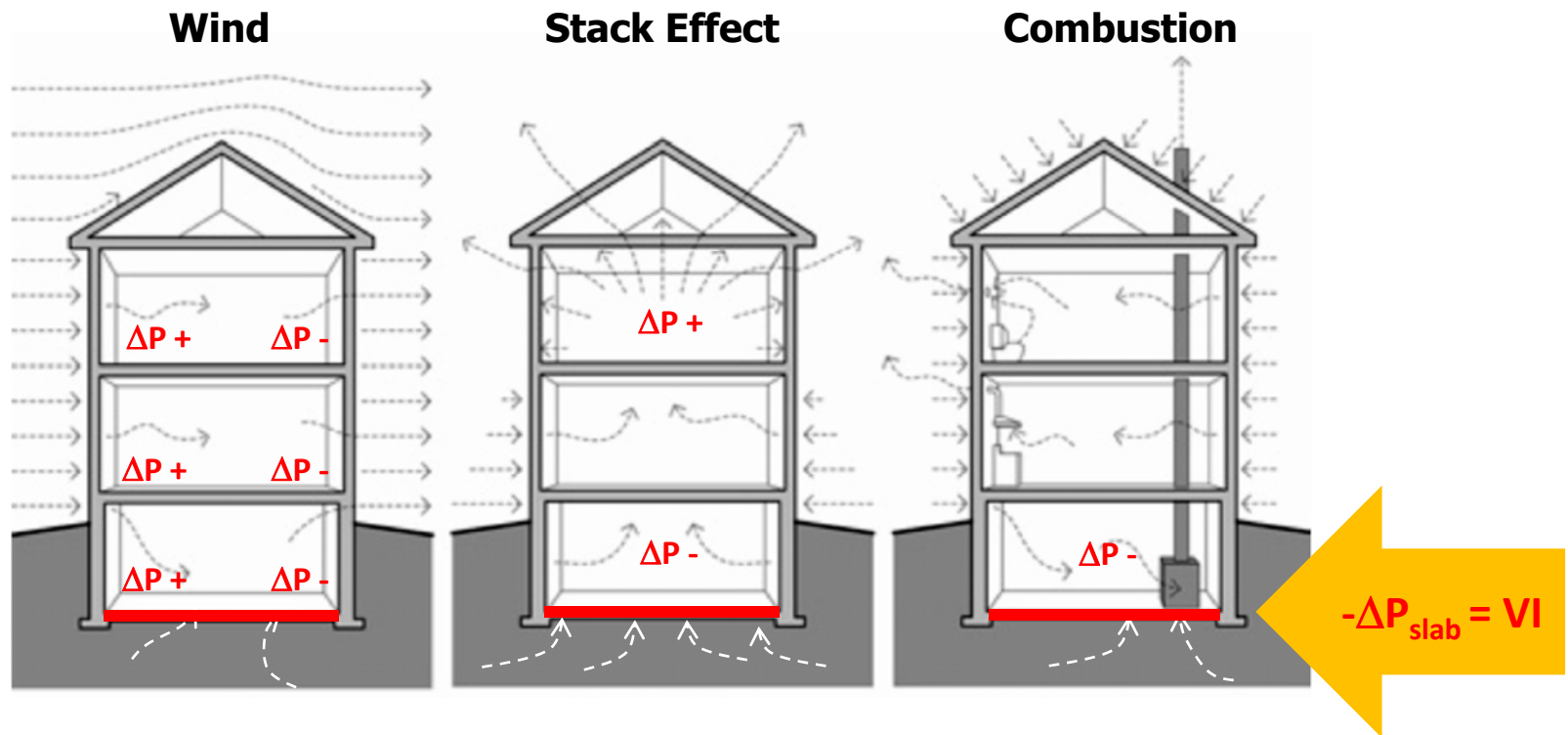
- Spatial variability in sub-slab concentrations



- Preferential Pathways



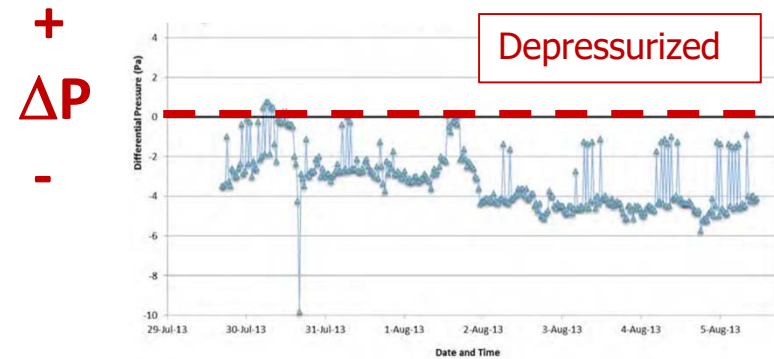
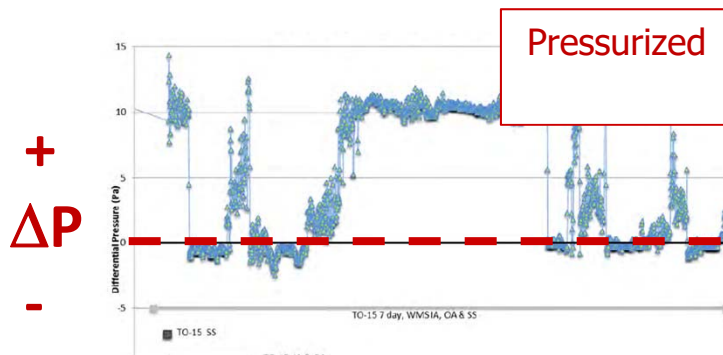
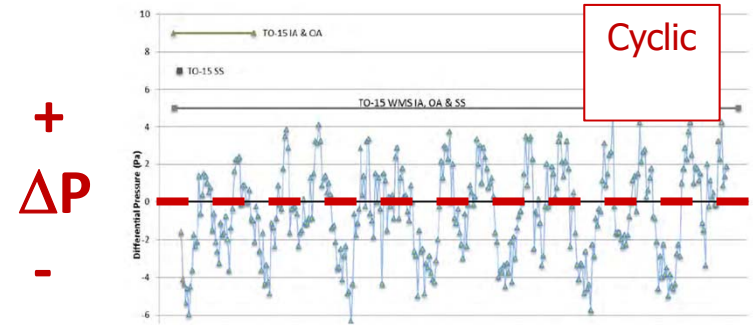
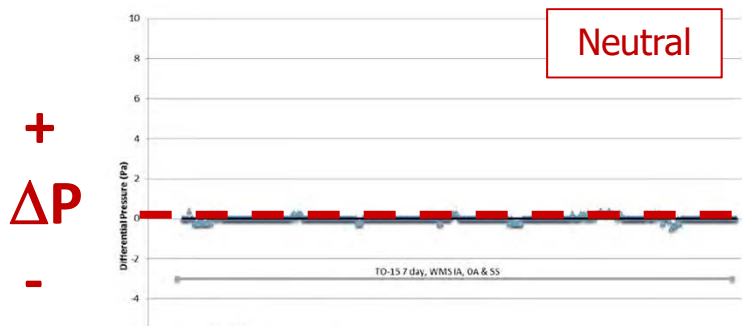
Key Factors Influencing VI



$\Delta P = \text{Building Pressure minus Exterior Pressure}$

Cross-Slab Pressure Differential (ΔP_{ss})

ΔP_{ss} characterizes building susceptibility to subsurface vapor entry



Sampling Approaches that Consider ΔP_{ss}

- Monitor ΔP :
 - Indicates whether and when the building was susceptible to VI during sampling
 - Simple, minimal cost, high data value-to-cost ratio
- Manipulate ΔP (Building Pressure Control (BPC)):
 - Induce depressurized building conditions and sample to characterize VI impacts
 - Induce positive pressure building conditions and sample to characterize background source emissions.

Case Studies (SERDP ESTCP ER-201503)

Raritan Arsenal, NJ

- Building 200
- Medical office
- Area: 2,100 ft²,
- Height: 8 ft
- Volume: 16,800 ft³

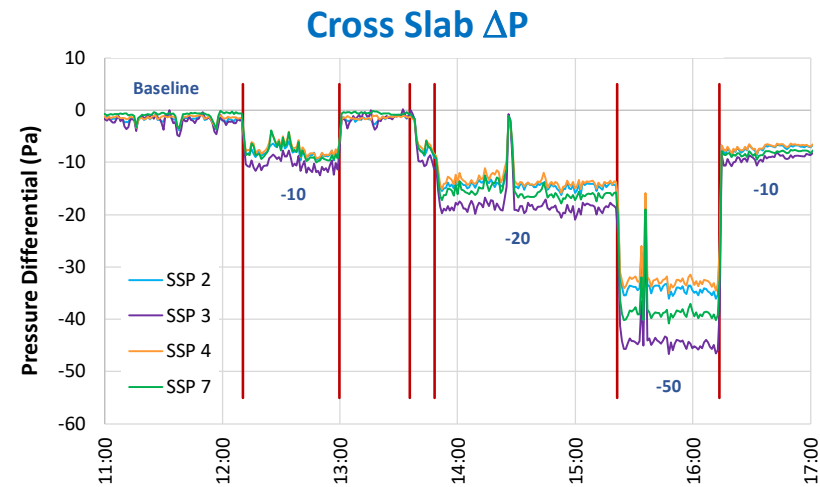
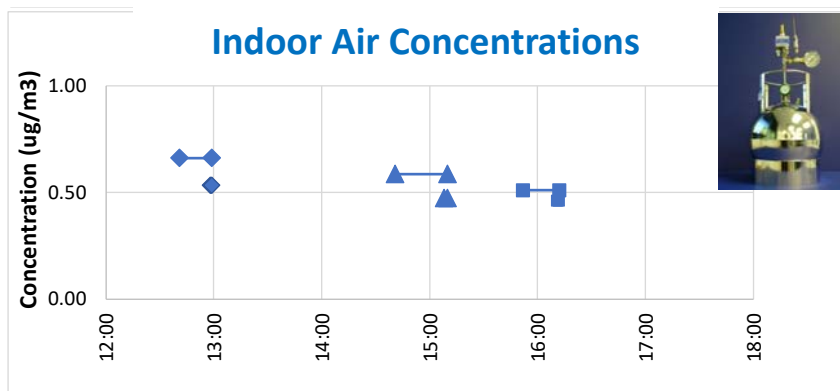
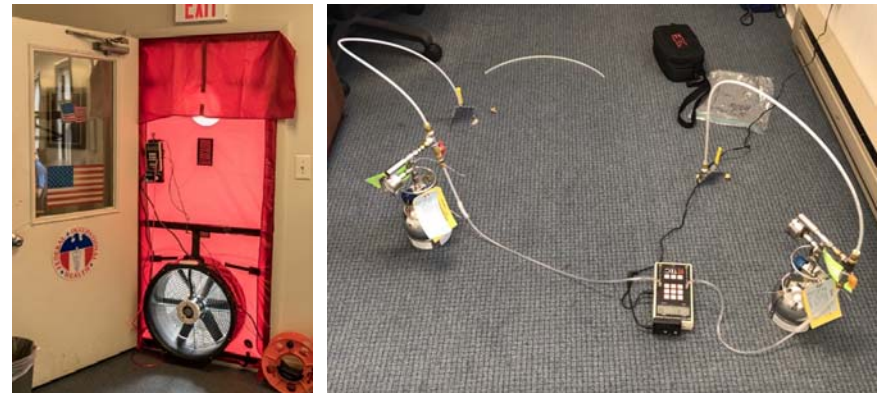
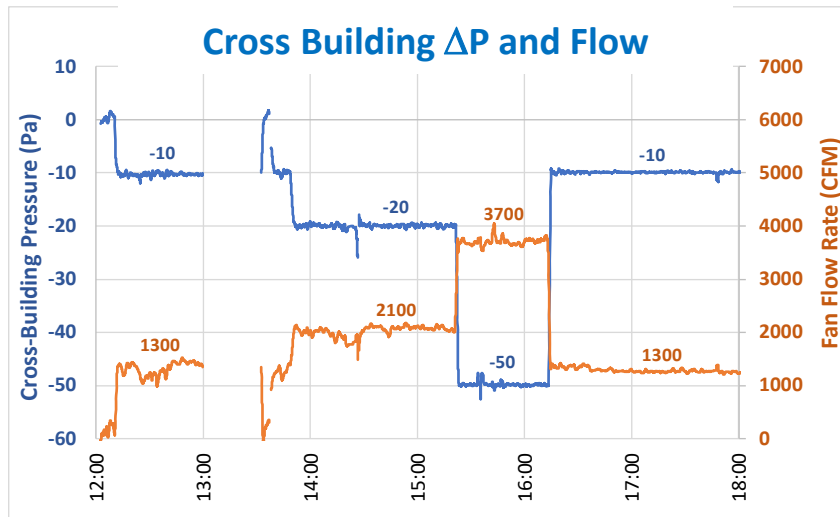


Vandenberg AFB, CA

- Building 11193
- Former dry cleaner facility & gym
- Area: 11,000 ft²
- Height: 13.2 ft
- Volume: 145,000 ft³

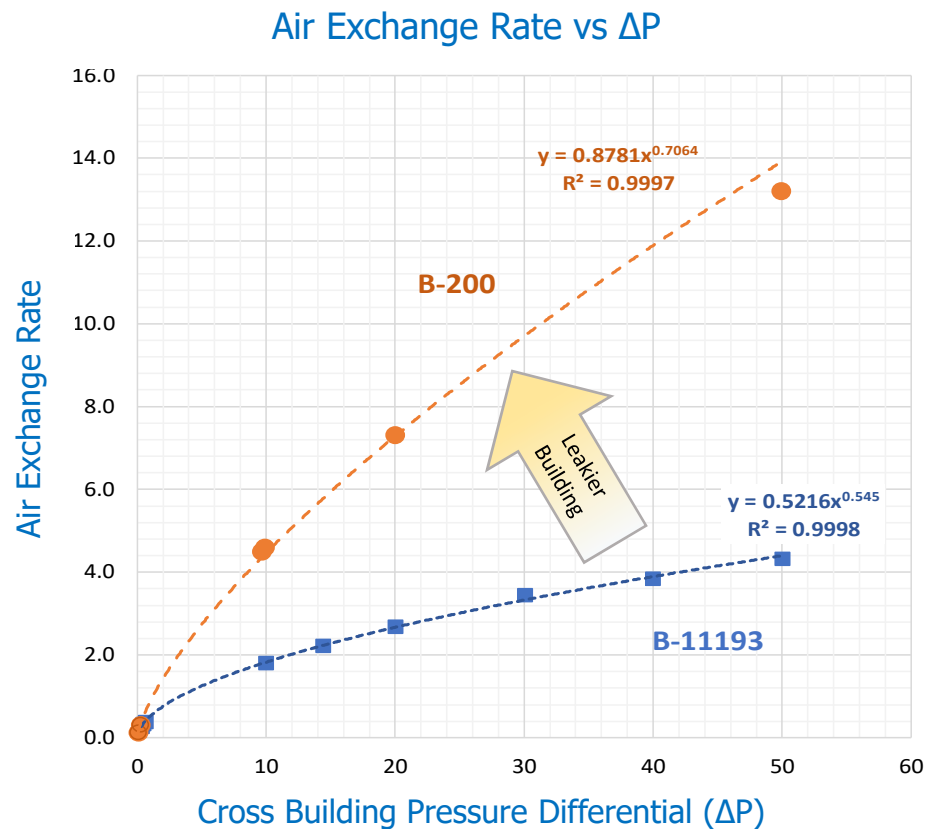
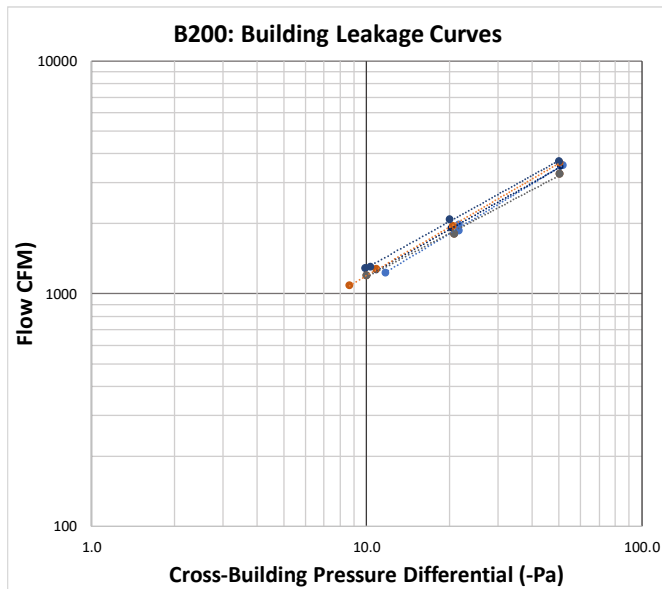
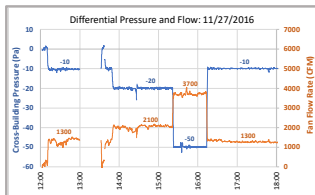


Building Pressure Control – Data



Cross-building pressure differential and flow relationships...

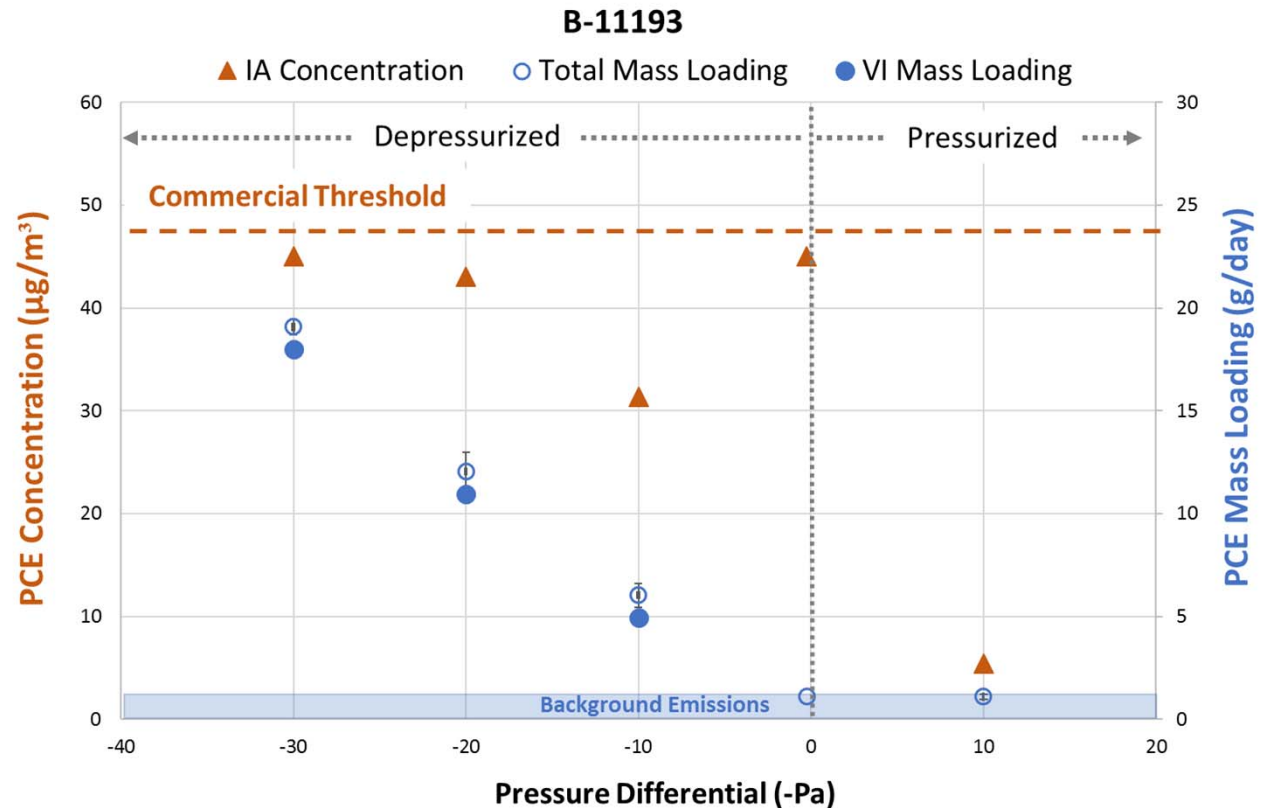
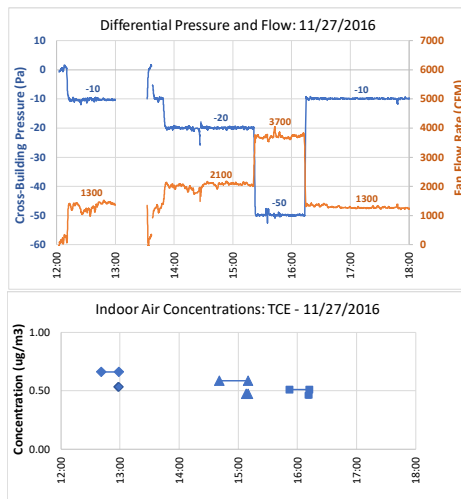
... provide information about building envelope leakiness.



Indoor air sampling combined with BPC

....provides:

- Reasonable upper bound indoor air concentrations from vapor intrusion
- Vapor intrusion mass loading (ML) through the slab: (ML = Conc. X Flow)
- Emission rates from background sources



Application to VI Risk Assessment

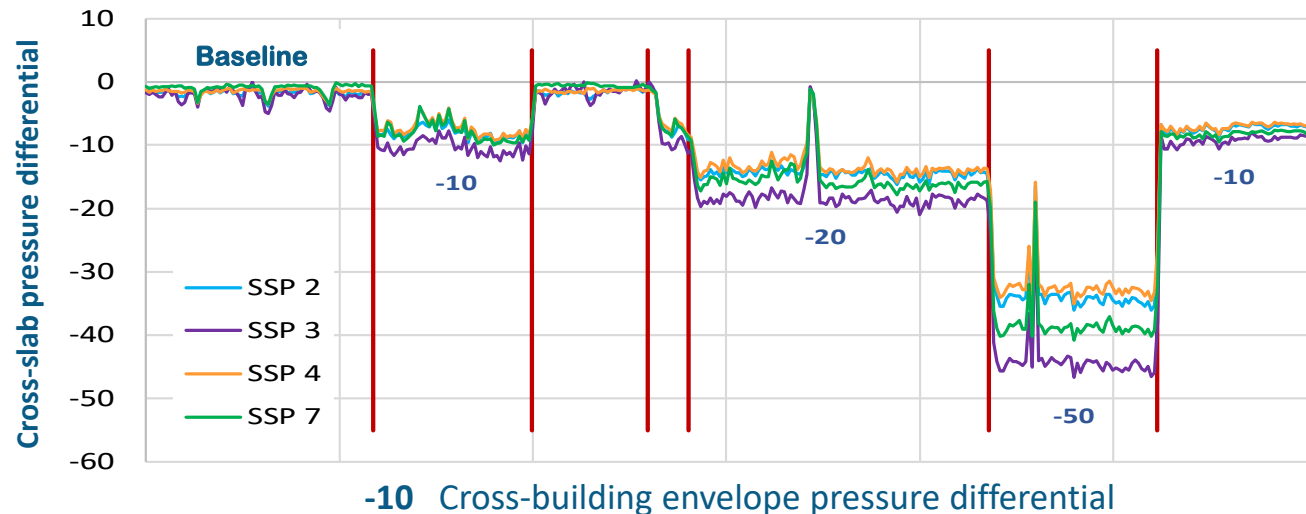
- Short term and reasonable maximum exposures:
 - Indoor air (IA) concentrations measured under upper-bound, natural range of depressurized building conditions.
- Long term average exposures:
 - IA concentrations calculated from building mass loading (ML_{BPC}) at average air exchange rates (AER):

$$IA = ML_{BPC} / (V_{BLDG} AER_{AVG})$$

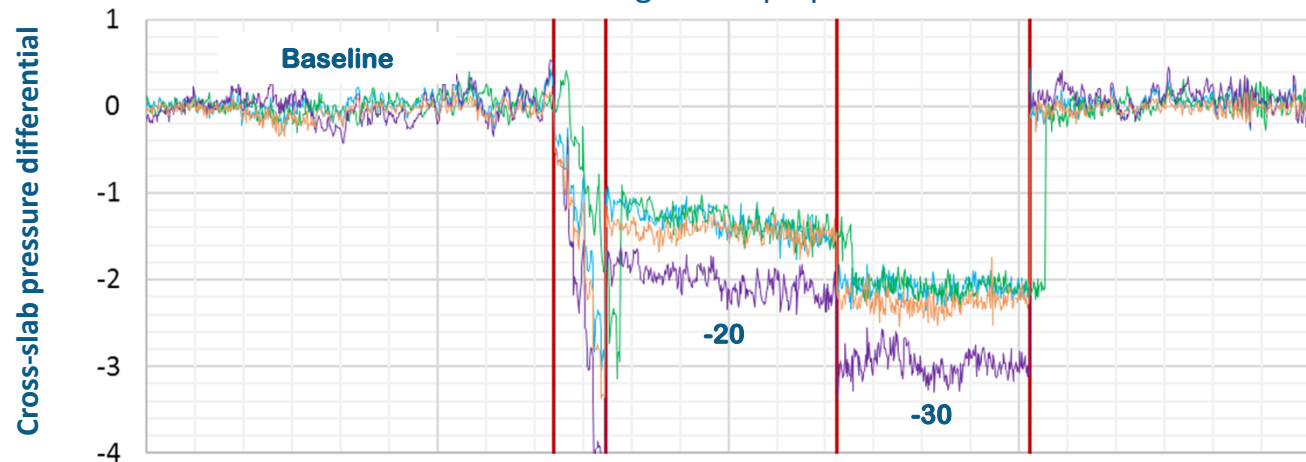
Cross slab pressure differential monitoring under depressurized conditions...

- ...characterizes relative leakiness of floor slab.

B200

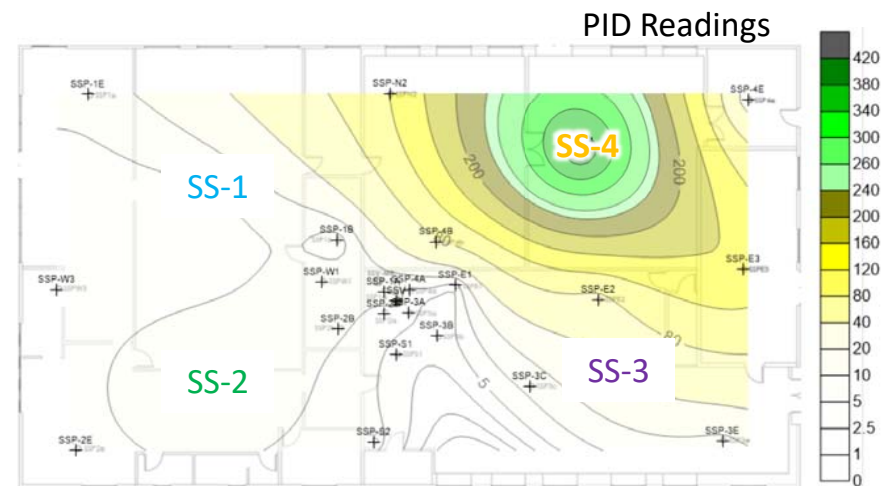
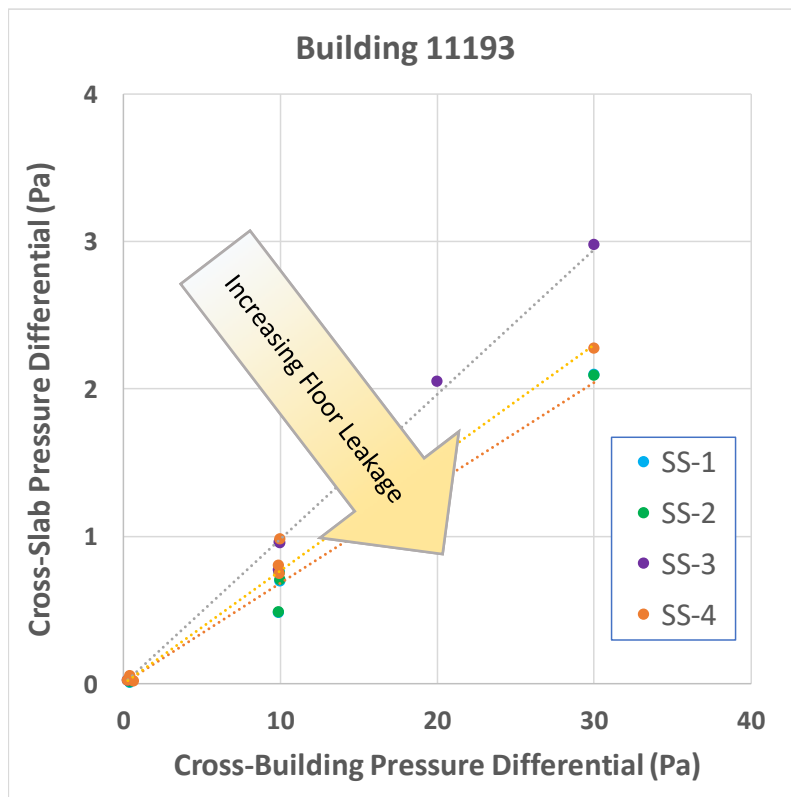


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Cross-slab and cross-building pressure relationships...

- ...identify heterogeneities in floor leakiness, and areas with greater potential for vapor entry.



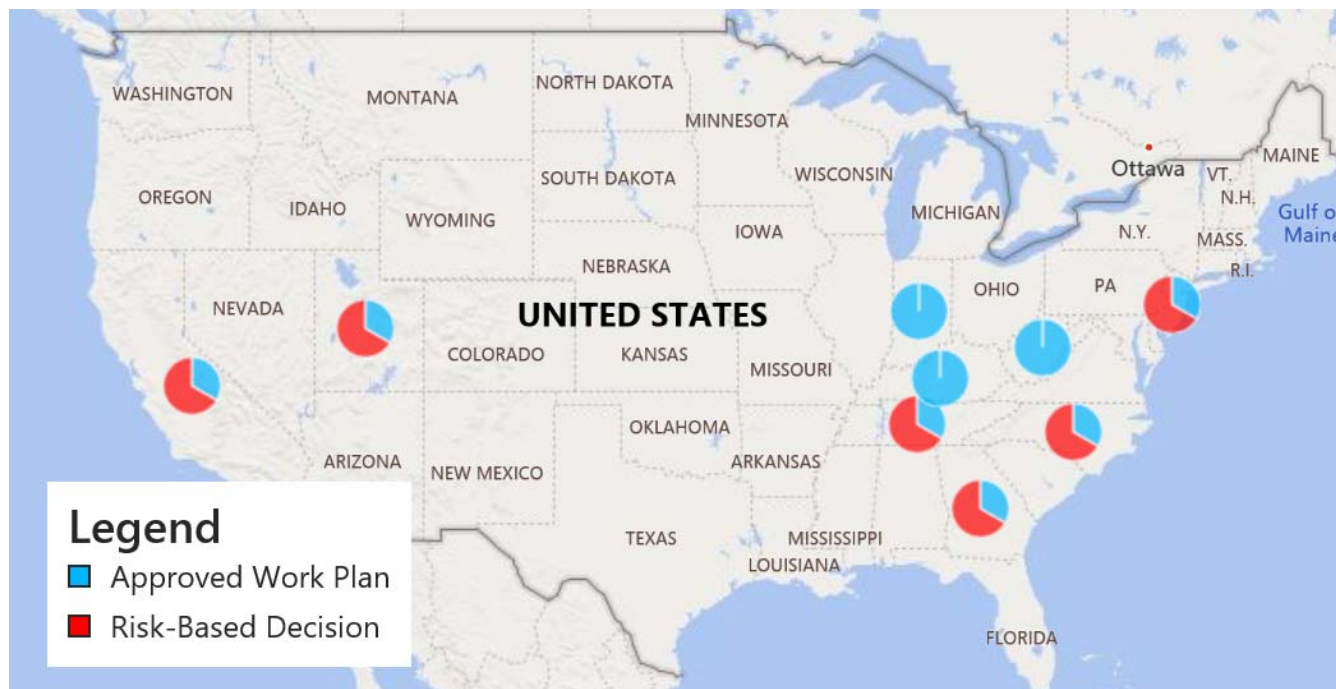
Source: ESTCP ER-201322

BPC Ballpark Costs

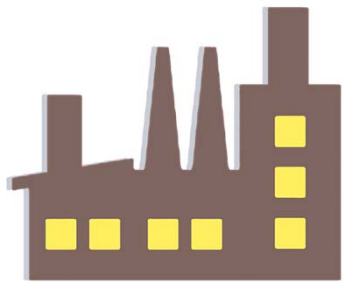
- ~ \$4,000 - \$8,000
- Similar to costs for 2 rounds of conventional IA and SS sampling
- A one day test in a typical residential or small commercial building; 1 to 2 days for larger buildings
 - Baseline, depressurization, and pressurization monitoring
 - 6 Summa[®] canister samples
 - Experienced mid-level professionals; 10 hour work days; travel
- Repeat seasonal sampling not needed

Regulatory Acceptance of BPC

- Approved everywhere we have proposed it.
- EPA Regions: 2, 3, 4, 8, 9
- States: CA, GA, IN, KY, NC, NJ, TN, UT, WV



Technology Applications



- Real Estate Transactions
 - Environmental due diligence
 - Liability assessment



- Environmental site investigation

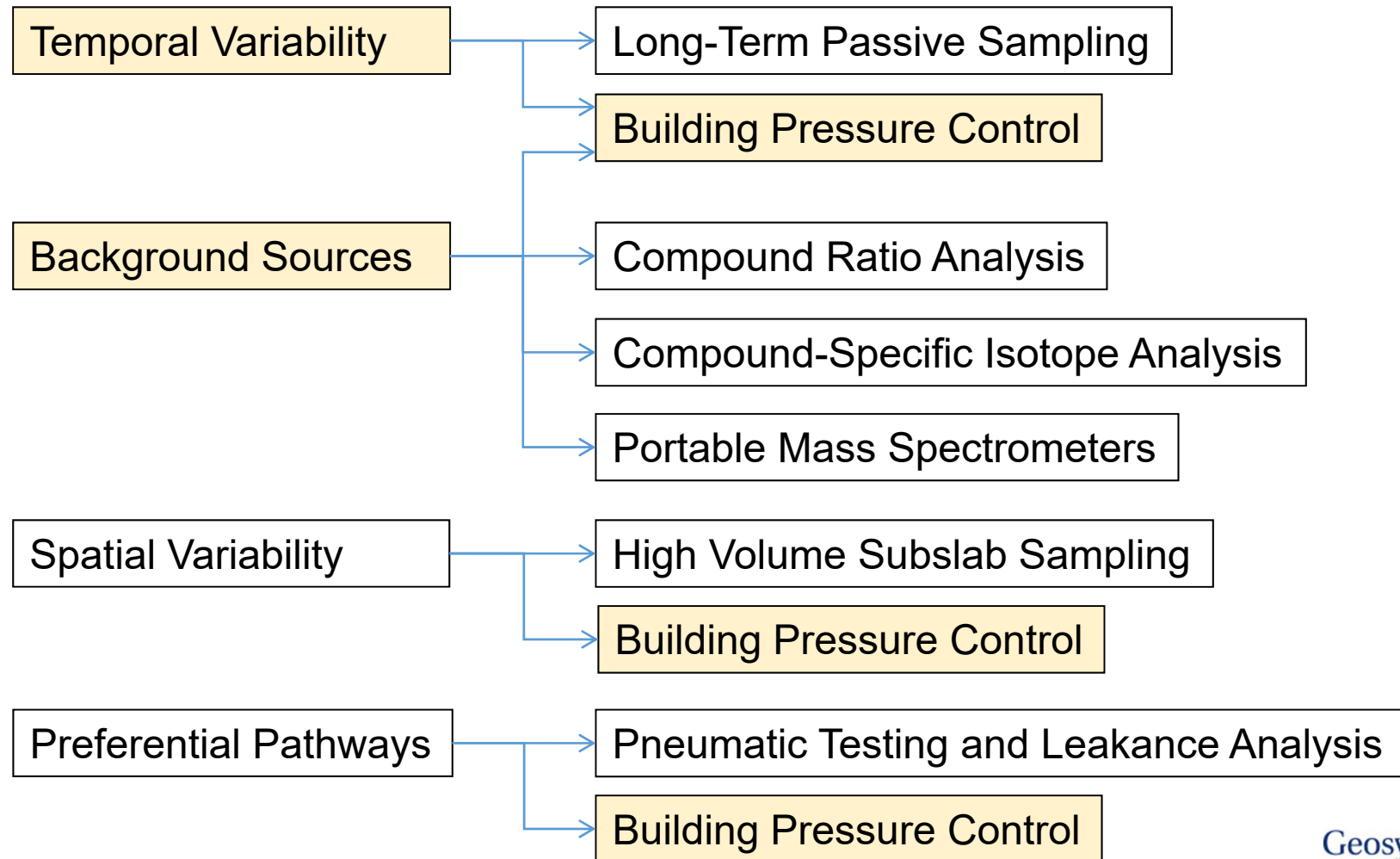


- Remedy performance evaluation

Building Pressure Control – Benefits

- Potential for VI impacts can be effectively evaluated with one day of testing.
 - Faster & less costly than multiple (>2) conventional monitoring events
 - No need for repeat sampling
- Better define building specific conditions for risk management decisions.

VI Challenges → Innovative Solutions



QUESTIONS?