

Exploratory Study of ASD Ground-Level Exhaust on Radon Re-entrainment

Bureau of Radiation Protection
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Environmental Protection

Objectives

- Compare impact of ground-level and roof discharge locations on indoor radon levels and other mitigation-related factors.
- Is ground-level exhaust an appropriate alternative in some cases or many cases?

Ground Level Exhaust



- Radon Re-entrainment
- Re-entry of radon-laden exhaust gas from a mitigation system (usually active sub-slab depressurization (ASD)) back into the building
- Can elevate indoor radon levels

Previous Studies

EPA 1991, 40 homes (Henschel and Scott)

EPA 1994, Wind Tunnel Simulations (Neff et. al.)

Penn State University, 1994, one home, Simulation

Colorado State University, 1994, four homes, Wind Tunnel

Canada, 2012, nine homes (Brossard. Et. al.)

Moorman, 2016, two homes

Previous Studies



Radon can re-enter homes through attic vents, indoor air leaks, windows, or building walls when discharge is near these openings.

High-system exhaust concentrations are an important factor.

Re-entrainment is not a common problem, even with ground-level exhaust.



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Study Design

- Ten homes with slightly elevated radon located in Harrisburg, PA.
- All homes have full basements and air conditioning.
- Install re-configurable ASD systems: ground and roof discharge.
- Some systems need to be in proximity to an operable window on first or second floor.
- Cycle systems on two-week intervals over a full year: baseline, roof, ground.
- Conduct continuous testing, intermittent testing, and monitoring throughout study.

Reconfigurable Mitigation Apparatus



Pipe to be Installed Above Roof

Gate Valve: Closed for Baseline & Ground Discharge

Cap: Closed for Baseline & Roof Discharge

Horizontal Ground Discharge

ASD Exhaust Discharge

US Standards (ANSI/AARST)

Outside the structure

At least 10' above grade

One ft above roof or parapet

Two ft above or 10' away from operable
opening in building

Ten ft from mechanical air intake openings

Ten ft from decks, patios, etc.

Six inches above projecting edge of roof

Canadian mitigation “options” for ASD discharge

Permitted, even encouraged, exhaust at/near
ground level due to icing concerns



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Ground-Level Discharge as an Option

Advantages

Aesthetics
Installation Safety
Installation Cost
Condensation and Icing
System Performance
Client Choices

Disadvantages

Noise
Re-entrainment



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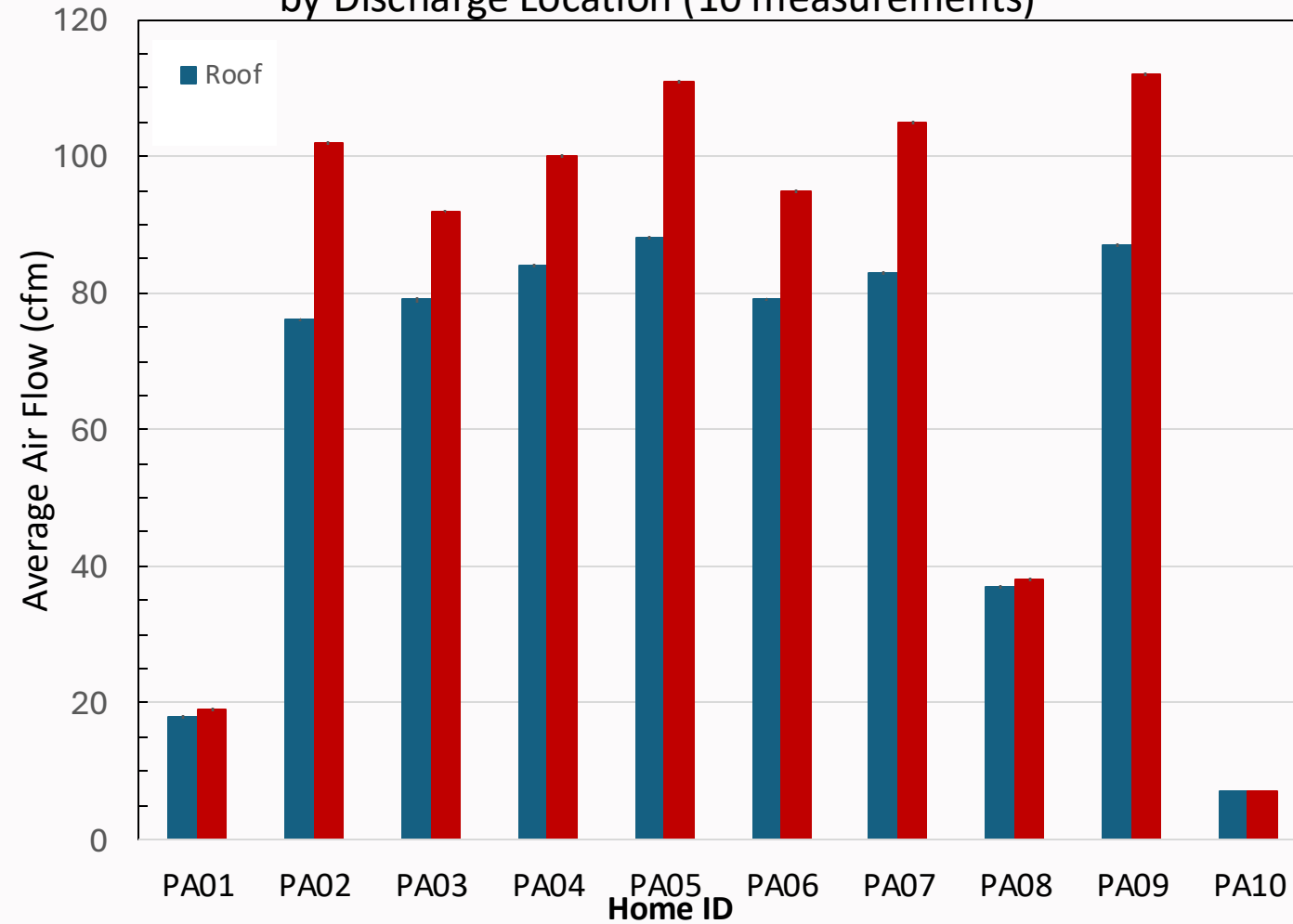


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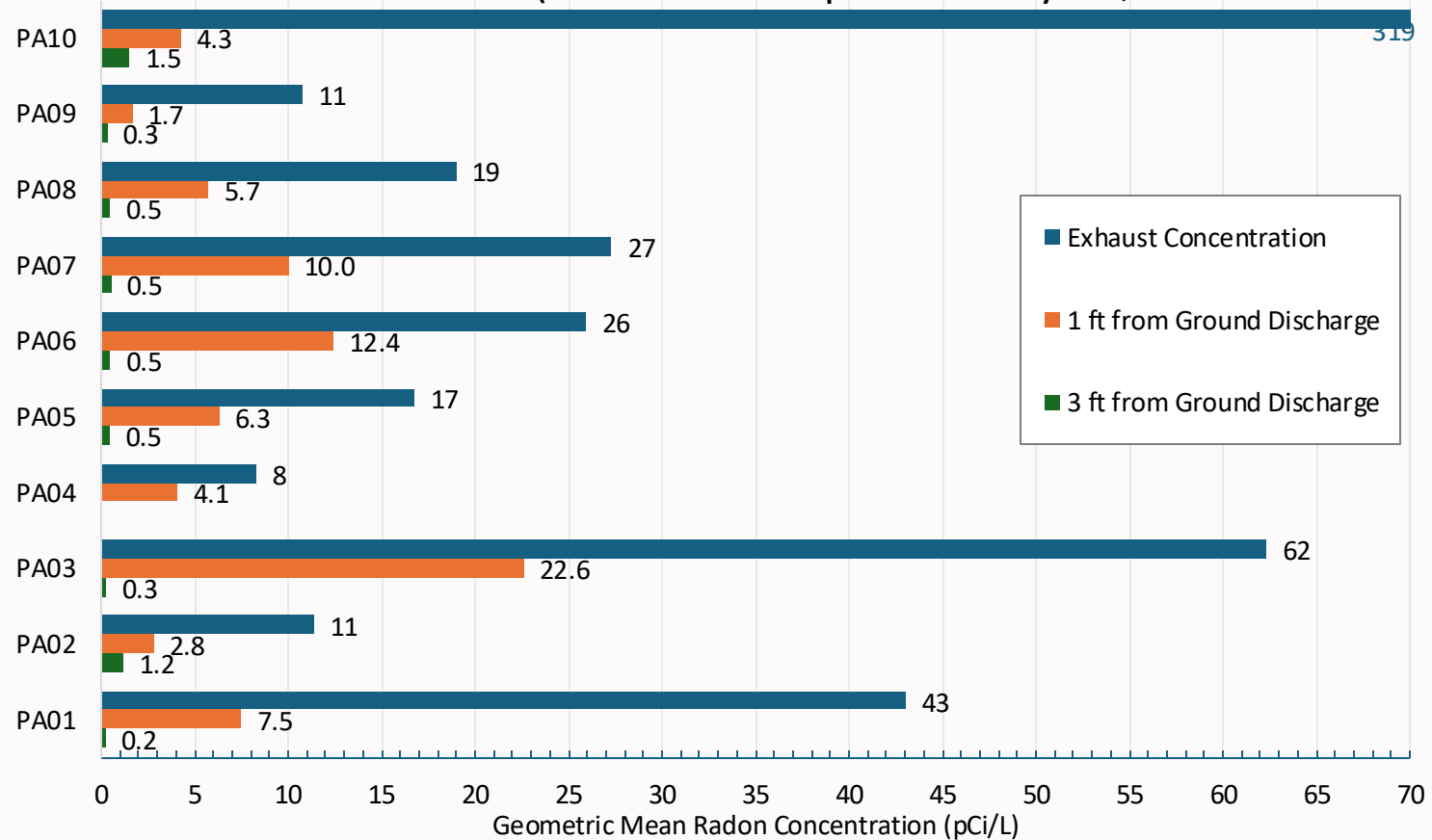


Annual Average ASD System Air Flow - All Homes by Discharge Location (10 measurements)





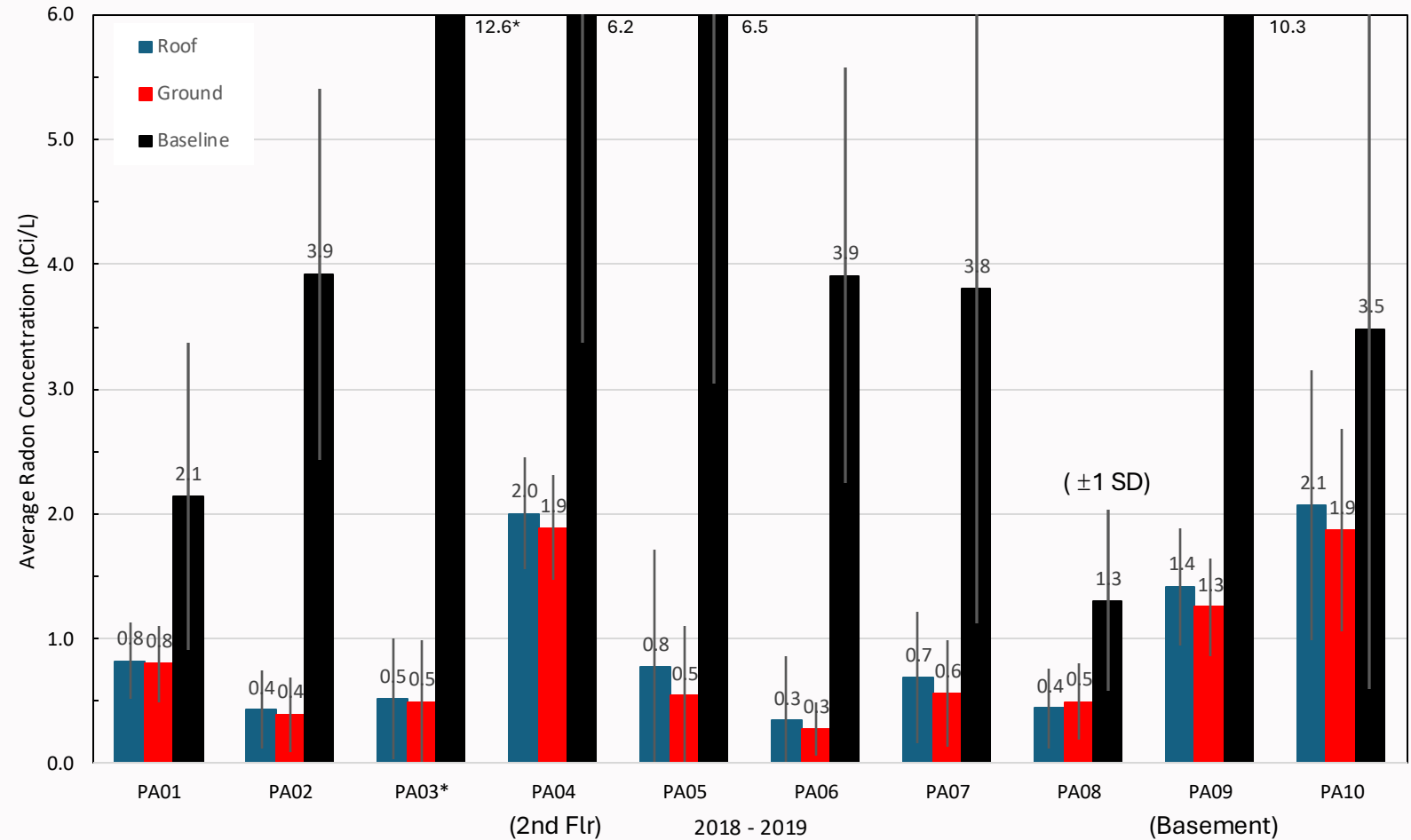
Radon Concentration at 2 Distances from Ground Discharge (5-12 Grab Samples over 1 year)



- Ambient at 1 ft is 1 to 48% of exhaust concentration
- Ambient at 3 ft is 0.5 to 3% of exhaust concentration



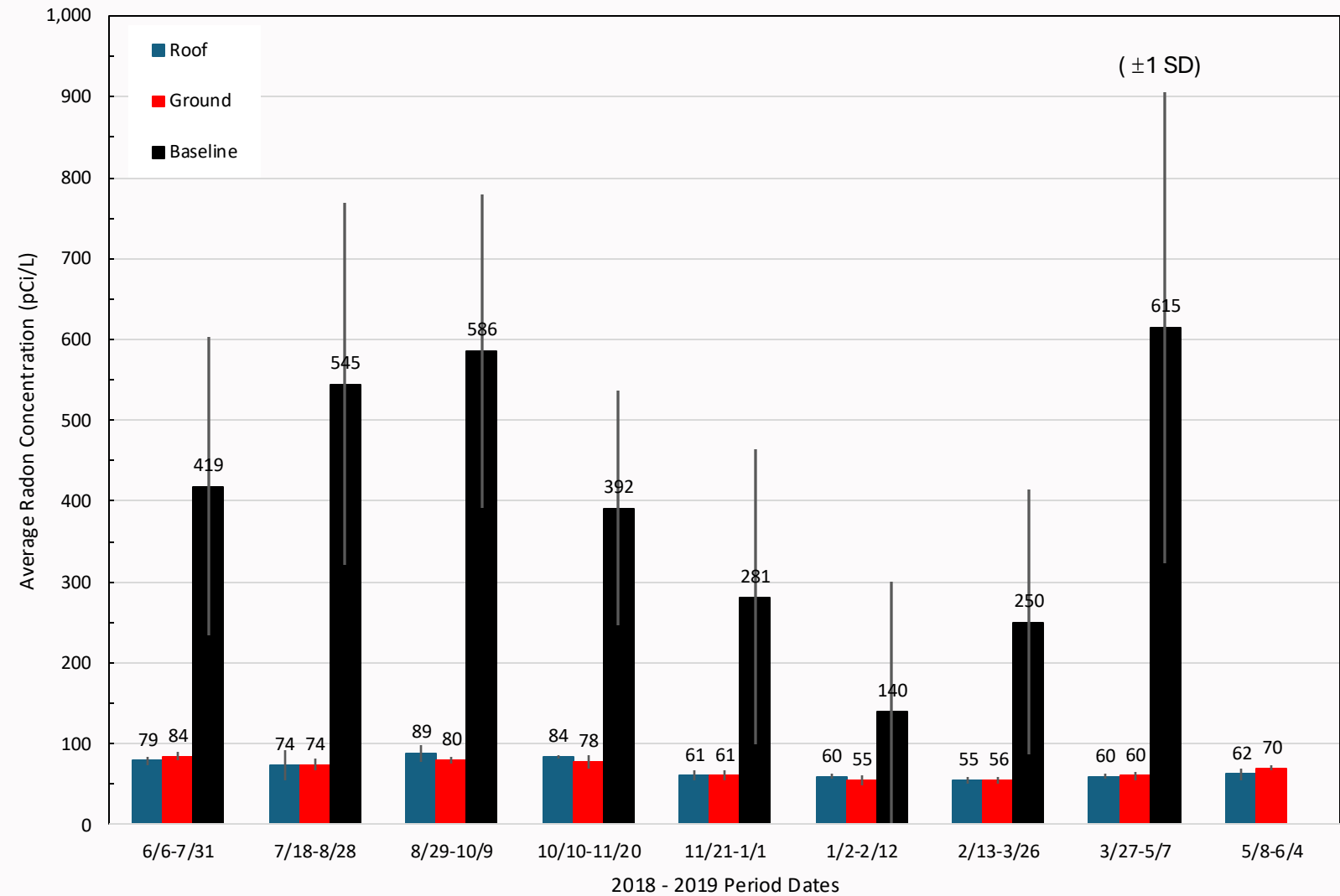
Year-Long Indoor Radon Comparison - All Homes 1st Floor (exc. as noted)



*Baseline testing suspended after first period due to high radon levels in basement occupied by children



PA01 ASD System Exhaust - Period Averages



Summary of Home Study Findings

Indoor Radon Levels Not Significantly Different: Ground vs. Roof
(with slightly higher indoor levels for Roof Discharge).

If Re-entrainment Occurs, it's Not a Significant Contribution.

System Radon Exhaust Concentrations for Most Homes were Low-Modest.

As Predicted by Models, Radon Levels Drop Quickly at Distance from Discharge Location.

Noise Levels Highly Variable, But May be Slightly Higher at Nearby Outdoor and 1st Floor Locations for ground level exhaust.



Interpretation & Guidance

- Ground discharge could cause more radon re-entrainment in other homes, especially with higher-system exhaust radon concentrations and/or without AC.
 - Upper limit for exhaust concentration needs more investigation.

Interpretation & Guidance

- Common sense still applies. Avoid discharge locations near openings or commonly-used outdoor play/seating areas.
- Ground-level discharge locations are a viable design and installation option
 - With above considerations
 - Also considering noise, aesthetics, icing potential, system operating characteristics (flow/pressures), installation safety, etc.



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Future Work

- Include larger numbers of homes with ASD, distributed across the country to examine geographic differences.
- Mitigator feedback on installed costs.
- Perform less-intensive analysis/sampling.
- Collect ASD exhaust gas samples (use U-tube) from larger number of homes across the country.

Future Work

- What is the average exhaust gas concentration?
- What is the maximum exhaust gas concentration?
- What is the upper limit on exhaust gas concentration for allowing ground-level exhaust?
- System flow and pressure.



Get In Touch

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