Radon Ventilation

Technical Lead: Vlad Korolevych

Project Objectives

Quantify the dose to neighbourhood residents from sidewall radon ventilation from residential buildings.

Rationale

Sub-slab radon mitigation systems have a positive impact on mitigating indoor radon concentrations. In Canada, there are many practical reasons for opting for discharging gases out of the basement sidewall. However, gases often have high (>10 kBq/m3) radon concentrations. The goal of this project is to evaluate the dilution and impact of sidewall discharge systems.

Approach

• Use tracer experiments to assess the airflow complexity and provide benchmark for Computational Fluid Dynamics (CFD)

• Merge benchmarked CFD with simple probabilistic safety assessment model (PSA) in the far field

• Evaluate airflow sensitivities using CFD

• Evaluate all met scenarios using PSA model merged to CFD

Flow-field statistics for boundary conditions

Velocity and Turbulence (profile parameters extracted for typical “calm”, “regular”, and “windy” conditions from data):

• Statistics from sonic anemometers

• Located near dispersion experiment

• Sonic anemometers @0.3 m 1.0 m (2D) and @3 m (3D)

• 20 days of data collection in November 2018

• Velocity, k-ϵturbulence profile defined by two parameters:

• Friction velocity, $u*$

• Foughness length, zo

Temperature and Atmospheric Stability (parameters extracted for typical “stable”, “neutral”, and “unstable” conditions during summer, spring/fall, and winter from data):

• Perch Lake Tower

• ~2 km from dispersion experiment

• Wind vane anemometers @30m, 60m

• Temperature @0m, 30m, 60m

• Continuous measurements (all of 2018 used in analysis)

• Seasonal average temperatures

• Stability parameters, depending on heat flux, qw

CFD Physics Models:

• Steady state

• Constant density gas flow

• Segregated flow and fluid temperature solvers

• Boussinesq model with gravity for buoyancy effects

• k-ϵ RANS turbulence model

• Passive scalar model for radon-laden exhaust gas

Work Complete

Dilution ratios in the vicinity of the structures are modelled with CFD as a function of:

• Wind direction

• Wind speed

• Outside temperature

• Atmospheric stability

• Ventilation flow rate

Airflow complexity is partially identified in the experiment:

• Along-gap winds keep plume from dispersing into the gap and towards the neighbouring building; at small exit velocities most of the plume remained within the thin boundary layer at the wall

• Airflow between buildings is essentially 3D and requires enhanced instrumentation followed by finescale CFD modelling

• Real-time measurements across the gap require the other tracer and sensitive monitoring instruments

Highlights on Current Progress

Benchmarking CFD study:

• Tritium tracer experiment - complete,

• CO2 tracer study objectives, design and field setup – complete

Literature review and CFD modelling

• Boundary conditions have been set based on observations (measured local wind speed, turbulence, temperature, and stability conditions)

• 35 CFD cases have been run, considering key effects

• Building angle is determined to have the largest influence

Future work

1. **Experiments:**

Tracer experiment with CO2. Focus on cross-gap wind directions. Characterization of winds at larger heights; use of the second 3D anemometer

2. **Modelling**

• Fine-scale computational fluid dynamics (CFD), including figures of merit (e.g., surface average or volume average concentrations) have to be set, and results compiled

• Future comparison of CFD results with field measurements

• New CFD model with more prototypical house-like structures to be completed in future, and possibly a study to explore LES

• Concentrations and doses at computational domain boundary for annual range of met scenarios (ADDAM)

• Evaluation of source term variability and its contribution

3**. Probabilistic characterization of concentrations** and annual dose based on PSA guidelines (ADDAM and CFD combined)

4. Results analysis

Federal Stakeholders

• Health Canada (primary)