US EPA Superfund
Need for Research on
Radon Progeny Equilibrium Levels

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Clu-In Webinar on August 24, 2022
"Factors Affecting the Fractional Equilibrium Factor of
Radon and Its Progeny Indoors"

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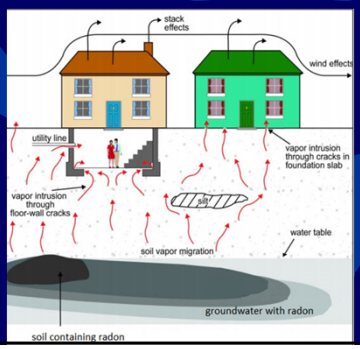
Purpose

- Provide background for why EPA needed this research project on Radon Progeny equilibrium levels
  - » This includes a brief overview of CERCLA (Superfund) tools for radon intrusion



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CERCLA Risk and Dose Calculators

Human Health - Radiological

Cancer risk (1×10^{-6})

- PRG (soil, water and air) 2002
- BPRG (inside buildings) 2007
- SPRG (outside surfaces) 2009

Dose (millirem per year)

- DCC (soil, water and air) 2004
- BDCC (inside buildings) 2009
- SDCC (outside surfaces) 2009

Cancer risk, Dose, and UMTRCA ARAR

- **RVISL (radon intrusion) 2021**

Human Health - Chemical

- RSL (soil, water, and air) 2008
- VISL (vapor intrusion) 2018

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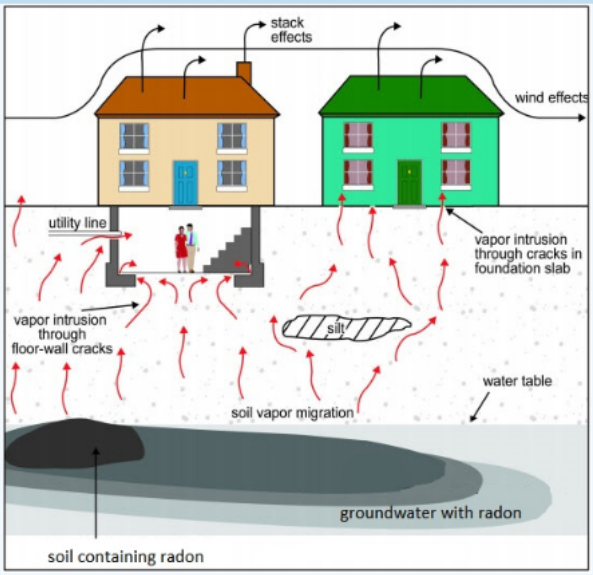
RVISL Home



Radon Vapor Intrusion Screening Levels (RVISLs)

- Home Page
- User's Guide
- What's New
- Frequent Questions
- Equations
- RVISL Calculator
- Radionuclide Decay Chain
- Generic Tables

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Radon Vapor Intrusion Screening Level, or RVISL

- Internet calculator tool developed to provide concentrations of radon and thoron in soil and groundwater that will not result in radon intrusion into buildings that exceed target levels
- Indoor Rn-222, Rn-220, and Rn-219 target level concentrations based on:
  - Risk (default to 1 x 10-6)
  - UMTRCA (only Rn-222 and Rn-220) correspond to 0.02 Working Levels
  - Dose (default to 1 mrem/yr)
  - pCi/l (default to 4 pCi/l)

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RVISL: Conceptual Site Model (CSM)

- Same as VISL conceptual model for chemicals
- Assumes a groundwater or vadose zone of vapors that diffuse upwards through unsaturated soils toward the surface and into buildings
- Soil is relatively homogeneous and isotropic
  - Horizontal layers of different soil types can used

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RVISL: Conceptual Site Model (CSM), cont.

- Receptors are occupants in buildings with concrete foundation
  - » Resident or
  - » Workers
- Subsurface and building characteristics reduce or attenuate radon concentrations

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Site Specific mode

0.18 ▼	Select air exchanges per hour for F_{eq}
26	ED_{res} (exposure duration - resident) yr
20	ED_{res-a} (exposure duration - resident adult) yr
6	ED_{res-c} (exposure duration - resident child) yr
350	EF_{res} (exposure frequency) day/yr
350	EF_{res-a} (exposure frequency - resident adult) day/yr
350	EF_{res-c} (exposure frequency - resident child) day/yr
24	ET_{res} (exposure time - resident) hr/day
24	ET_{res-a} (exposure time - resident adult) hr/day
24	ET_{res-c} (exposure time - resident child) hr/day
1.0	GSF_a (gamma shielding factor - air) unitless
161000	$IFA_{res-adj}$ (age-adjusted inhalation factor) m^3
20	IRA_{res-a} (inhalation rate - resident adult) m^3/day
10	IRA_{res-c} (inhalation rate - resident child) m^3/day
26	t_{res} (time - resident) yr
1E-06	TR (target cancer risk) unitless

NOTES:

1. Input fields with a "blue" background are calculated dynamically.

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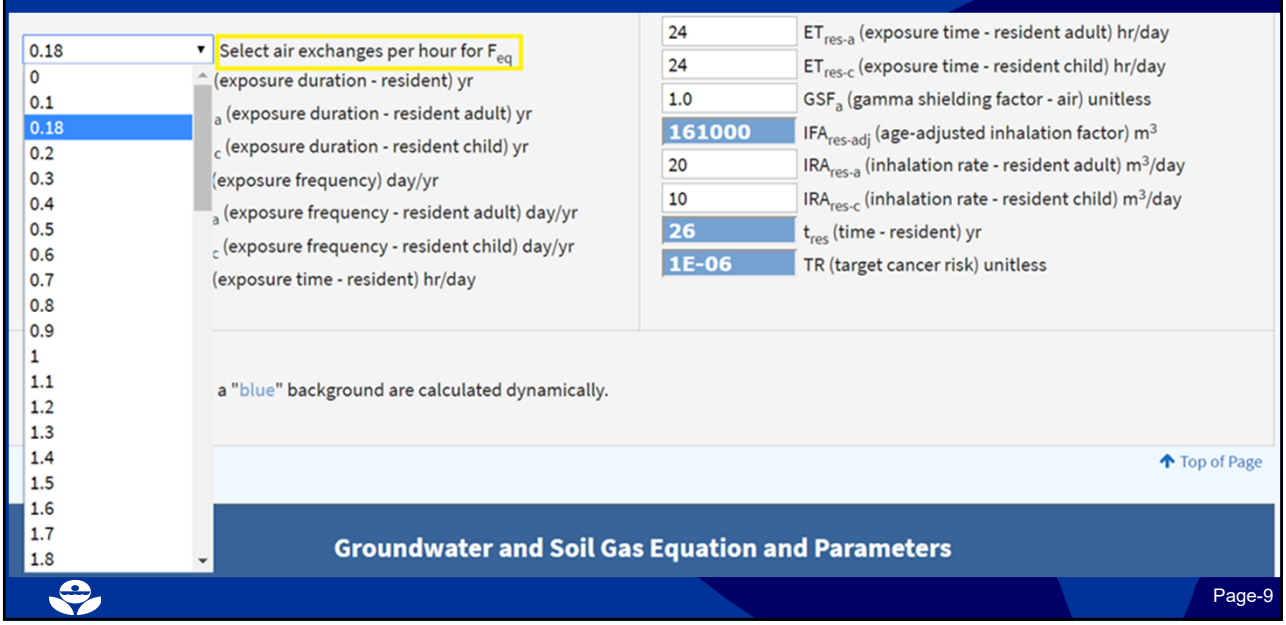
Changing air exchange per hour



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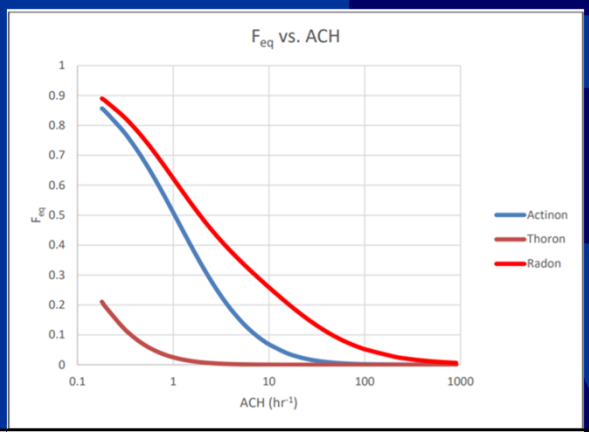
Air Exchange Rate

- As the air exchange rate increases, the inhalation fractional equilibrium factor (Feq) decreases (less progeny present indoors). This decreases:
  - » Risk
  - » Dose
  - » WL



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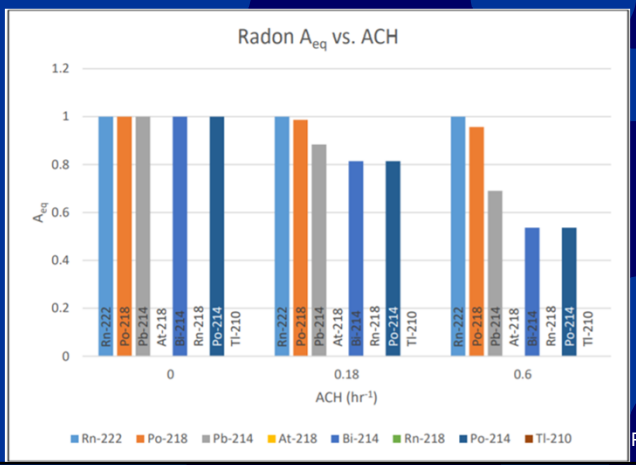
Air Exchange Rate, cont.

- Table compares for Rn-222, and ACH of:
  - 0
  - 0.18 (Residential default)
  - 0.6 (Commercial default)



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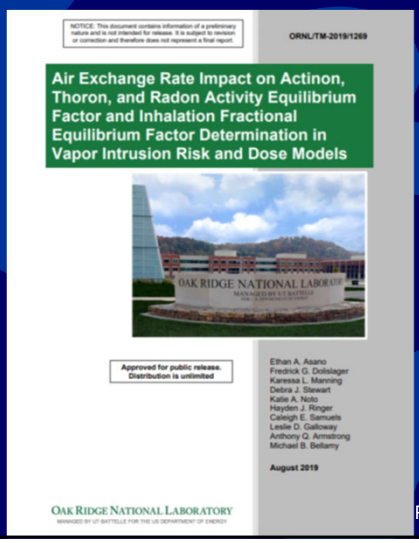
Air Exchange Rate, cont.

- Supporting 50 page analysis underlying RVISL
  - "Air Exchange Rate Impact on Actinon, Thoron, and Radon Activity Equilibrium Factor and Inhalation Fractional Equilibrium Factor Determination in Vapor Intrusion Risk and Dose Models"



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Existing approach may not be enough

- Other factors can significantly impact equilibrium levels of radon progeny (e.g., exhalation, solid-particle concentration, surface deposition, and air quality)
- Equilibrium levels of radon progeny affects:
  - » Compliance with UMTRCA WL standard as an ARAR
  - » Risk assessment, and
  - » Dose assessment