Radon Workshop
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Overview

- Underlying issues with background radon
- Radon measurement issues
- Regulatory issues
- Proposed plan to address regulatory requirements and license conditions

Issues with Background Radon

- **Range of outdoor radon (UNSCEAR 2006)**
  - Average = 10 Bq/m^3, range = 1 – 100 Bq/m^3
  - Average = 0.27 pCi/L, range = 0.027 – 2.7 pCi/L
- **Factors impacting background radon concentrations (independent of measurement systems)**
  - Long-term weather patterns
  - Seasonal variation
  - Small scale differences due to soil type and meteorological dispersion
- **Variability of background can be much greater than the values we are trying to measure**

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Issues with Background Radon

- **Crow Butte background station radon results (annual averages)**
  - June 1998 to December 2013
  - Median = 0.4 pCi/L
  - Range = 0.2 – 1.5 pCi/L (individual sample max 2.1 pCi/L)
- **If EF = 1, trying to measure increment that is less than 1/10th of background fluctuations and ½ of the equipment LDL**

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Radon Measurement Issues

- **Sample station measurements have similar uncertainty**
- **To determine incremental radon subtracting two numbers with relatively high uncertainty**
  - Equipment uncertainty (systematic and random)
  - Background uncertainties (long-term, seasonal, local geological)
  - Physical (terrain, soils, distances)

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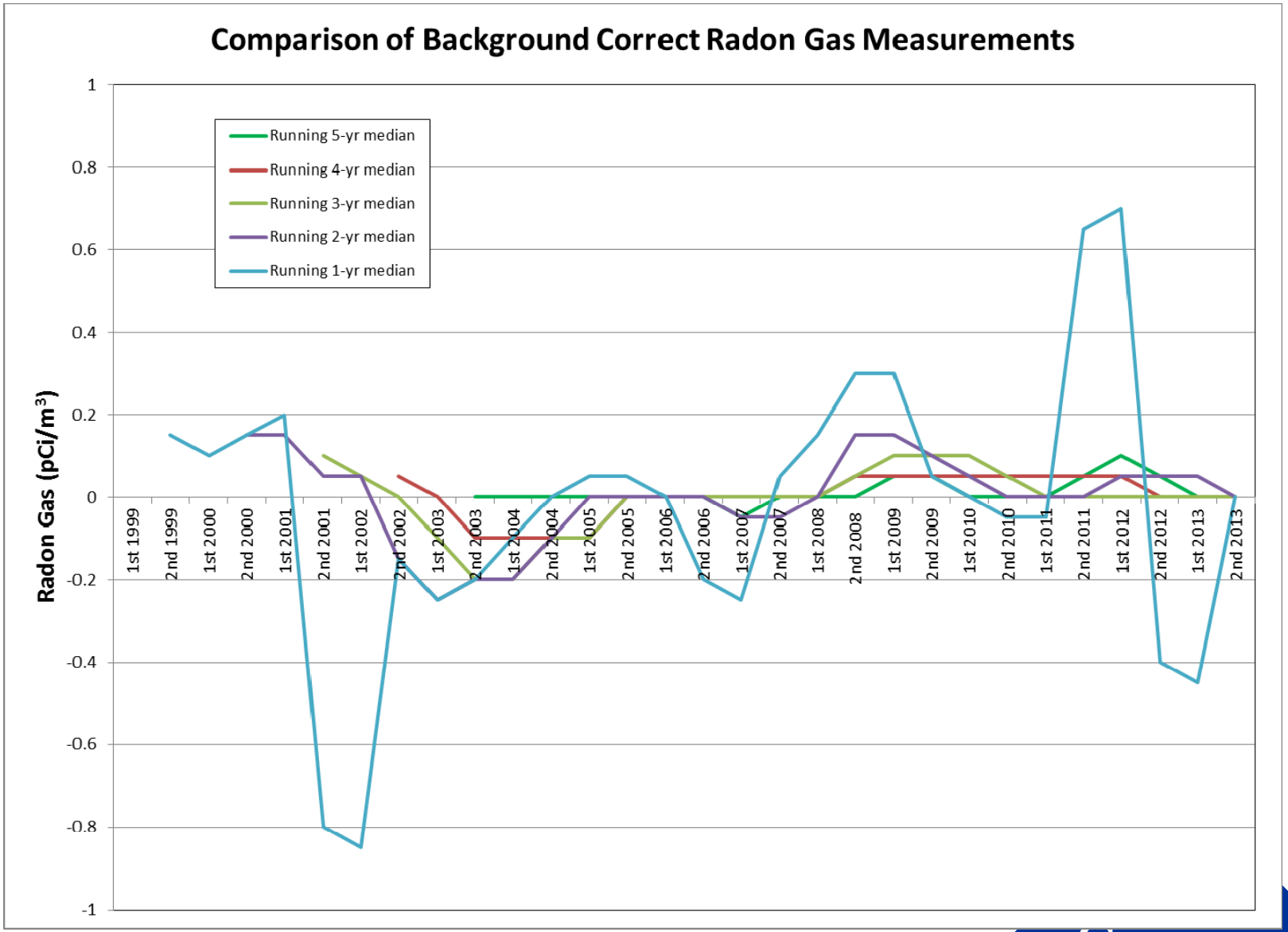
Radon Measurement Issues



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Radon Measurement Issues

- The amount of incremental radon permitted to remain below dose limits is small
- There is a small margin for error – we need high level of accuracy and certainty about measurements
- Quick MARSSIM assessment indicates on the order of 100's of samples are required at each station to ensure incremental radon below 0.1 pCi/L with reasonable accuracy and certainty (alpha = 0.05).
- A system based solely on measurements is not practical

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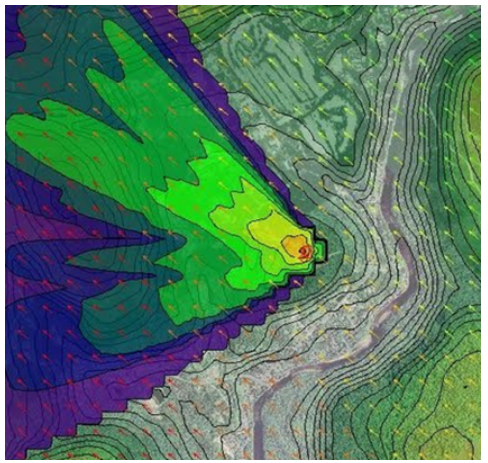
Regulatory Requirements

- **10 CFR 40.65 states:**

  "…the report must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation…."



- **For gaseous releases, this is a 3D problem with dispersion, deposition, radioactive decay, etc.**
- **2 options:**
  - Measure at each source and model the amount going to the unrestricted areas (each source: wellheads, pipes, HH, CPP, etc.)
  - Measure at some environmental stations and model backwards to source
- **Measurements alone do not satisfy 10 CFR 40.65**

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Path Forward

- **Combination of measurements and modeling**
  - Measurement alone is not practical, does not fulfill all regulatory requirements
  - Models need to be verified to ensure reasonable and accurate
- **MILDOS-Area model that is verified statistically with measurements:**
  - Reg Guide 3.59 for sources with optimization of release terms
  - Model optimization - attempt source term measurements (e.g. RnG in water) to better quantify model inputs
  - Validate dispersion modeling results with field measurements

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Path Forward

- **Verified modeling:**
  - Is a practical and reasonable approach that meets regulatory requirements
  - Is a solution to relatively high uncertainties with sampling
  - Provides equilibrium factors to allow more realistic dose calculations
  - Promotes regulatory confidence by reducing erroneous results (false positives over dose limit)

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- Thank you!