

# Comments on Measuring Long-Term Average Radon Levels

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Presented To:

**NRC Workshop on Evaluation of Radon and  
Radon Progeny in Air and Compliance with  
10CFR20.1301 and (2)**

Presented By:

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April 2, 2014

# Objective

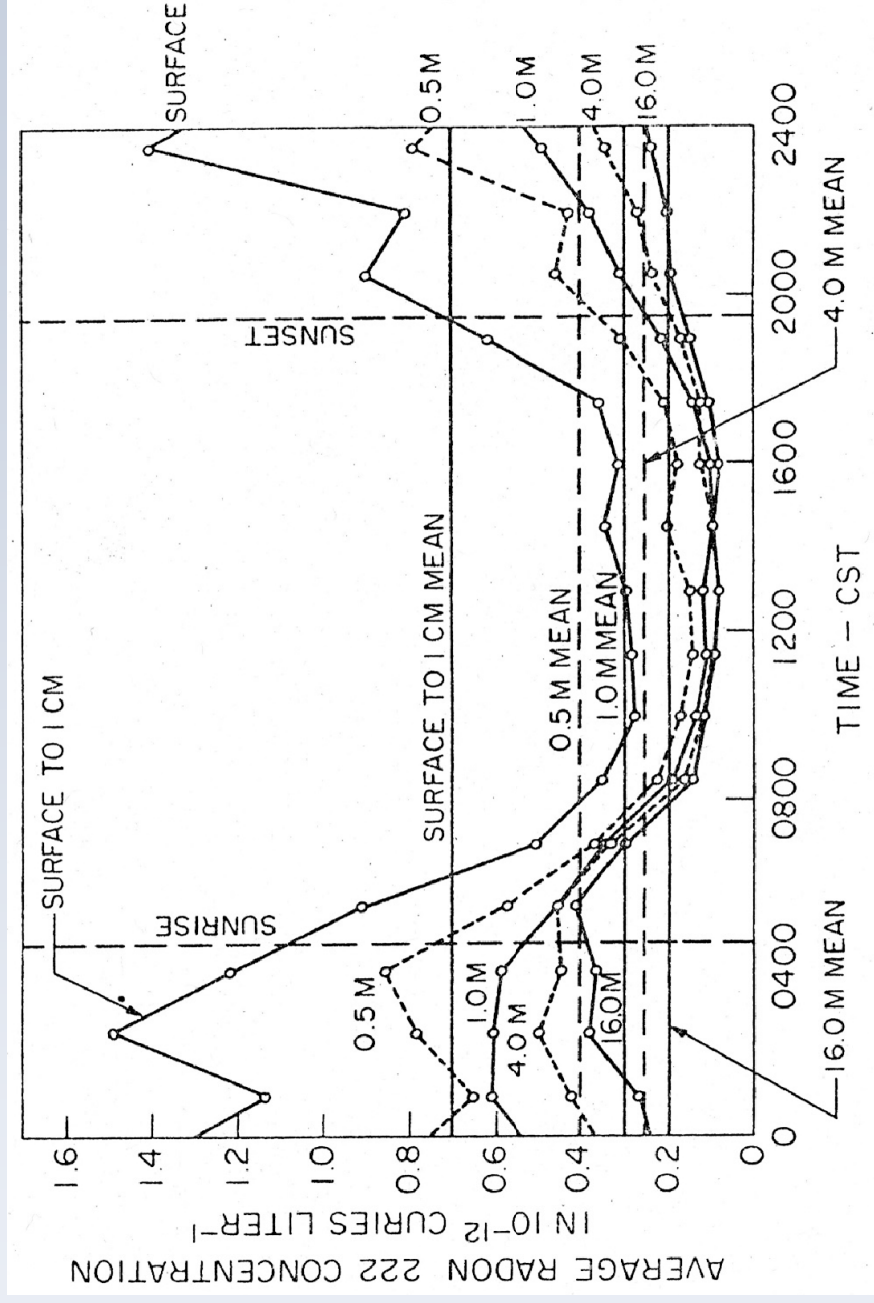
- ◆ Not a detailed critique of interim Guidance, rather
  - a short commentary on natural levels of ambient radon, and selected comments on challenges of measuring small incremental (above background) levels of Rn-222*

# Outdoor Radon

- ◆ Radon released from Ra-226 in soils is the single largest source of Rn-222 in the atmosphere
- ◆ Radon levels in outdoor air are affected by the regional geology, meteorology, local topography...
- ◆ Studies of outdoor air in Nevada indicate a median outdoor concentration of 0.4 pCi/L with concentrations of up to 1.4 pCi/L at measured locations (Price 1994)
- ◆ Radon levels change diurnally and by season
  - radon concentrations typically reach their maximum in the summer to early winter, whereas from late winter to spring, concentrations are usually at a minimum as a result of meteorological changes and soil moisture conditions (NAS 1999).

# Rn-222 Concentration

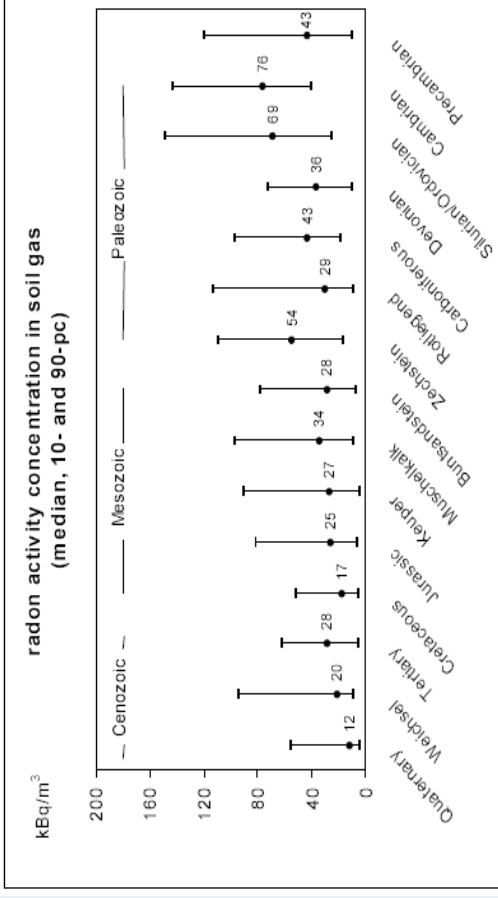
## Diurnal Variation



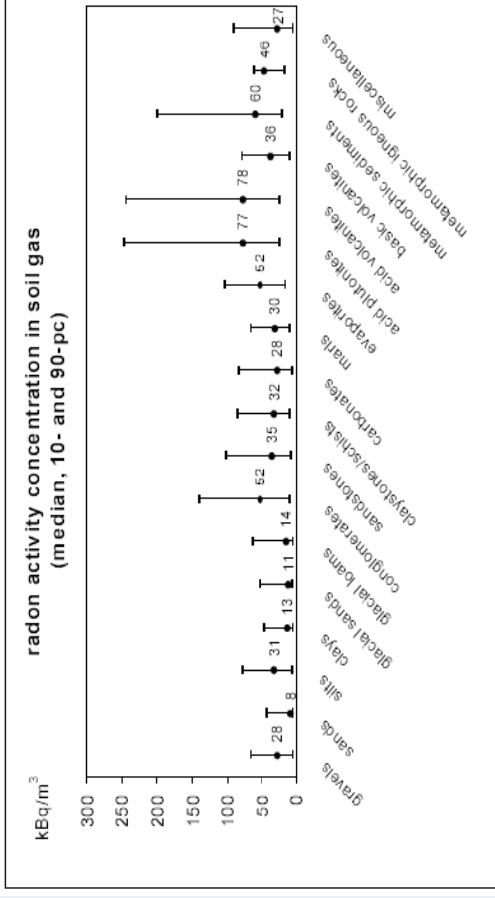
SOURCE: After Pearson, U.S. Department of Health & Welfare, 1967

# Radon Concentration in Soil Gas of Sedimentary Rocks

◆ according to geological  
age



◆ according to rock type



# Outdoor Radon cont'd

- ◆ According to NAS 1999, measurements taken over the continental US, Alaska and Hawaii show the highest concentrations are found in the Colorado Plateau where measurements ranged from 0.5 to 0.75 pCi/L of air (18.5–30 Bq/m<sup>3</sup>)
- ◆ The NAS 1999 also report many areas with outdoor radon levels ranging from 0.12 to 0.3 pCi/L

# Types of Radon Monitoring (1)

## ◆ Short Term

- 2 days up to 3 months
- *Use results with caution*
- Radon concentrations vary over long time periods.  
Long-term data most relevant.
- Devices for Short Term Monitoring include
  - Activated Charcoal Adsorption - Electret Ion Chamber
  - Charcoal Liquid Scintillation - Continuous Radon Monitoring
  - Continuous Working Level Monitor - Alpha Track

# Types of Radon Monitoring (2)

- ◆ **Long Term Monitoring**
  - 3 to 12 months in duration
  - Recommended Devices for Long Term Monitoring
    - Alpha track detector
    - Electret Ion Chamber
    - Digital Detector
  - Long term measurement provides better indication of annual average radon concentration than short term measurement (diurnal and seasonal effects already accounted for)

# Recent Experience from Indoor Radon Monitoring in Port Hope

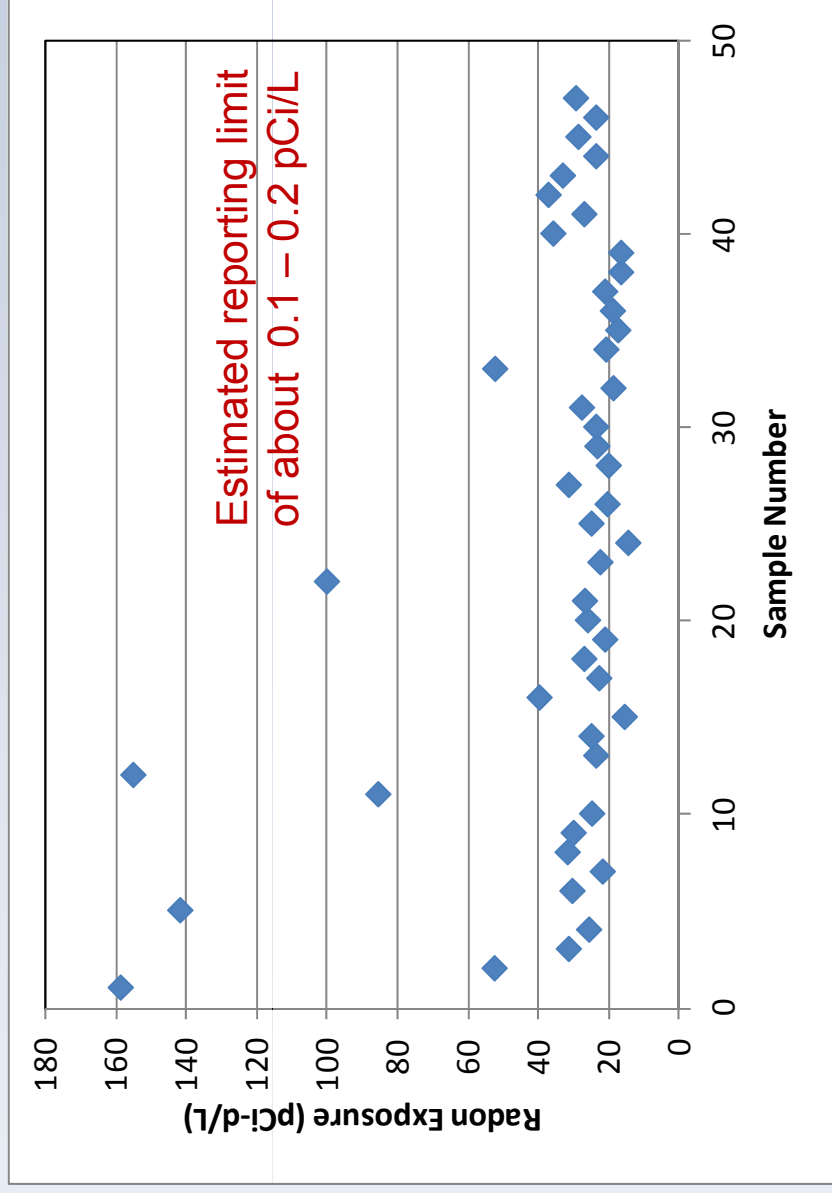
- ◆ SENES retained to complete indoor radon monitoring for approximately 1350 properties
- ◆ Client decided that monitors would be alpha-track radon monitors supplied by RSSI (CR-39)
- ◆ Long-term measurements (5-6 months)
- ◆ An example to illustrate challenges in measuring radon at low concentrations



# Quality Assurance/Quality Control (Port Hope)

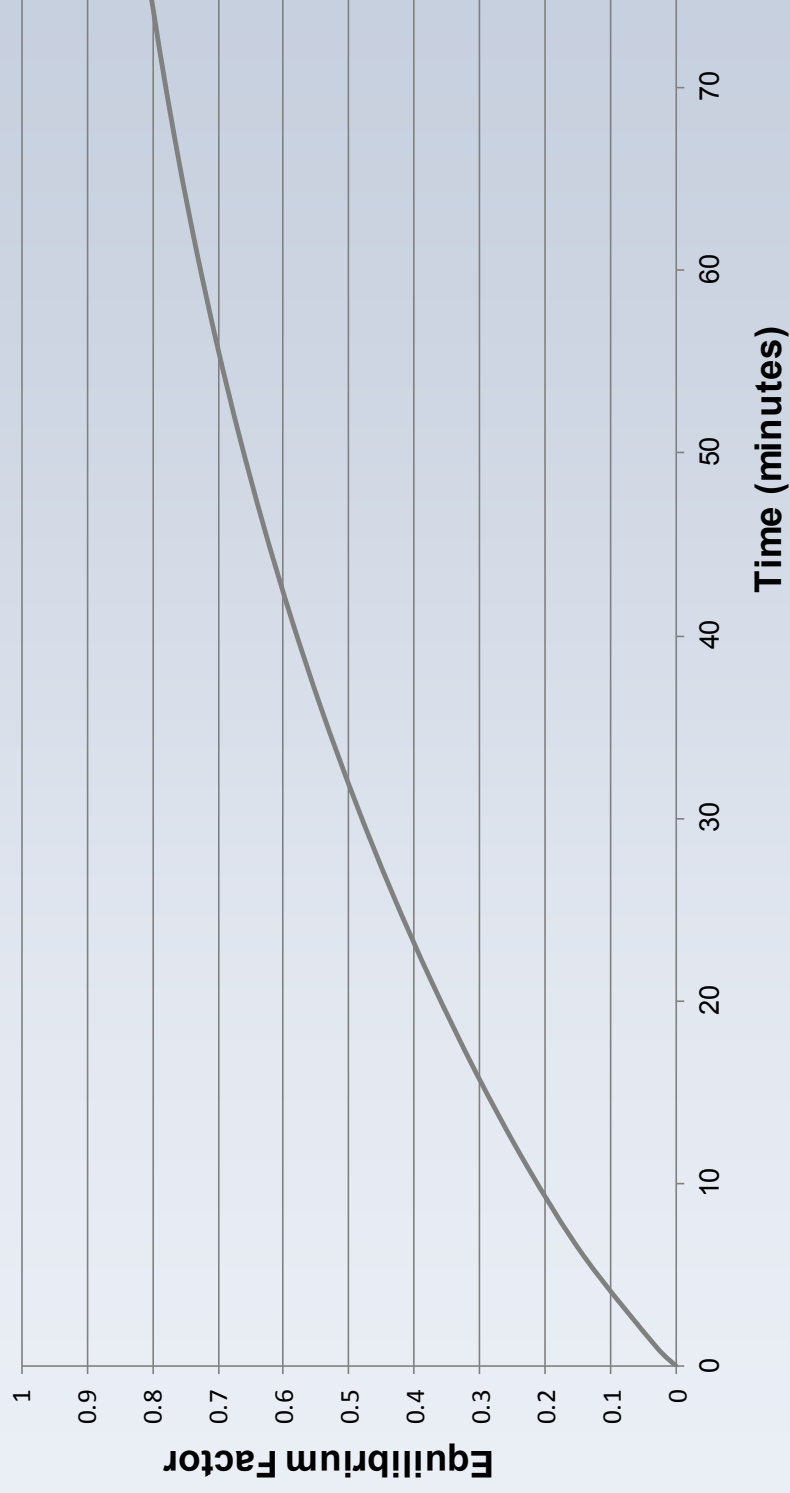
- ◆ Duplicates (at about 10 % of locations)
- ◆ Additional radon monitors were deployed for QA/QC
  - Blind spike samples
    - 30 blind spikes sent to Bowser-Morner
  - Travel blanks
    - Travel blank monitor sent with each shipment
  - **Blanks**
    - **Unexposed radon monitors, sent in sealed bags that were never opened**

# Radon Exposure in “Never-opened” Blanks

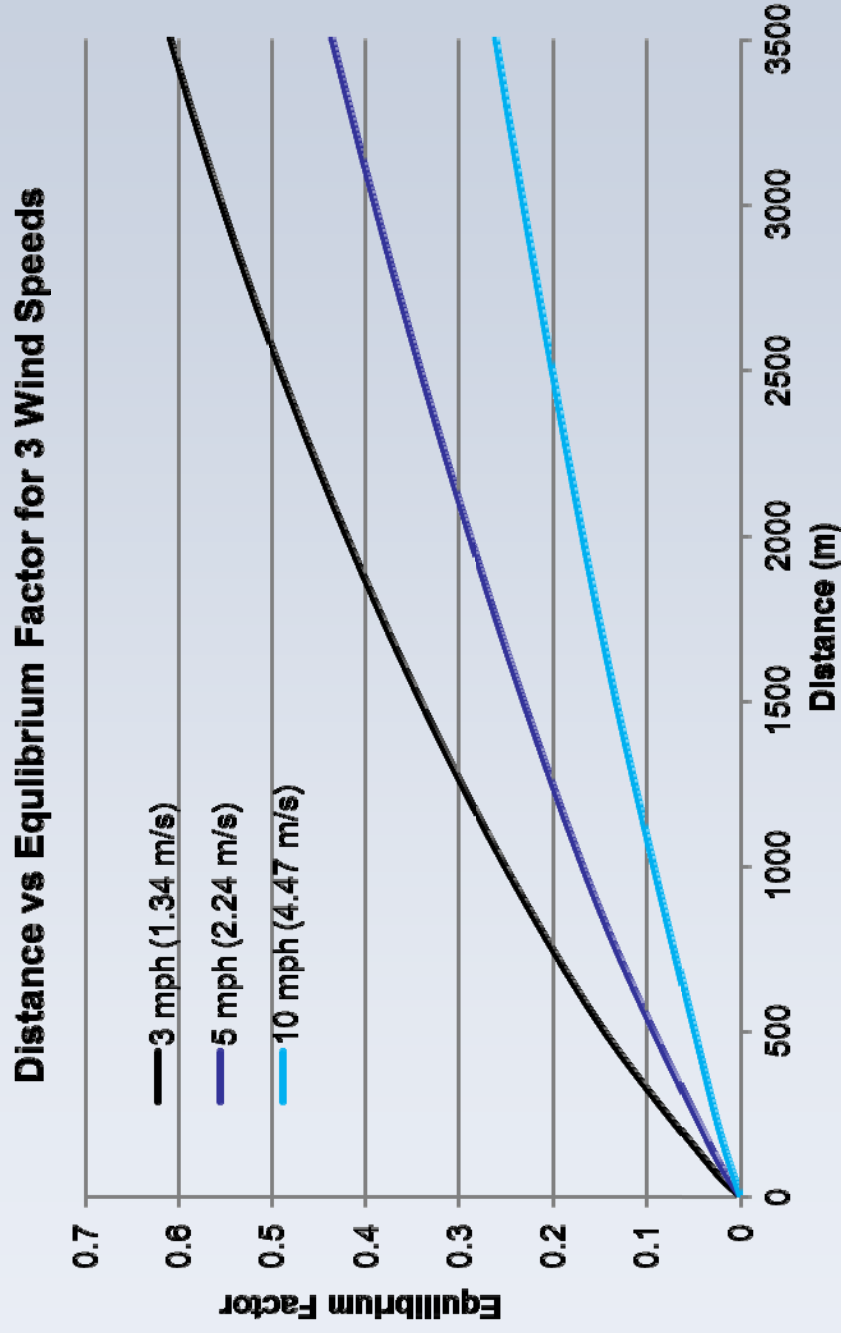


# One Other Consideration -

## Dose is from the ingrowth of Radon Progeny



# Equilibrium Factor (F) as Function of Distance



# NRC Interim Staff Guidance

- ◆ Intended for NRC staff when reviewing uranium recovery licensee surveys for radon
- ◆ Suggests can demonstrate compliance by measurement or calculation
  - 0.1 pCi/L with daughters
  - 10 pCi/L without daughters
- ◆ “net”, i.e., above background
- ◆ Challenging (perhaps not possible) to measure annual increments of order of 0.1 pCi/L given natural variation and measurement limitations

# Main Observations

- ◆ Background levels of ambient Rn-222 are quite variable
- ◆ Variation in background levels of Rn-222 > 0.1 pCi/L
- ◆ The detection level of track etch detectors > 0.1 pCi/L
- ◆ Challenging, perhaps not possible, to measure such small increments with any precision
- ◆ A bright-line approach doomed to failure
- ◆ Consider combination of modelling (MILDOS) with “appropriate” confirmation by measurement (acknowledging limitations and use of statistical test)