Air Sampling

ACADs (08-006) Covered

3.2.4.1	3.2.4.5.2	3.2.4.5.3	3.3.7.6.2
3.3.9.6	3.3.10.5	3.3.10.6	3.3.14.7.4
3.3.14.7.5	3.3.16.3	3.3.16.4	

Keywords

Types of air samplers, air sample locations, particulates, noble gases, radon, flow rate, concentration, DAC, dose calculation, ALI.

Description

Supporting Material

RCNET
Regional Center for Nuclear Education & Training

Purpose -Type

- Purpose of air sampling
  - Comply with regulation
  - Monitor for worker safety
  - Confirm models
  - Estimate dose to public

- Types
  - Personnel
  - Area
  - Chemical
  - Particulate
  - Gasses

Air sampling

- Material can be in the air in two forms
  - Particulate
  - Gasses
- Particulate material can be separated from the air by means of filters
- Gasses since they blend in with the other gas ions in the air, they are more complicated to separate out

Sample Locations

- Air samplers are expensive so usually the minimum amount of samples will be taken
- The location of the samples should be
  - Facility boundary
  - Residence with highest predicted concentration
  - In the closest town
  - At background locations which are usually upwind from facility or source.

Particulate Air sampling instruments

- BZ samplers
- Area samplers
- Low volume
- High volume

BZ Pumps

- Small pumps that sample the breathing zone of worker
- Worn by workers
- Battery operated, light weight
- Usually set at 1.2 l/min
- Can be used to see if respiratory protection is needed

Area Monitors

- Set off the side and collects air from general work area.
- Can be used to determine work airborne concentrations or off site concentrations
- Usually need AC to operate
- Fairly portable

Sampling

- Radionuclides are usually in particulate form
- Usually in very low concentrations
- Typical method is to use filters to catch particles
  - Usually a glass fiber filter
- Draw large volume through filter to get enough so one can count
- Store filter paper in paper envelope

Sample counting

- In areas high in radon, the sample is usually counted twice to see if Rn is a factor.
- once several hours after collection and a second time 10-20 hours after collection
- If there is a significant difference one may have to wait longer to get an accurate reading because of thoron daughters in the sample
- One must take into account background count rate of the filter when calculating activity

Concentrations

- Collect sample
- Get flow rate off of instrument
  - Start/stop rates will be different
- Get start and stop times
- Calculate total time
- Calculate total volume of air

Flow rates

- As mentioned the flow rates will be different from start to finish of the sampling times
  - This is caused by the loading of the filter
- One usually takes the average of the start and stop time flow rates
- This is usually acceptable unless there is a known cause that would make the flow rate change in a nonlinear fashion
  - Dust storm, pump failure, etc

Concentrations

- Count sample on some sort of detector, usually a alpha counter
- Calculate total activity(uCi)
- Divide total activity by total volume of air
- Get results in uCi/ml of air

- Compare to DACs to see if some action is needed.

Dose calculation

- From the air concentration one can calculate the dose given to a person breathing this air all year long
- The DAC-Derived Air Concentration- is the concentration of material in the air that if breathed for 2000 working hours would result in the inhalation of 1 ALI
- ALI- Annual Limit of Intake- is the amount of activity if in the body would lead to a dose of 5 rem over the course of a year

Calculation

- Take the concentration of the air sample in uCi/ml and multiply by the amount of air breathed per minute (20000 ml/min) times 60 min in an hour times 2000 (approximate number of hours in a working year) to get total activity potentially breathed in by this person

- Total activity = # uCi/ml X 2 E 4 ml/ min X 60 min/hr X 2000 hr

ALI

- Compare the total activity calculated from the air sample to the ALI listed in the chart
- The ratio of those numbers is the same ratio as 5 rem is to your dose due to that radionuclide
- Say you have

Example

- Say you have a results of 2.5 E -10uCi/ml of Am-241 found in the air
- Take this result and multiply by all your factors
- 2.5 E -10 uCi/ml X 2 E 4 ml/min X 60 min/hr X 2000 hr = 0.6 uCi
- ALI = 6 E-3 uCi
- So .6/6E-3 = X/5 rem
- X = 500 rem

Calculations from start

- Have air monitor starts at 12 noon on Monday and finishes 12 noon on Friday
- Start flow rate is 40l/min end in 32l/min
  - What is total volume of air
- Put filter on detector and it reads
- 100 cnt in one min
  - Eff is .05
  - What is the activity in uCi
  - What is concentration

cont

- Say your radionuclide of interest is U-238
- Get ALI

- Take concentration from last slide
  - Find total inhaled activity
  - Compare to ALI
  - Total inhaled activity/ALI= dose/5rem

- Determine total dose to person

Particulates

- Some large particulates can be collected but using open Petri dishes or other large flat collection pans
- Some have a sticky coating to prevent material from being blown off
- Can be used to determine particle distribution around a source of particulate radiation.

Sample protection

- Samplers are usually out in the environment but this leaves them open to mercy of the weather
- They can be enclosed in a protective housing
  - Cannot interfere with sampling
- Ideas on protective enclosures!

GASSES

- Gases are hard to capture on filter paper with any reliable efficiency they need to be either
  - Adsorbed
  - Absorbed
- Most are collected using activated charcoal

Gasses in Air

- I-131
- Ar-41
- Kr -85-89-91-92
- Xe-133-135-137-138-139
- Radon
- H-3

Iodine

- Collected on activated charcoal
- Radioactive Iodine (mostly I-131) is significant dose to public
- Can be sampled by
  - Particulate filter
  - Cd-I canister- elemental
  - Iodophenol canister- HOI
  - AgZeolite canister- organic I
- Only Elemental I can get into food chain
- Water is big factor in efficiency of I collection
- I-131 sampling should be done weekly

Noble gasses

- Can be collected on charcoal but very inefficient
- Direct measurement by in stack scint monitors set up with SCA
- Can count the daughter products
- Large volumes of air can be cooled to a point where only noble gasses are left an they are then counted
- Most have short half lives

Radon

Noble gas

Very dense

densest mononuclear gas

9.73 Kg/m^3 (O-1.43 Kg/m^3)

Rn 222, 221, 220, and 219 are in nature

222 is most prevalent

Emanation rate is dependant on the concentration of Ra, type of soil, soil moisture and rain

- Outdoor concentration are higher
  - In the morning
  - Dec-Jan

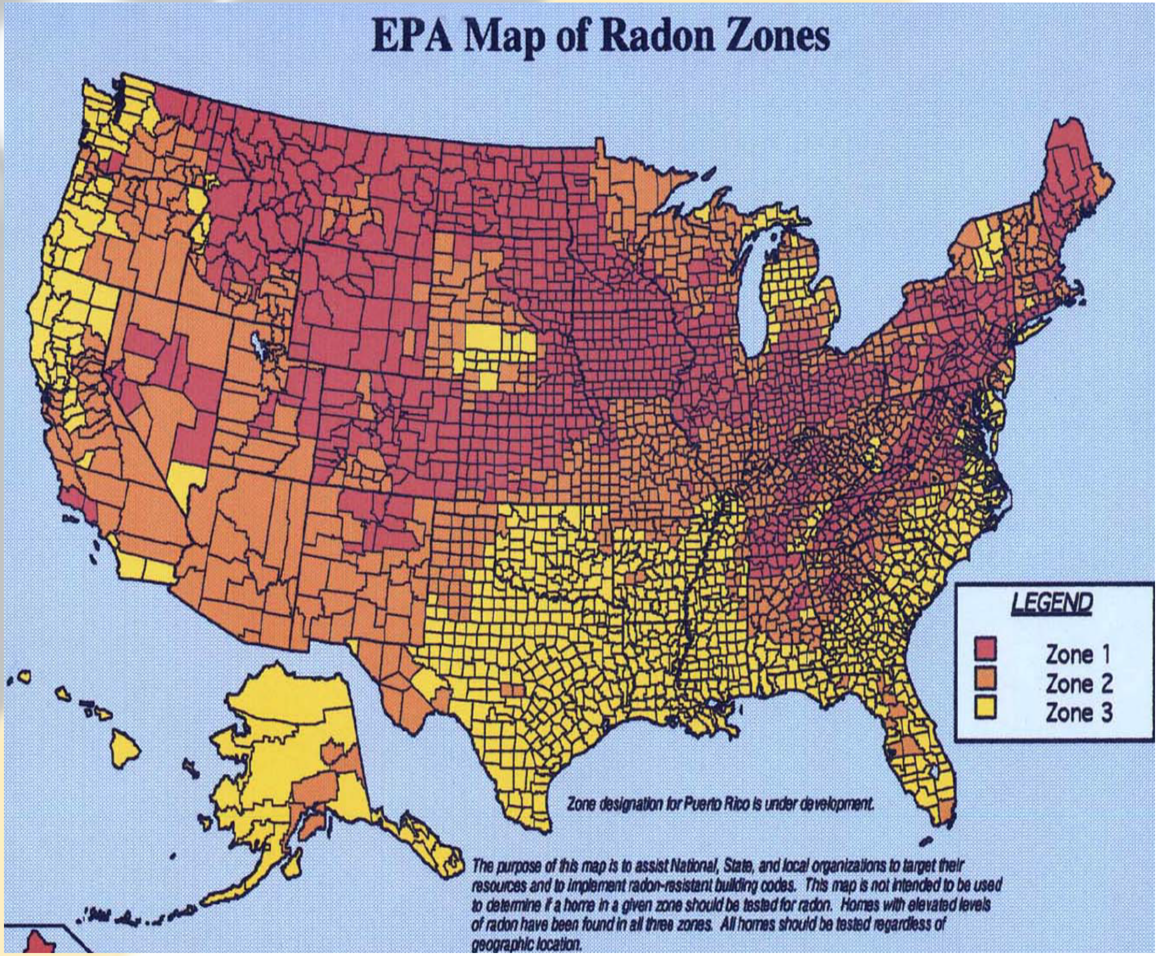
Radon

- Rn is usually 3-10 time higher concentrations inside as outside
- Higher in basements that in rest of house
- Usually emanates from the ground at .5 pCi/ m^3 and the Ra concentration is for the soil at 1 pCi/g
- Working level(WL) equal to 1.3 E5 Mev of energy emitted by radon daughters equal to about 100 pCi of Rn

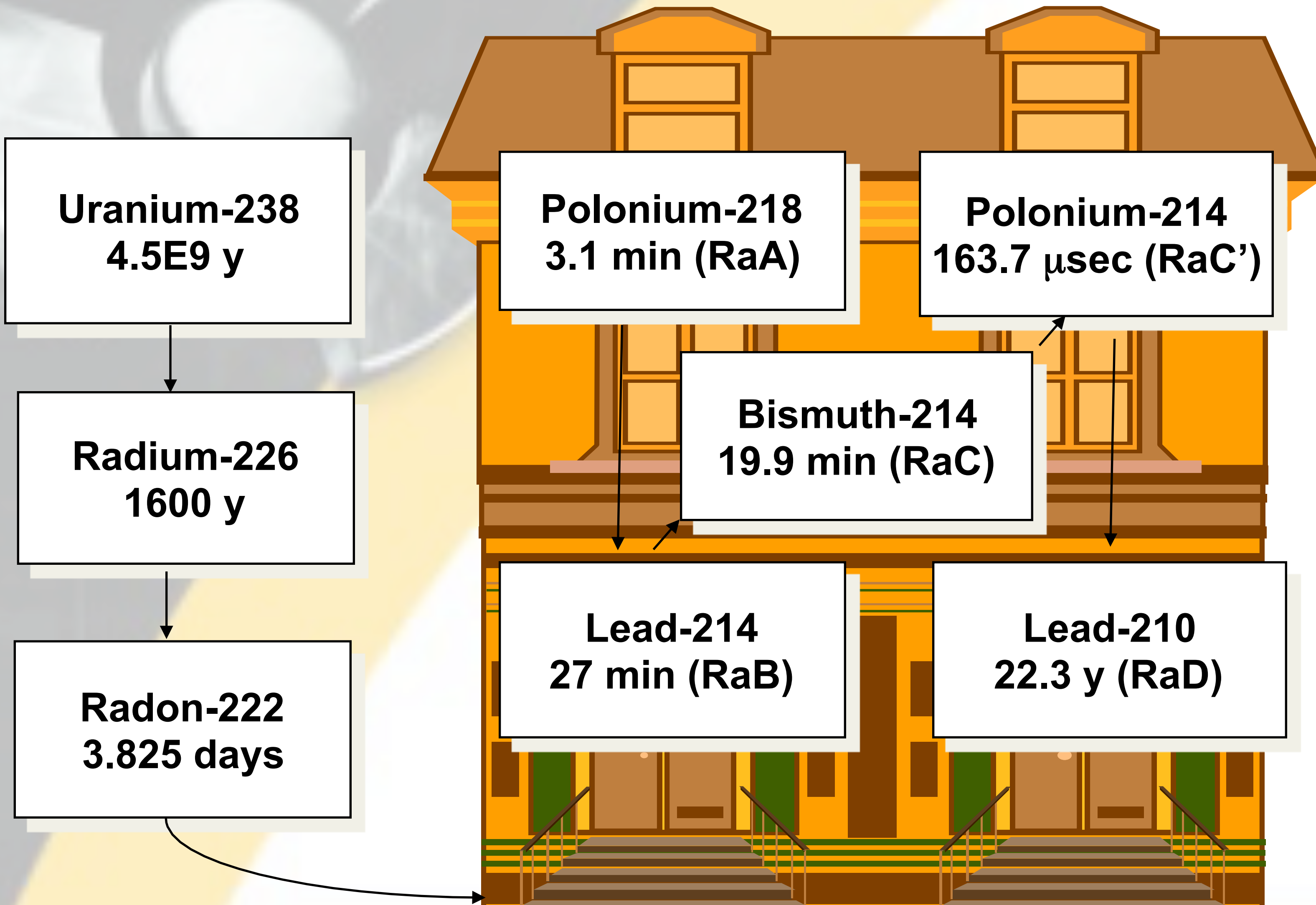
Radon remediation

- EPA says need to do something about Rn if concentration gets above 4 pCi/l
- Some states have mandatory Rn sampling for homes
- Remediation
  - Active soil depressurization
  - Mechanical ventilation
  - Above slab air pressure differential barrier

Radon Map

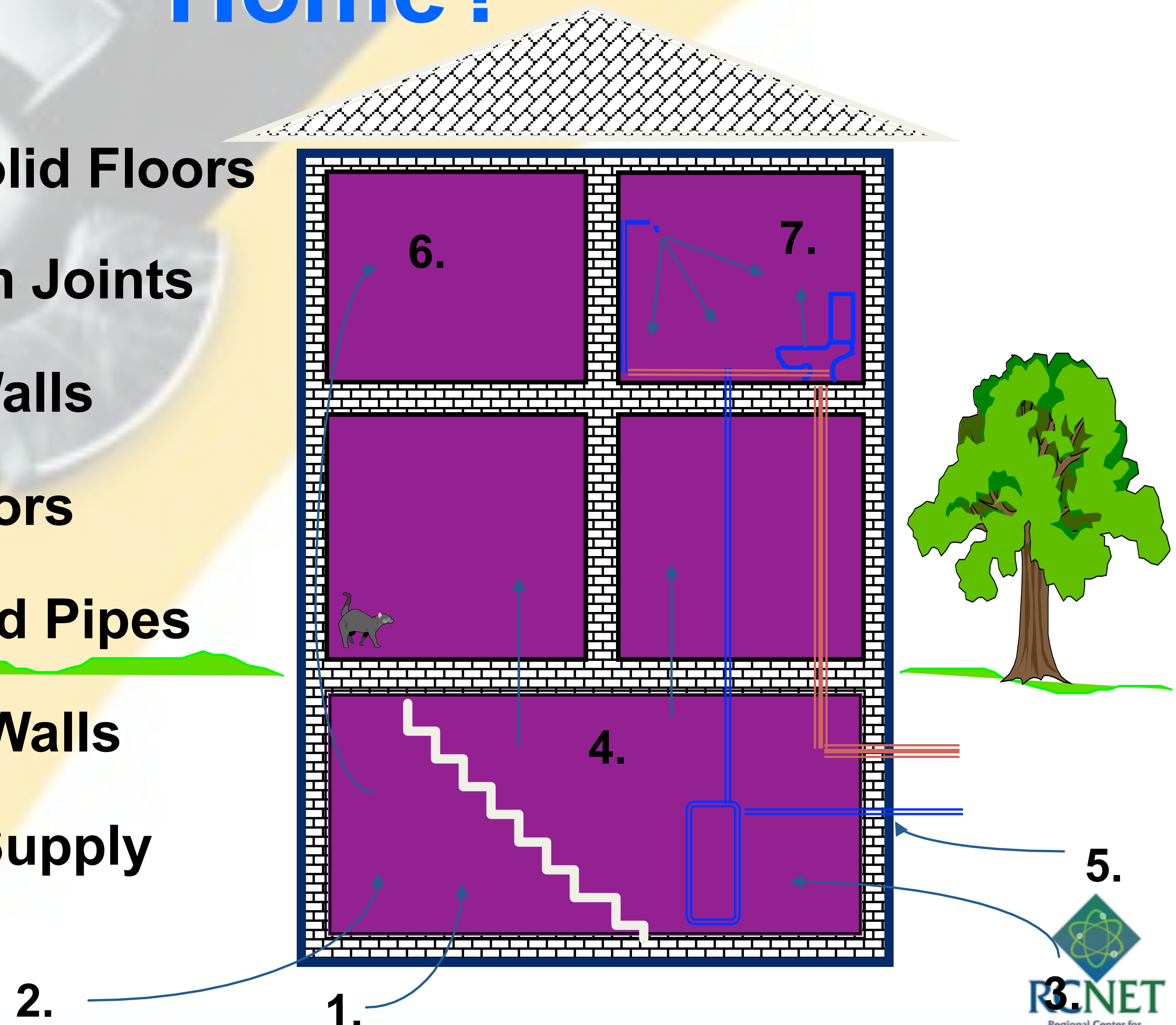

EPA Map of Radon Zones
LEGEND
Zone 1
Zone 2
Zone 3
Zone designation for Puerto Rico is under development.
The purpose of this map is to assist National, State, and local organizations to target their resources and to implement radon-resistant building codes. This map is not intended to be used to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones. All homes should be tested regardless of geographic location.

Radon and the Uranium Decay Series



How Does Radon Get in the Home?

1. Cracks in Solid Floors
2. Construction Joints
3. Cracks in Walls
4. Gaps in Floors
5. Gaps around Pipes
6. Cavities in Walls
7. The Water Supply



Radon

- Two methods
  - Count for Rn directly
  - Count for daughters
- Charcoal canisters have been used in the past to count radon and daughters
  - Gas gets into charcoal and decays
    - Count canister in a gamma spect system
  - But is weighed to the last 8-10 hours of collection time
- Eperm Radelec system
  - Collects Rn and then daughters decay in chamber causing a voltage drop in teflon disc
  - Calculates radon concentration

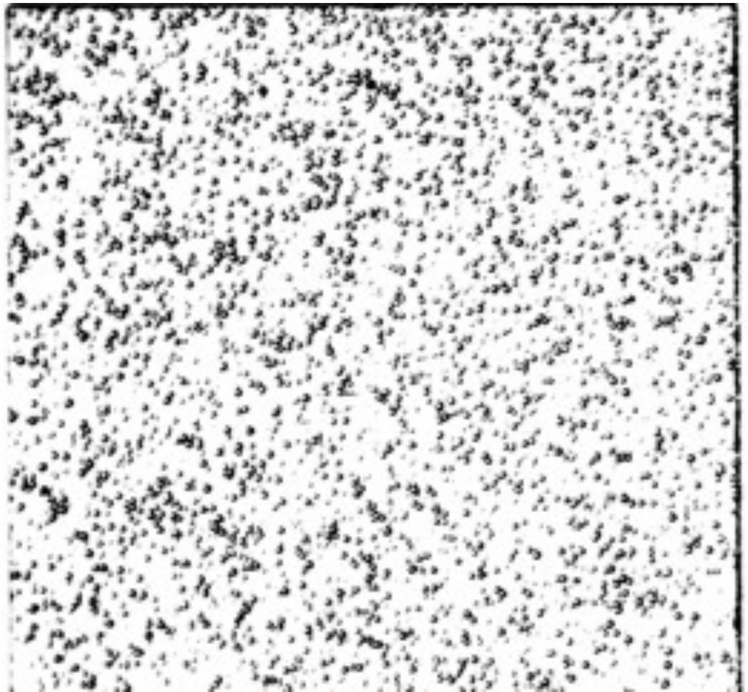
Rn canister

EPerms

Track Etch

- Thick emulsion (similar to film badge material) can be used to detector Radon gas
- It is set out where the gas is and over time the Rn in the air will decay emitting alpha particles
- the alpha particle will leave a imprint on the emulsion
- When the emulsion is process the tracks will be easy to see and count
- The number of tracks it related to the number of alpha particles which is then related to the amount of Rn gas in the air

Track Et



Tritium

- Tritium is collected usually as HTO
  - higher probability of dose to the public
- Drawn into a container that has silica gel in it
- Flow rate times time equals total volume of air collected into the container
- Sample is then analyzed by liquid scintillation
- Concentration of pCi/ml can be calculated
- Water samples can be counted directly by putting sample into liquid scintillation vials

Questions