

Radon: An Environmental Concern with an Easy Solution

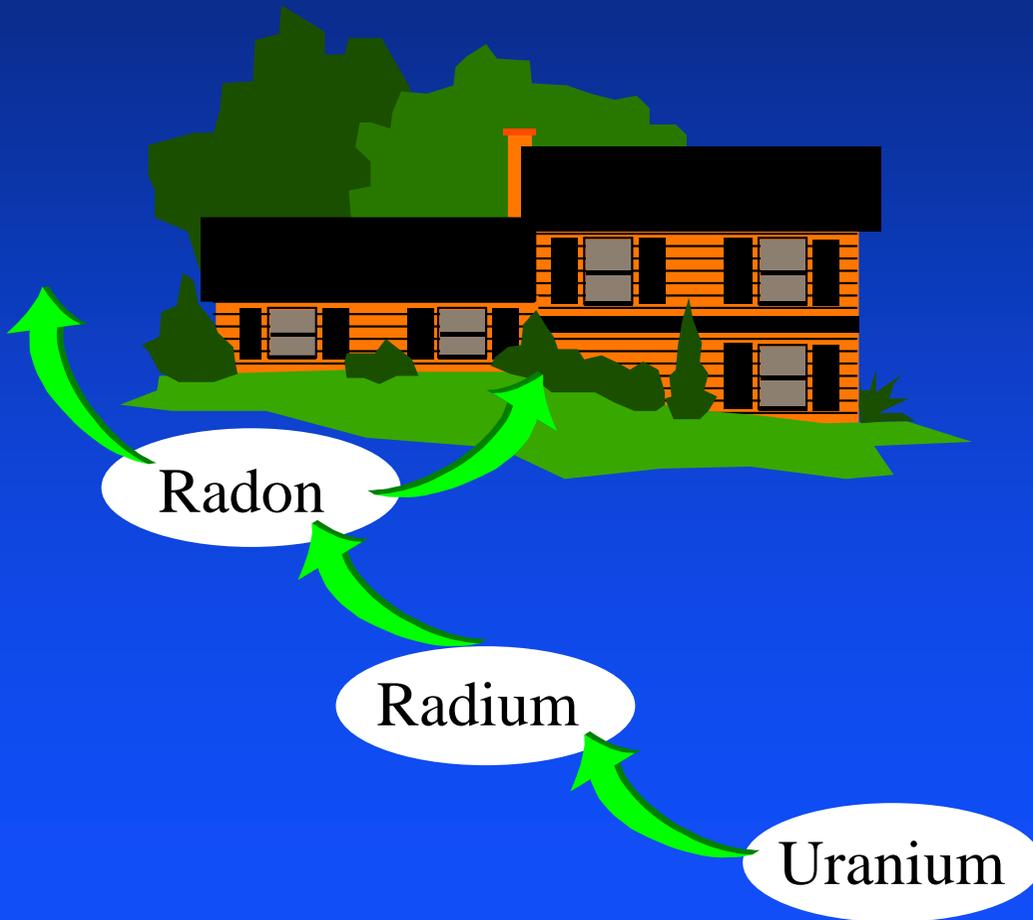


Laramie, Wyoming September 18, 2019



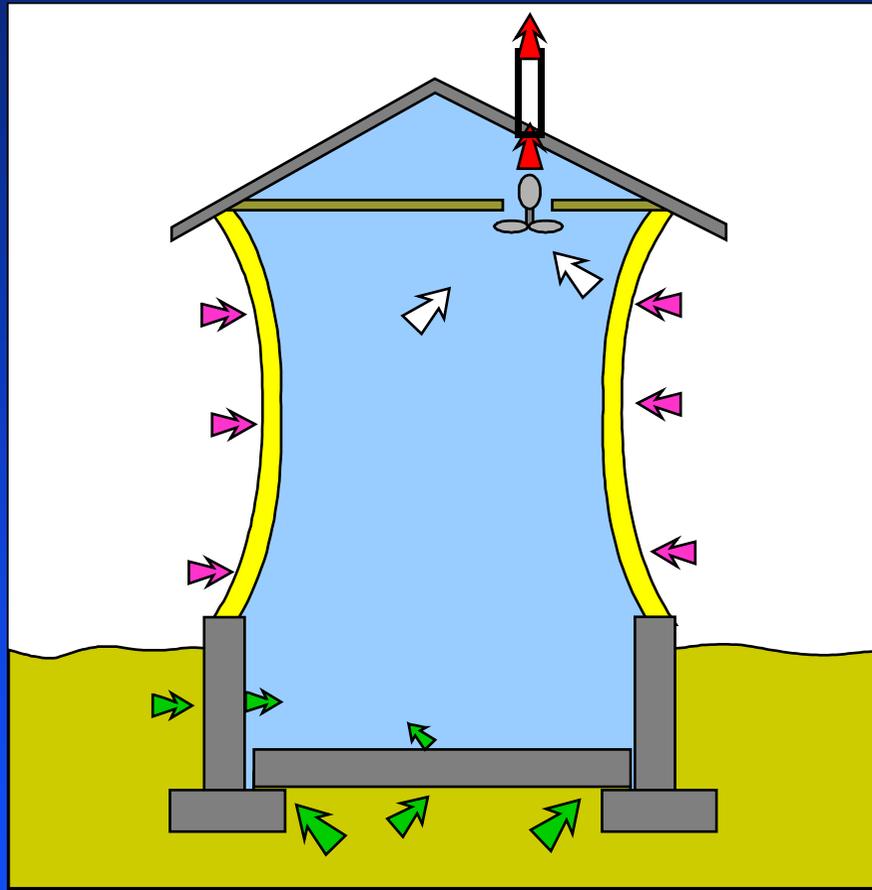
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Radon Created from Breakdown of Natural Deposits of Uranium and Radium



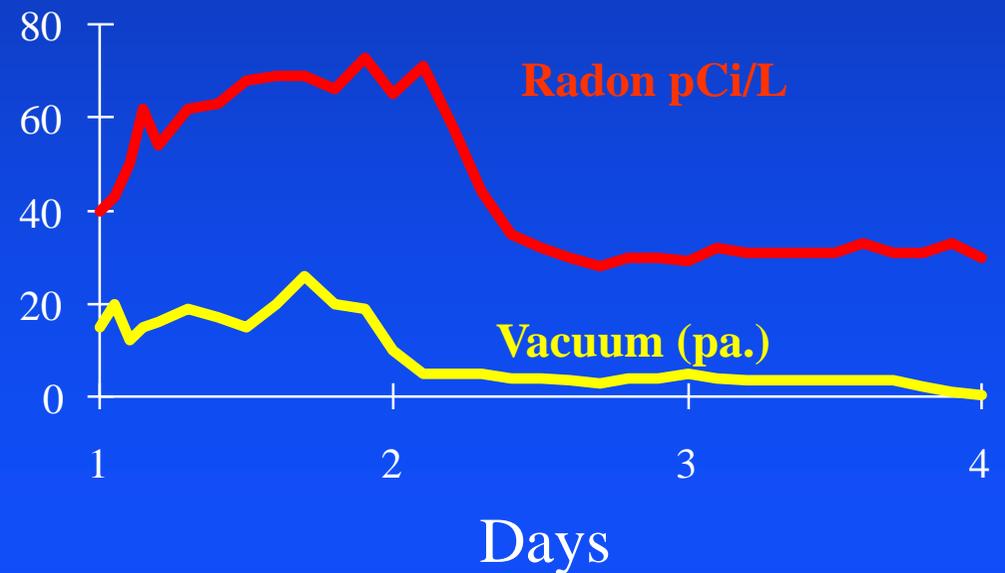
- Radon is a gas
- It is naturally occurring
- It is inert
- It cannot be seen or smelled
- It enters a building from the soil beneath

How Is Radon Drawn Into A Building?



■ Vacuum

- Exhaust systems
- Thermal stack effects



Radon Can Be Elevated in:

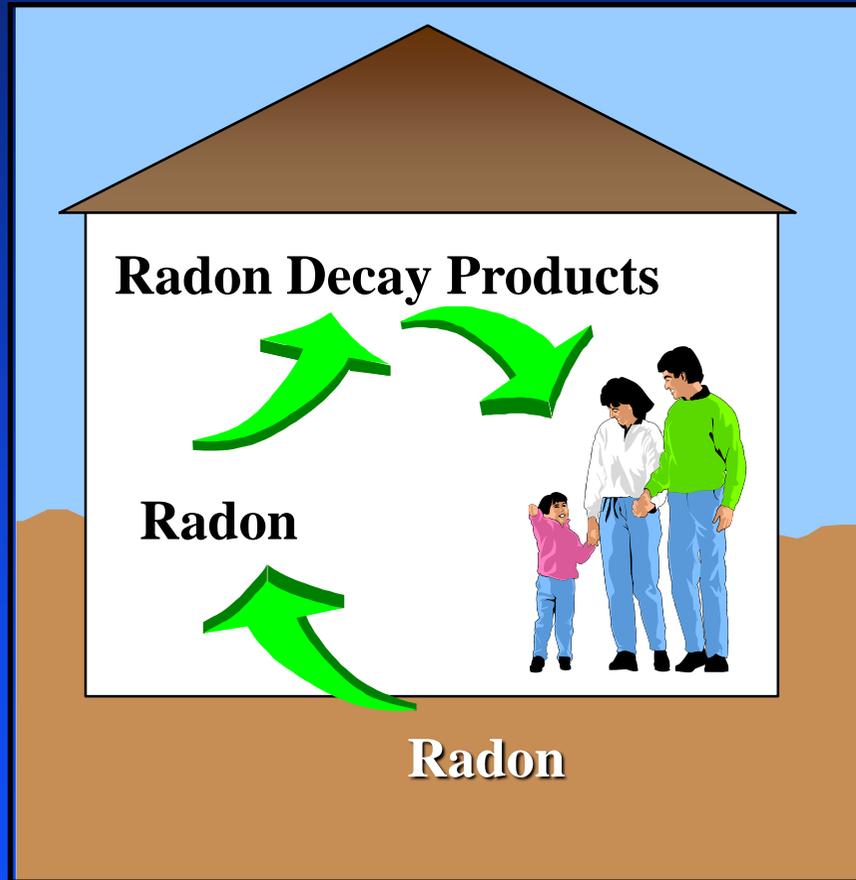
- New homes
- Old homes
- Homes without basements
- Apartment buildings
- Schools
- Offices
- Administration Buildings

Low Radon Potential Homes



Unless you live on a houseboat or in a tree house, your home can have elevated levels of radon!

Why Is Radon A Concern?

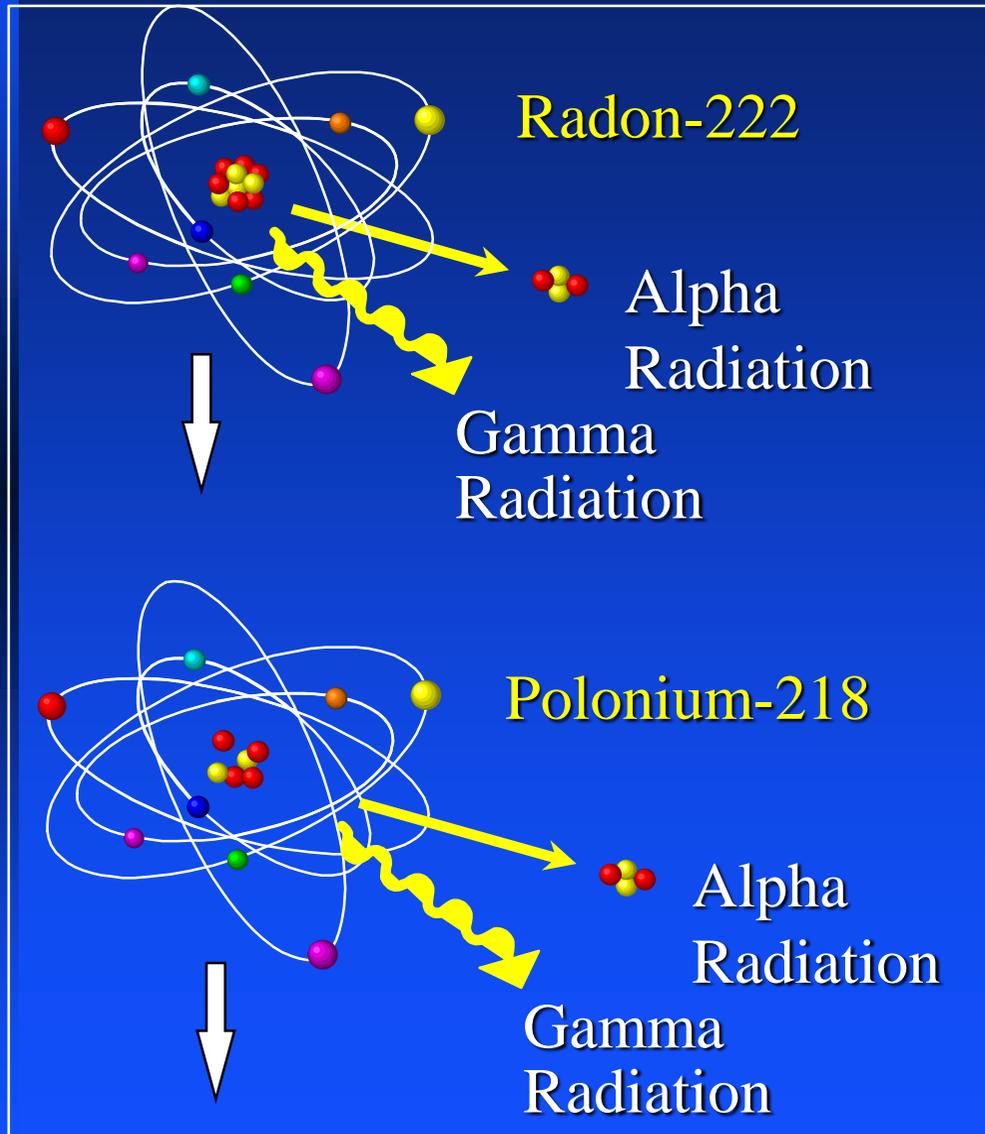


- Radon decays into radioactive particles known as radon decay products.
- These particles are easily inhaled and deposited in the lungs where they can damage sensitive lung tissue.

Let's get technical, for a moment



Radioactive Decay



- Spontaneous
- Radiation is released in the process
 - *Alpha* - very damaging
 - *Beta* - little damage per impact
 - *Gamma* - little damage per impact

Radon and Its Short-Lived Radon Decay products

Half Lives

3.8 days

Radon-222

← Radon

- Gas
- Measured in pCi/L

α, γ

3 minutes

Polonium-218

α, γ

27 minutes

Lead-214

β, γ

19.7 minutes

Bismuth-214

β, γ

.00016 minutes

Polonium-214

α, γ

19.4 years

Lead-210

β, γ

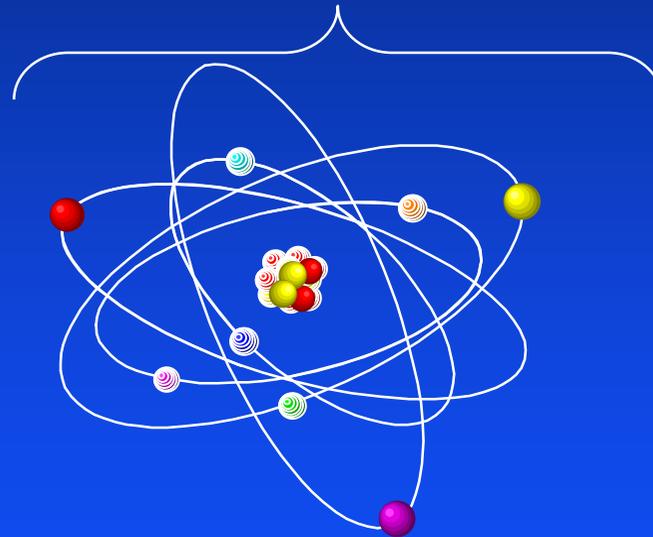
Short-lived decay products

- Solids
- Inhaled & stick to lungs
- Create health concerns
- Adhere to solid objects
- Measured in terms of Working Levels

Recoil from Alpha Release Strips Electrons Causing Resultant Decay Product to be Charged

+ Ion

Stripped Electrons

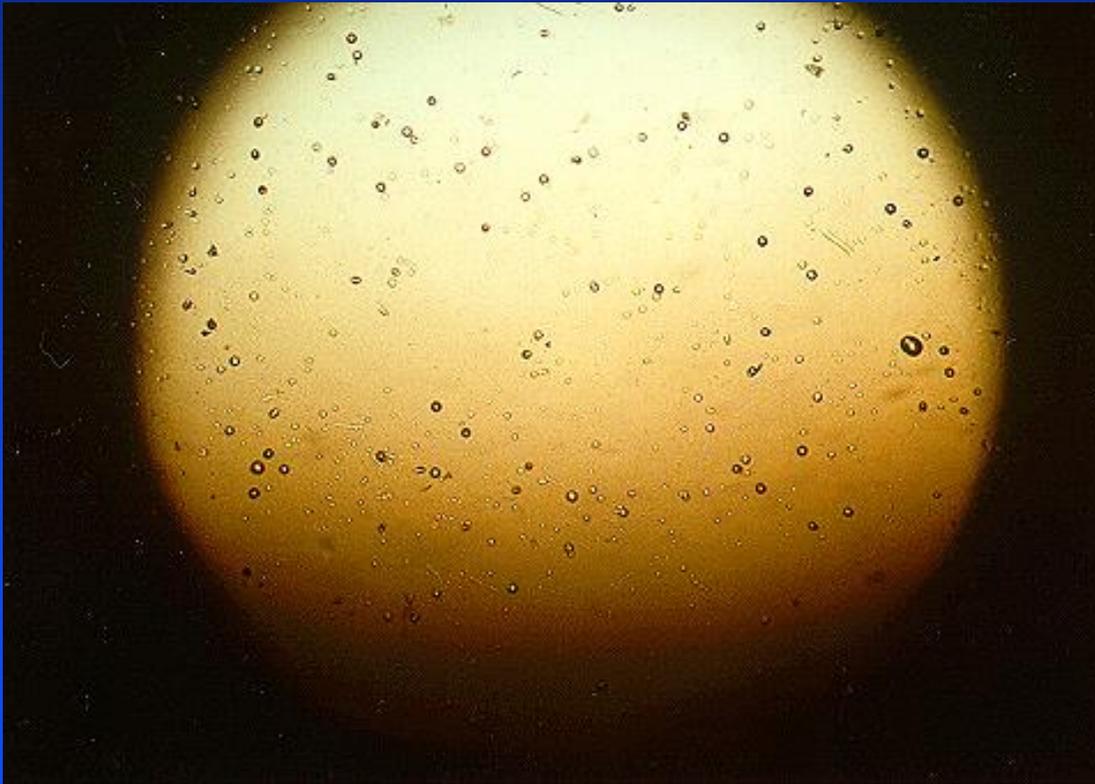


Alpha particle

Radon Decay
Product

Radon Atom

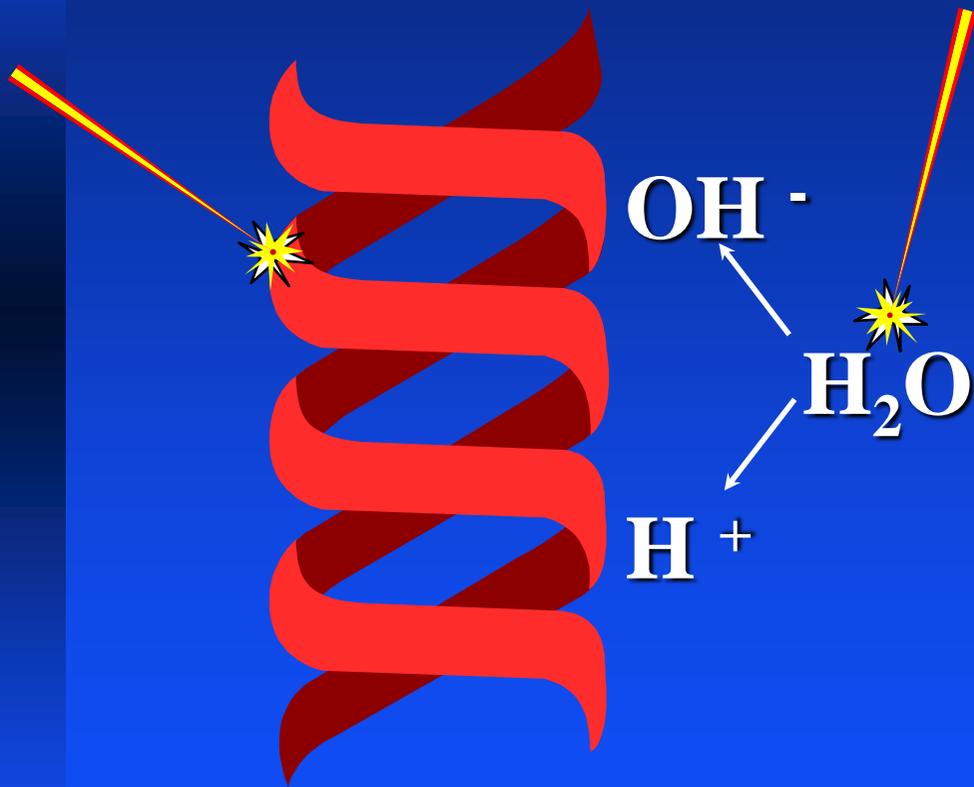
Alpha Particles Are Strong Enough to Pit Plastic



- Plastic chip from passive radon test (alpha track)
- Magnified only 100 times
- 3 months at EPA Action Level of 4 pCi/L

Photo: Dr. J.F. Burkhart

Effect of Alpha Particle Release in Lungs



Chromosome 6, P53 gene impacted

- Random in direction
- May kill cell
 - Preferred result
- Chemical reactions
- Direct strike of DNA
- Can impair cancer suppressant genes
 - P53 & others
 - Cell loses ability to defend against cancer.

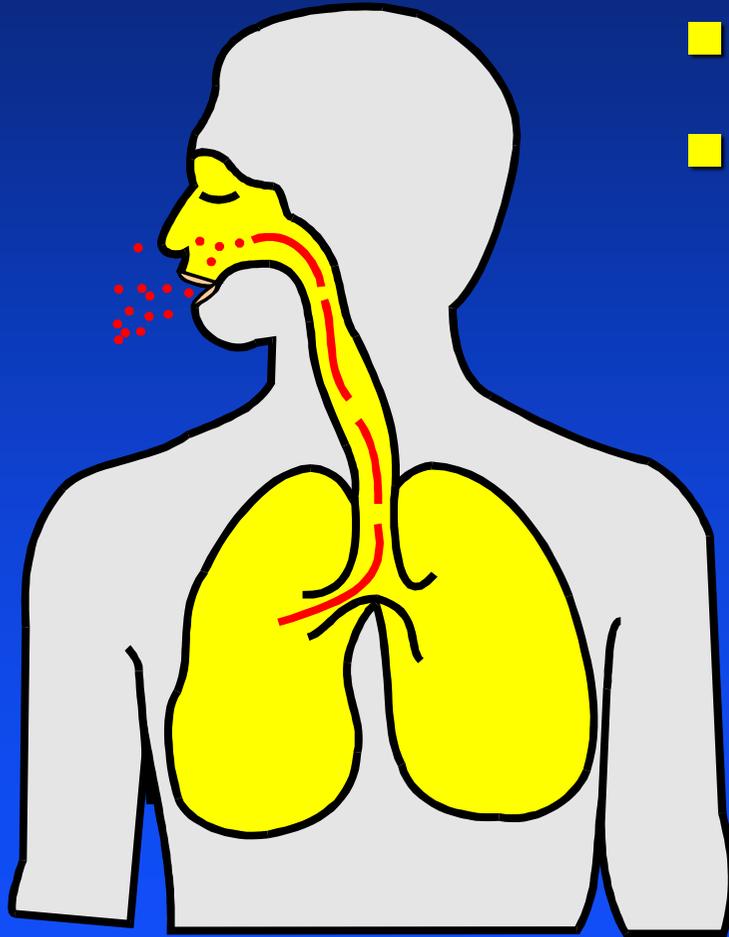
Radon Induced Lung Cancer



- Risk increased equally by both duration and concentration of exposure
- One dart at a time for a long time, or handfuls of darts over a short time

Equal weight of time and dose creates linear model of risk.
One dart could be enough, hence no threshold in risk model.

Radon Is a Lung Cancer Causing Gas



- Radon decay products inhaled.
- While in the lungs they can decay.
 - Alpha particles released
 - ☞ Like small bullets
 - ☞ Lung cells do not have covering to shield themselves
 - ☞ Can kill or cause damage to cells that leads to increased potential of lung cancer

EPA & Surgeon General Recommend That People Not Have Exposures Above 4 pCi/L On A Long-Term Basis



Regardless of where one lives or
works



**A Citizen's Guide
To Radon** (Fourth Edition)



CDC

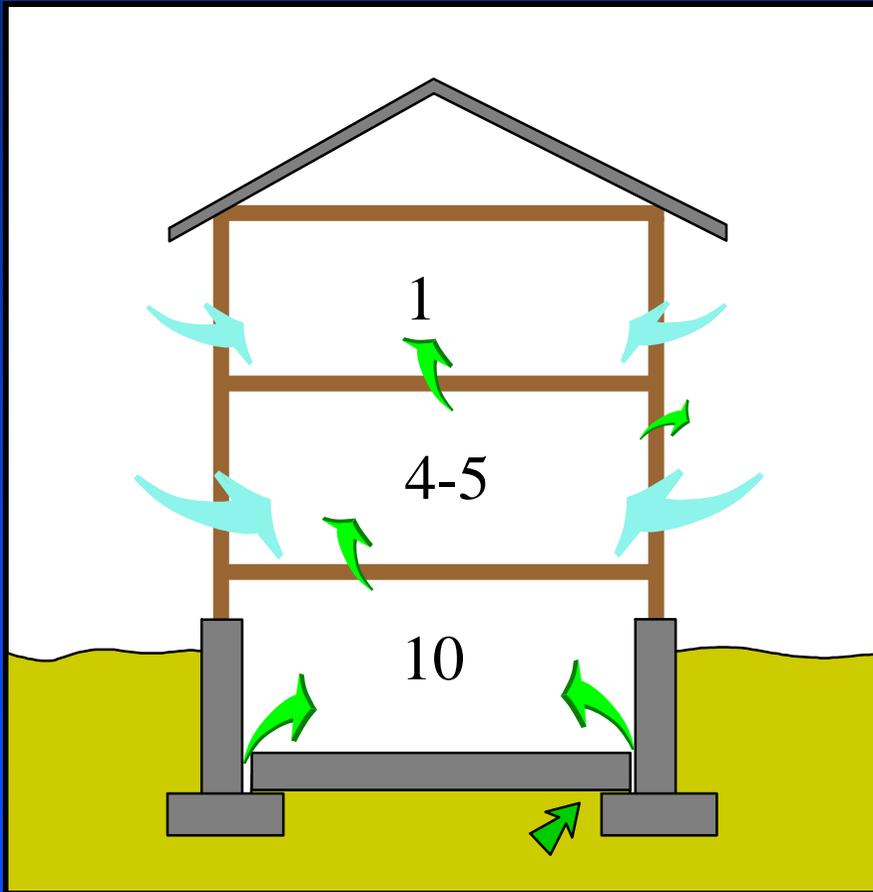
The Guide To Protecting
Yourself And Your Family
From Radon



EPA & Surgeon General Recommend People Not Have Exposures Above 4 pCi/L on a Long-Term Basis

- One is advised to take action if a home is at or above 4.0 pCi/L (or 0.016 WL)
- Curie: the amount of radiation generated from 1 gram of radium
- One pico Curie: one trillionth of a curie
- Average indoor: 1.3 pCi/L
- Average outdoor: 0.4 pCi/L

Radon Distribution

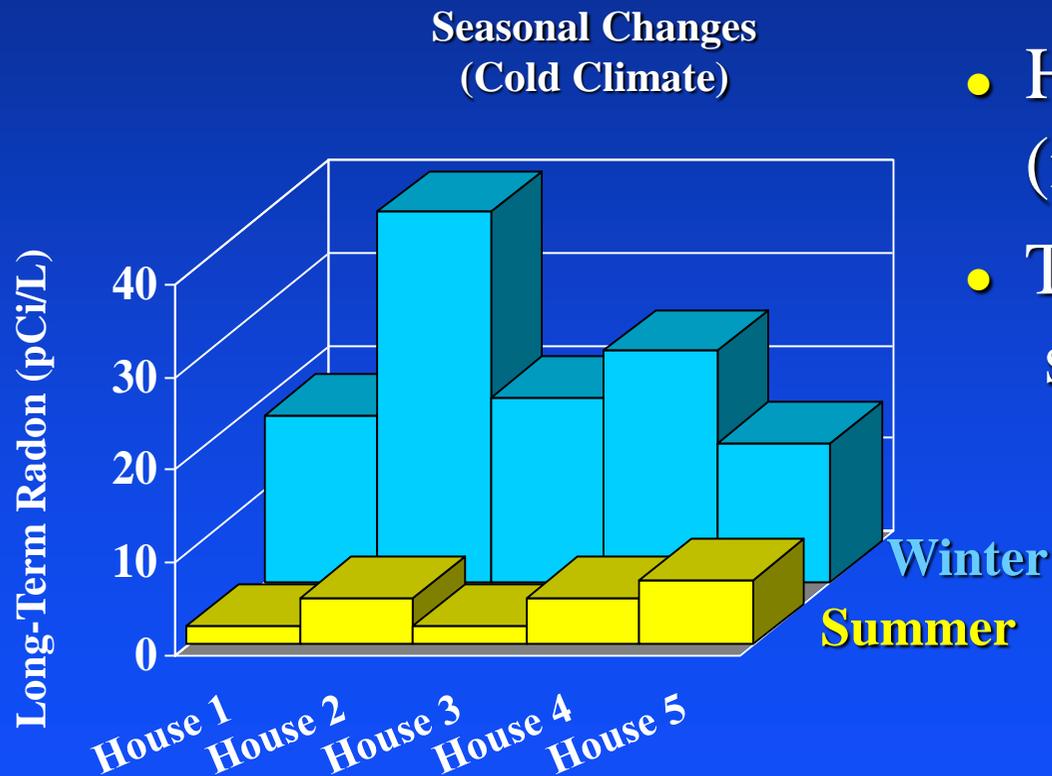


- Radon enters from beneath foundation and travels upward.
 - Diluted with outdoor air infiltrating building.
- If radon is less than 4 pCi/L in lower level, one can say with reasonable confidence that upper floors are also less than 4 pCi/L.

Overall Radon Entry Is Seasonal

Entry rates can be higher in:

- Cold climates in winter
- Hot climates in summer (no evaporative coolers)
- Tropical climates in rainy season



Test Purpose Dictates Conditions

■ Radon Potential:

- Short-term test
- Typically 2-5 days
- Closed building conditions 12 hours prior to and all during test
- Device deployed on lowest occupiable level of home
- Commonly used at time of resale

■ Occupant Exposure:

- Long-term test
- Typically 91 days to year
- Normal lived in conditions without special closed building conditions
- Device deployed on lowest occupied level of home
- Commonly used outside of resale, or as basis of escrow fund release

Common Short-Term Test Devices



Activated charcoal devices
from certified laboratories

- Placed by:
 - Measurement Providers offering Standard Services
- Analyzed by third-party labs
 - Results not available on site
- Deployed for 2-5 days

Continuous Monitor Use in Real Estate Testing



Variations can detect tampering

- Single device
 - Must measure and report in hourly increments and be calibrated
- If average is equal to, or greater than 4 pCi/L, mitigation is recommended

Long-Term Tests Indicate Occupant Exposure

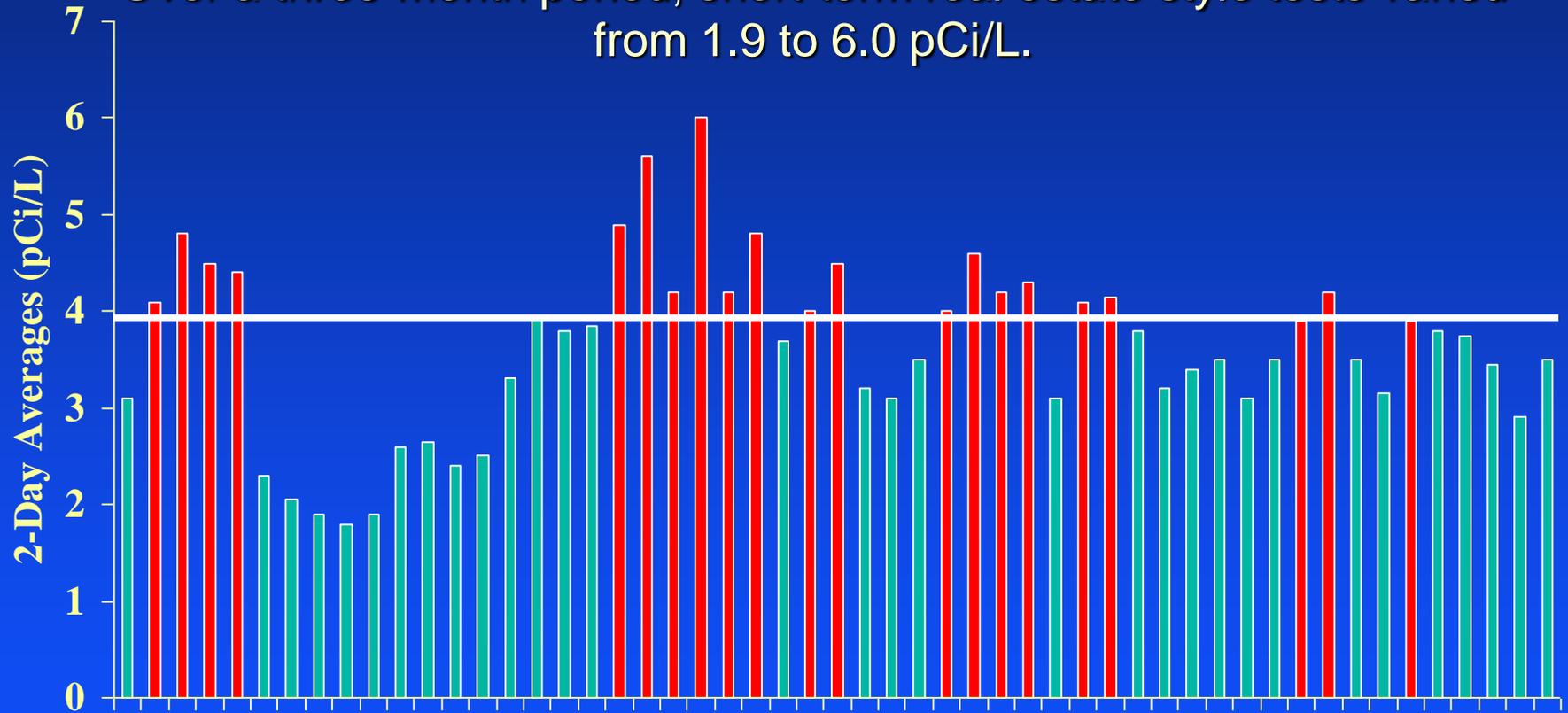


Alpha Track Detector

- Placed for a minimum of 91 days
- No special closed building conditions
- Can be used for release of escrow funds
- If result is equal to, or greater than 4 pCi/L, mitigation is recommended.

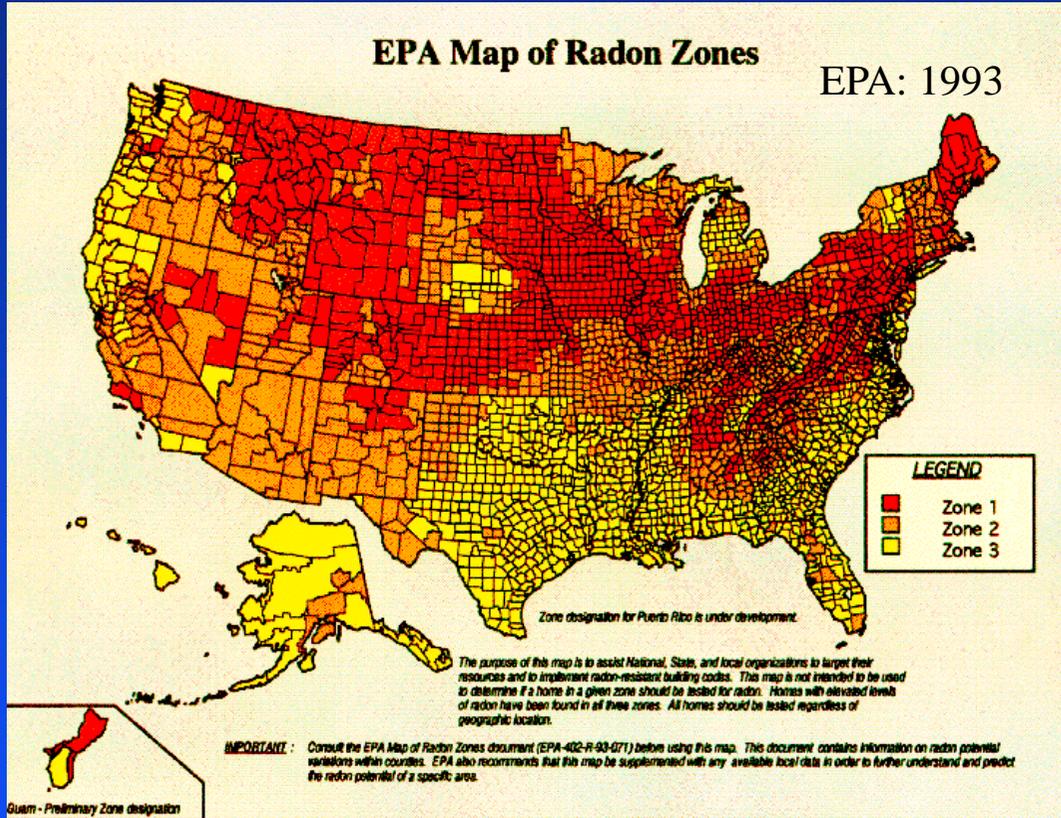
Successive 2-Day, Short-Term Measurement Results in Same House

Over a three-month period, short-term real estate style tests varied from 1.9 to 6.0 pCi/L.



Average for entire period was 3.8 pCi/L

EPA Radon Zone Map



- Based on geology and survey results
- Expected short term radon (pCi/L):



- Zone 1 > 4.0
- Zone 2 > 2 < 4.0
- Zone 3 < 2.0

Many parts of the country have radon concerns!

Maps are interesting – but to be sure, all buildings should be tested!

**So, if there is a risk, how can we
reduce it?**

Radon Mitigation

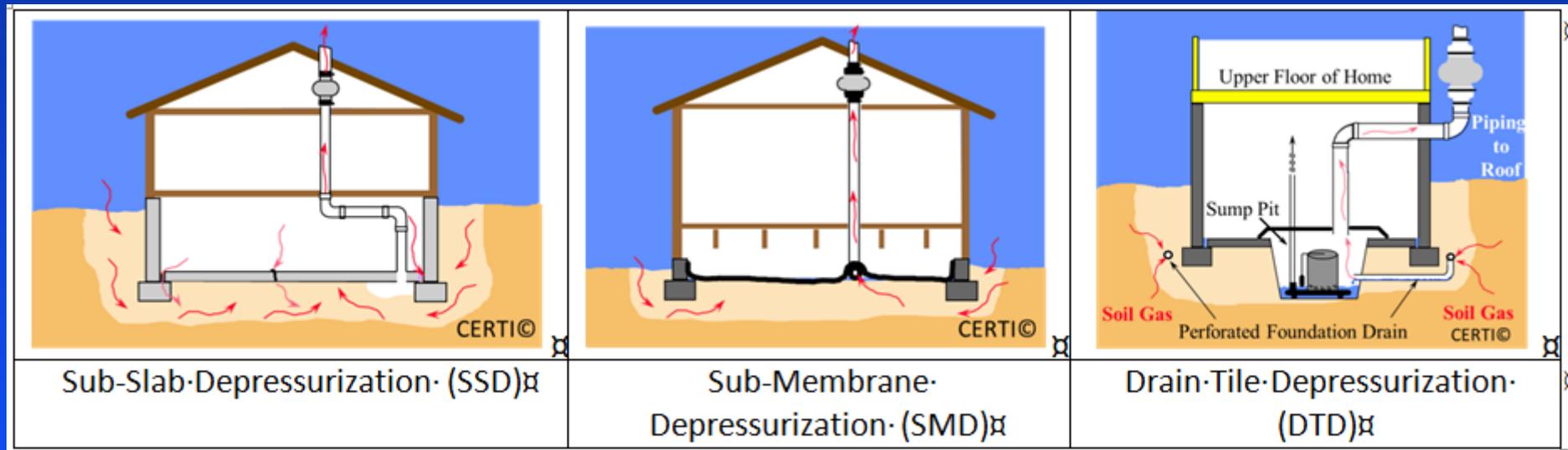
Can't We Just Seal The Cracks?



- Radon can enter through very small openings.
- Without affecting house pressures, sealing is not a stand-alone technique.

Mitigating Existing Homes

- Active Soil Depressurization is still the primary method



- Difficulty, expense, and aesthetics are a function of foundation and NOT radon level

New Technical Reference

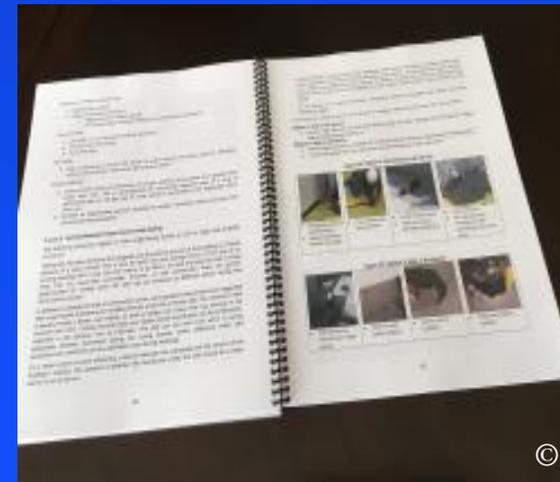
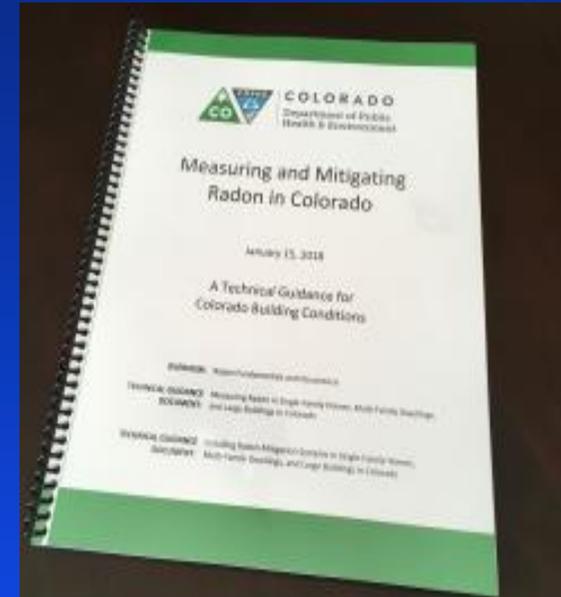
■ Detailed guidance

- ◆ Consumers
- ◆ Home Builders
- ◆ Real Estate Professionals
- ◆ Homes, Multi-Family, Offices and Schools

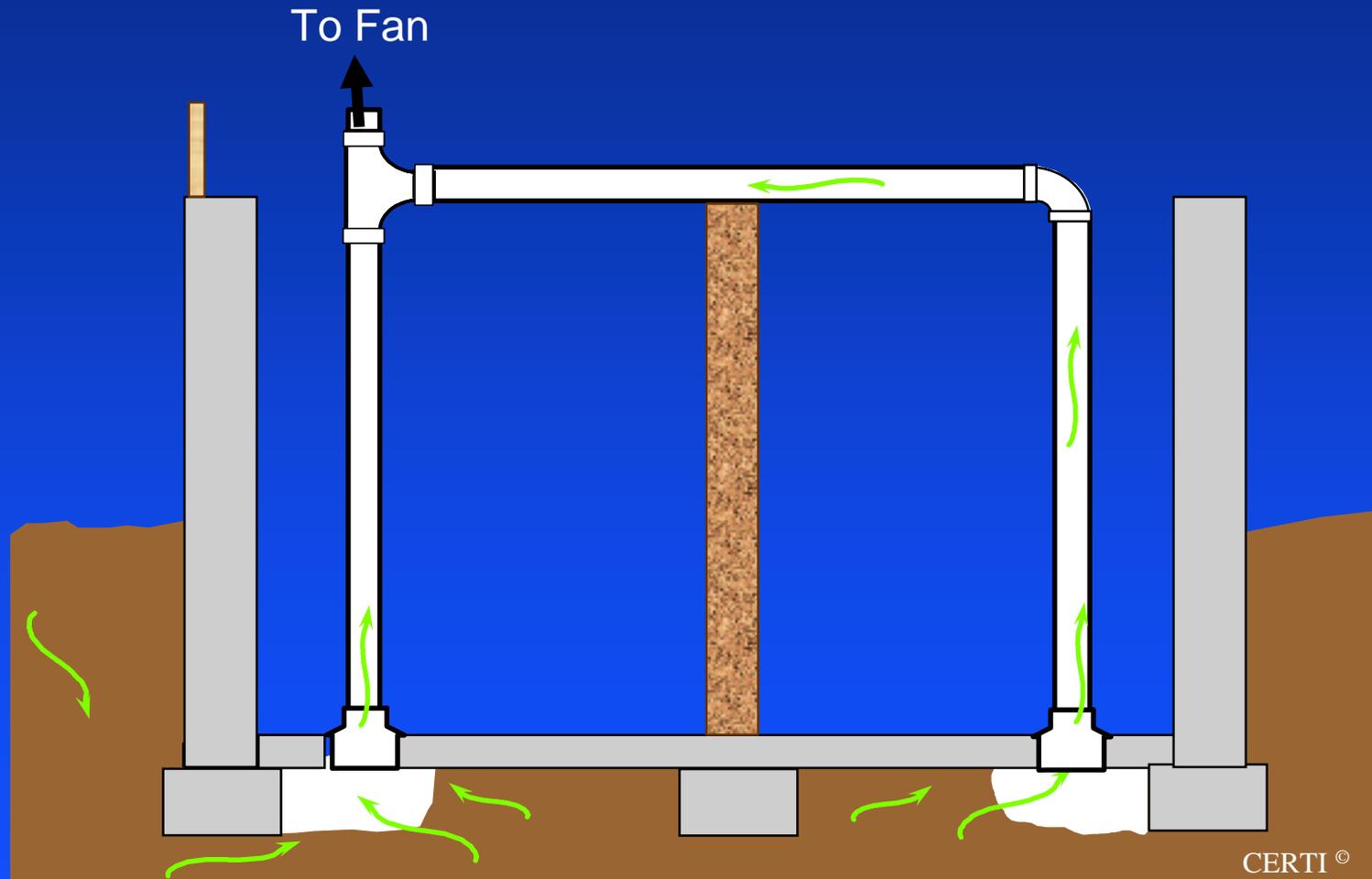
■ Colorado focus

- ◆ Applies throughout Rockies

■ Download at www.coloradoradon.info



Capture Efficiency is a Function of Foundation



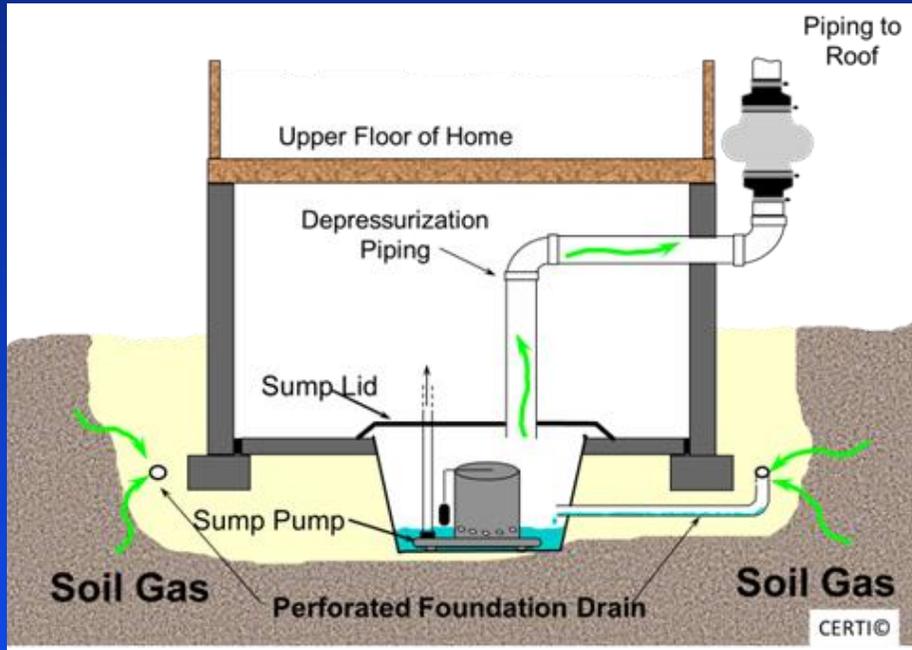
- Grade beams or foundation separations may require multiple suction points
- Can be tied to common fan

Crawlspaces

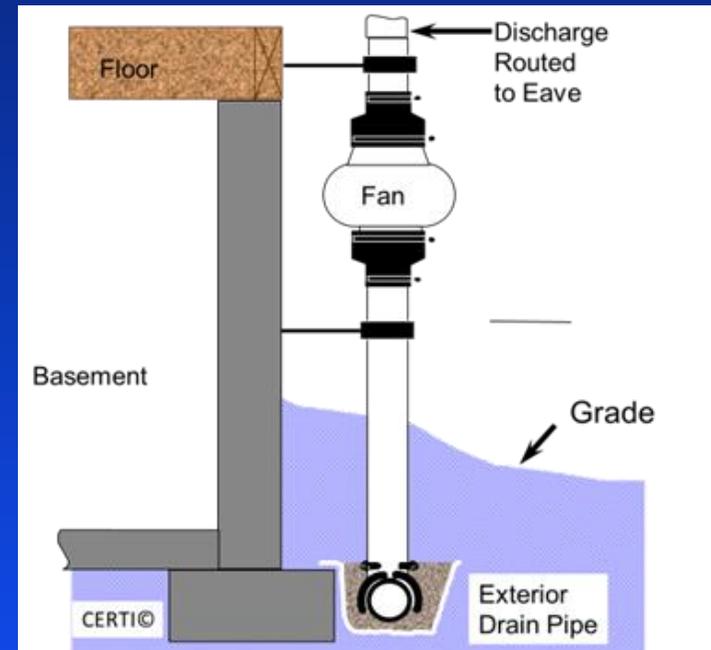


- Captures radon prior to entry into crawl
 - ◆ Very important when crawl is part of conditioned space
- Seal poly to walls and at seams/penetrations
- Has collateral benefit for moisture reduction

Drainage System Use



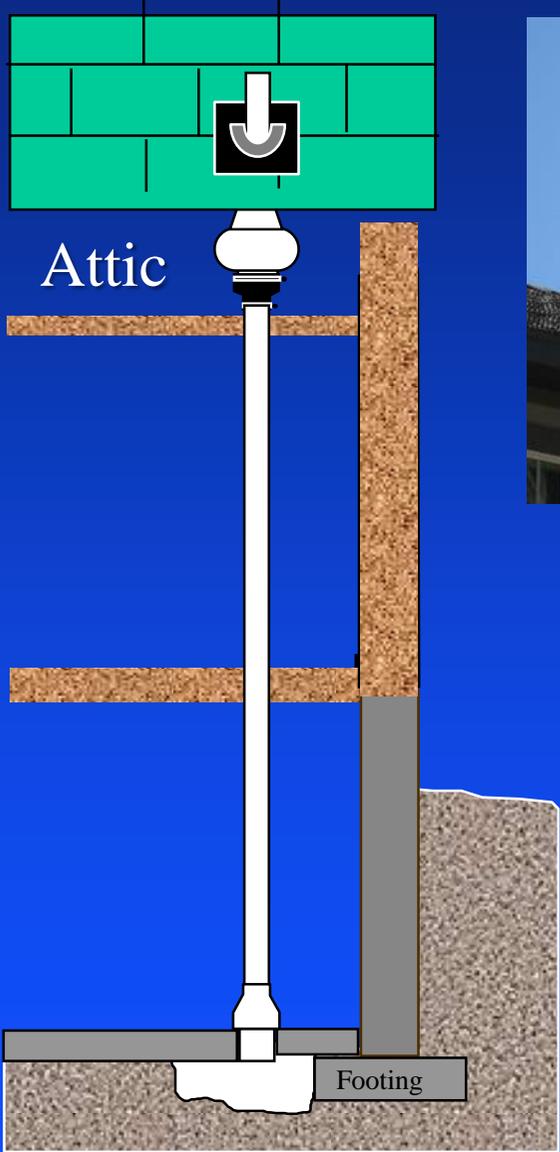
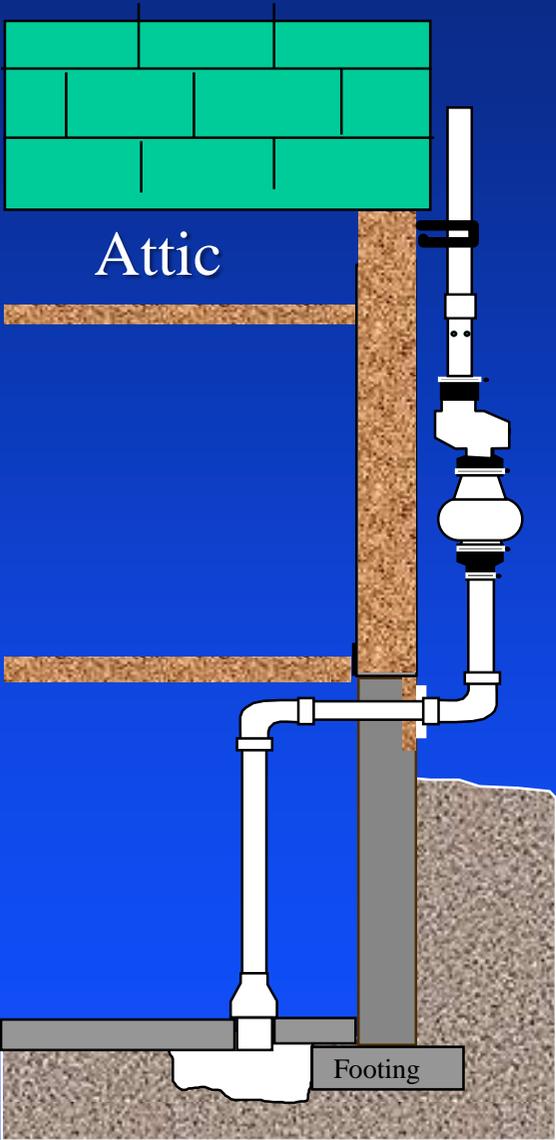
System Connected to Sump



System Connected to Exterior Perimeter Drain

- Works well - even if drain is outside foundation and does not completely encircle building
- Care to be taken not to interfere with water collection

Existing Building Routing Inside or Outside



Performance Indicators

Knowing When Active System Fails



U-Tube manometer connected to suction piping with label indicating initial installation



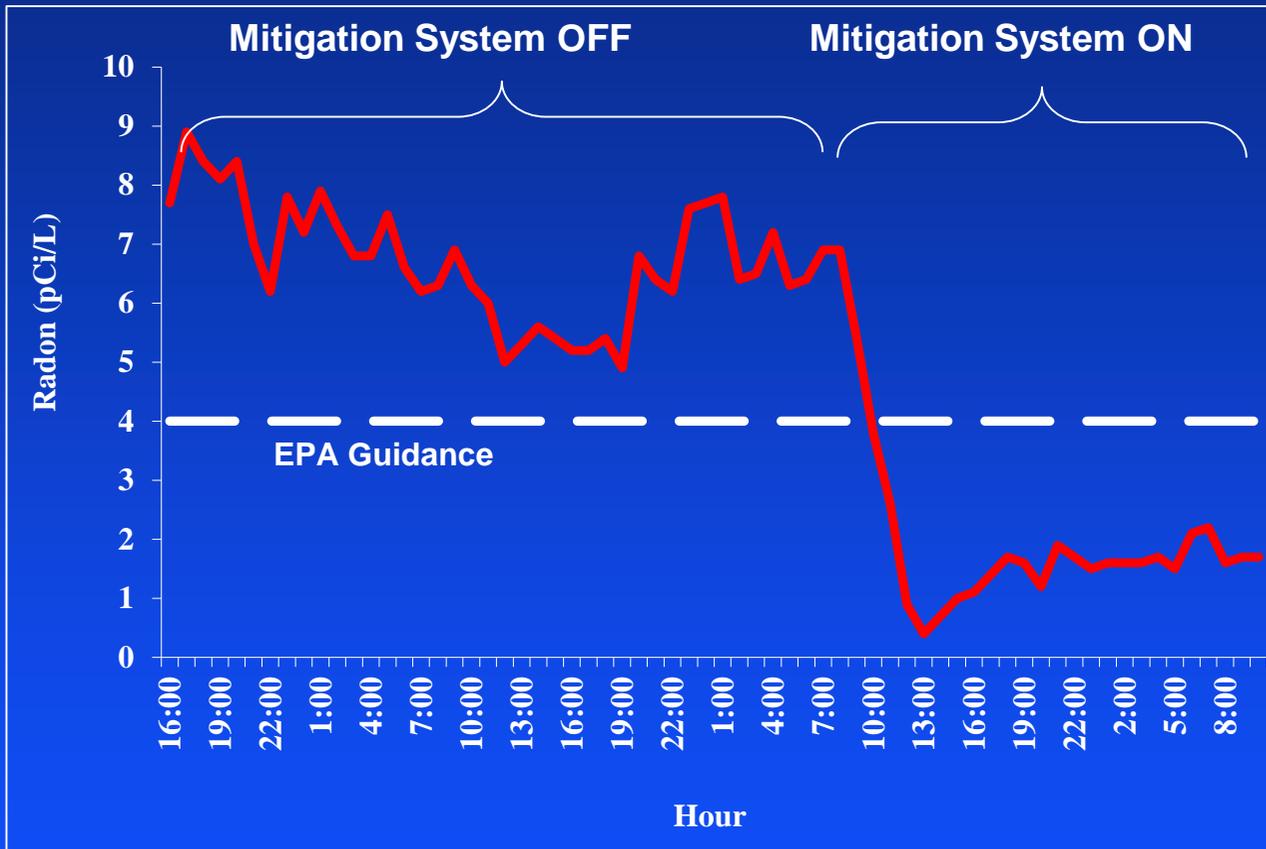
Electrical current style indicator. in line with wiring to fan



Consumer grade radon indicator can sense changes in indoor radon

NOT An “approved” device for determining the need for or success of mitigation

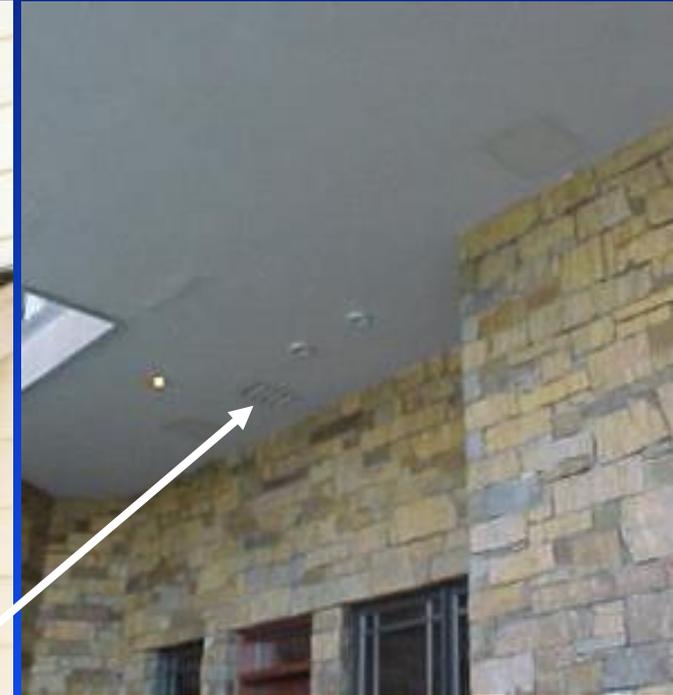
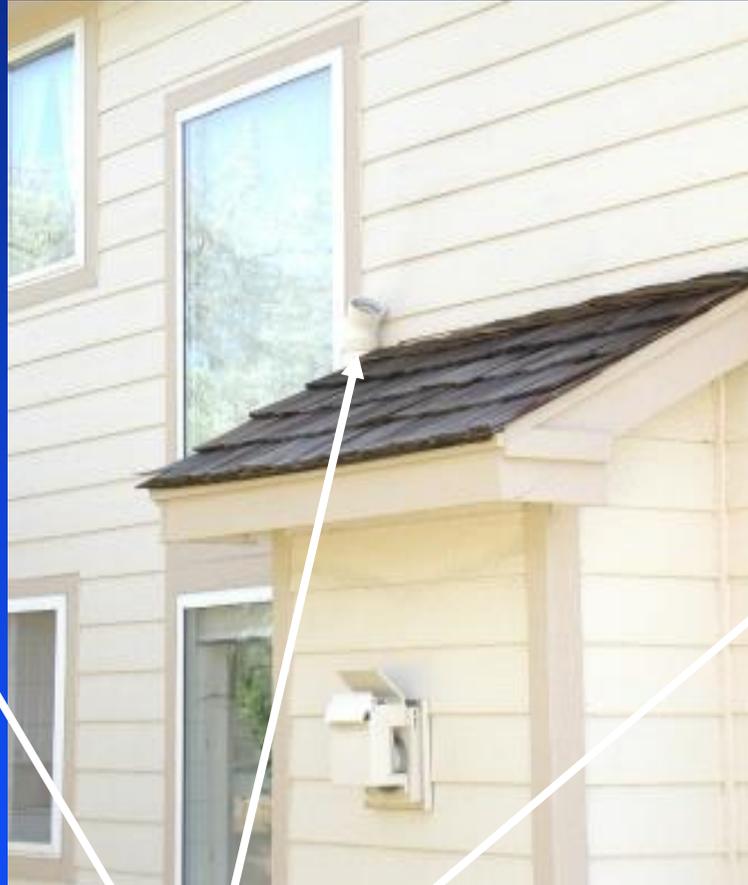
Radon Mitigation Works!



- Retest as soon as 24 hours after completion
- Retest every two years thereafter

But is reducing radon the only consideration?

Discharges to be Away From Openings



Discharge

Discharges Carry Moisture



El Paso County

Fan Location

EPA Standards: Fans Should be Outside Living Space



Leakage on positive pressure side of fan can introduce radon into building

Use Solid PVC!



Dryer vent in Attic??



Caused Leak Through Ceiling

Unique Systems

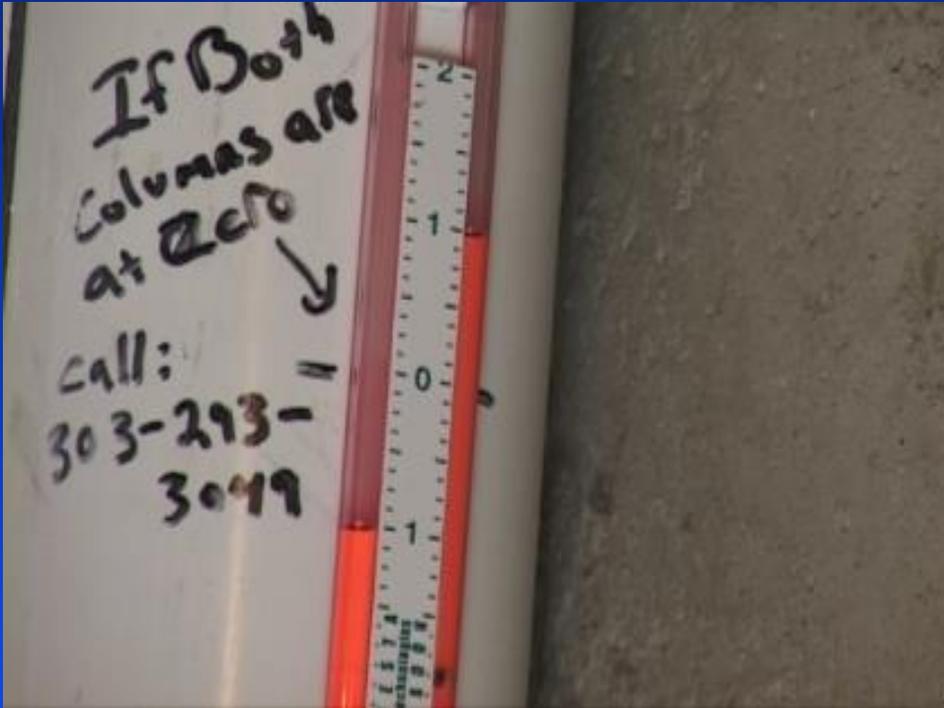


Boulder



Denver

Labeling



- What should it say?
- How durable should it be?
- Where should it be?



“Honey, how about a cozy fire tonight?”

“Nah, I think I’ll just let the noise from our radon system lull me to sleep instead.”

Existing Home Systems in Compliance



Insure pipe and fan
does not obstruct with
escape window well

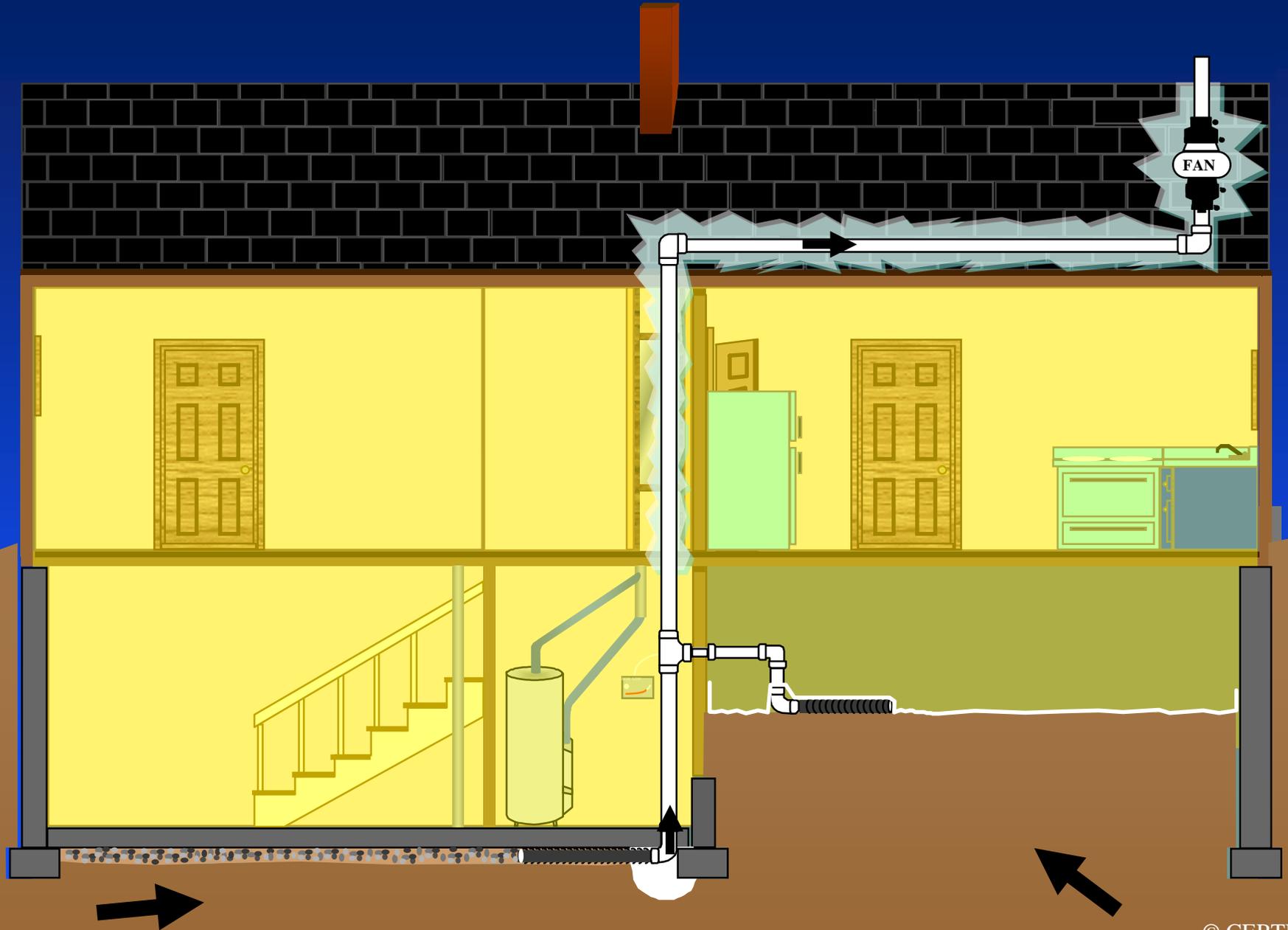




Pick Your System



New Construction



Passive to Active



Install Passive System



Buyer Takes Possession



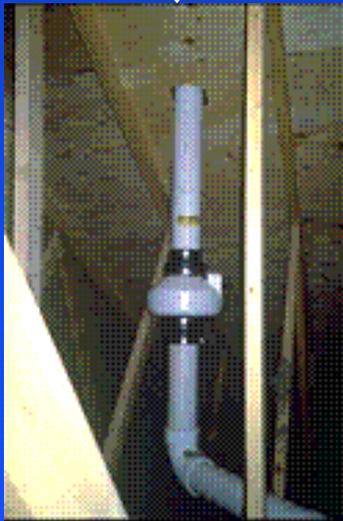
Buyer Conducts Test



Fan Installed if Elevated



Buyer Conducts Re-Test



- Active soil gas reduction suggested as design approach
- Passive vs Active Study in Fort Collins:
 - ◆ 49% reduction with passive, yet 40% were still in excess of 4.0 pCi/L

How Well Do Passive and Active Systems Work?



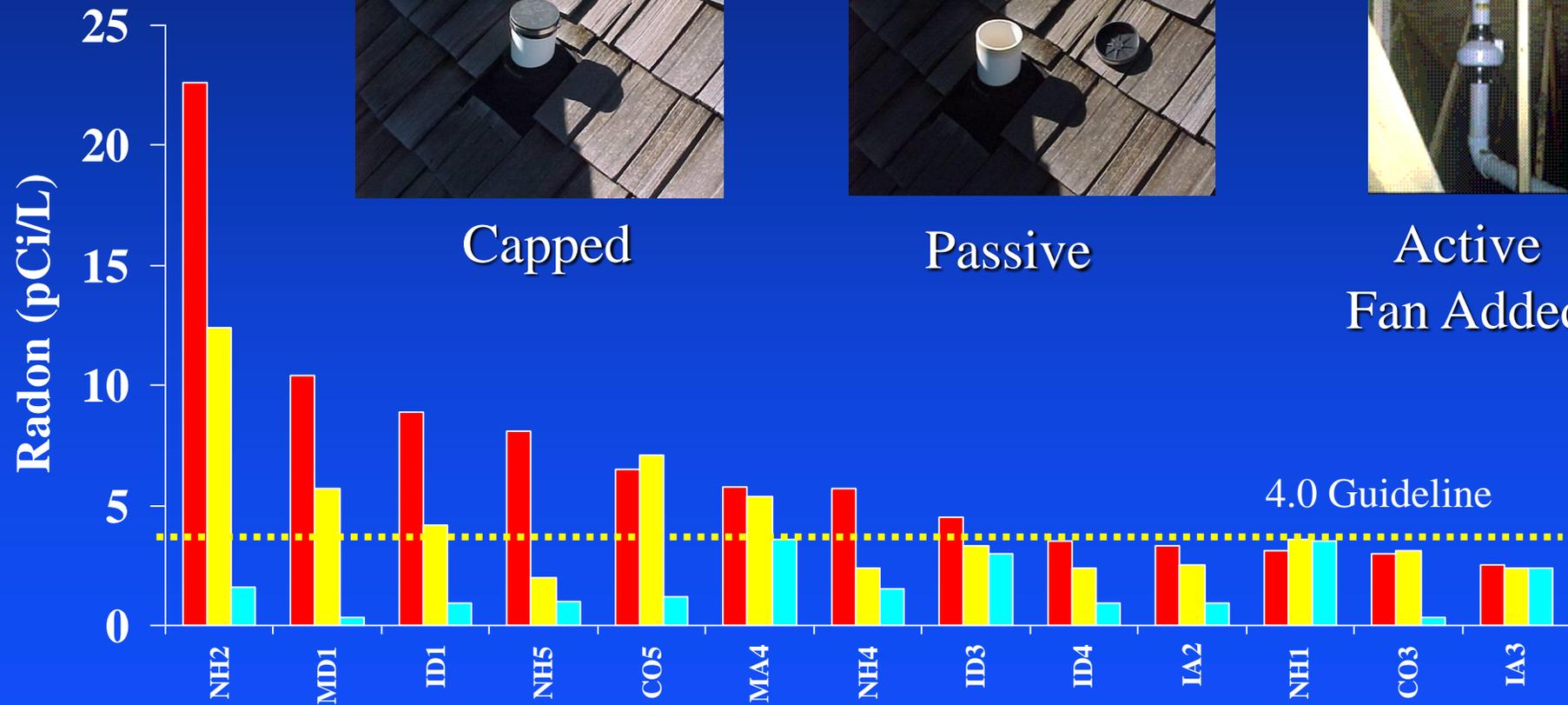
Capped



Passive



Active
Fan Added



Active Systems From Outset

- Allows for more flexible design
- If designed properly, fans can require very low power consumption (15 watts)
- Inspections are easier
- Results assured to be well below 4 pCi/L

Finding Certified Measurement and Mitigation Professionals



<https://nrpp.info/>



<http://www.nrsb.org/>

- Individuals:
 - ◆ Trained
 - ◆ Examined
 - ◆ CE requirements
 - ◆ Agree to follow protocols and building codes

Questions?

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