

# Conducting and Assessing Radon Surveys in Schools & Commercial Buildings

CIHC

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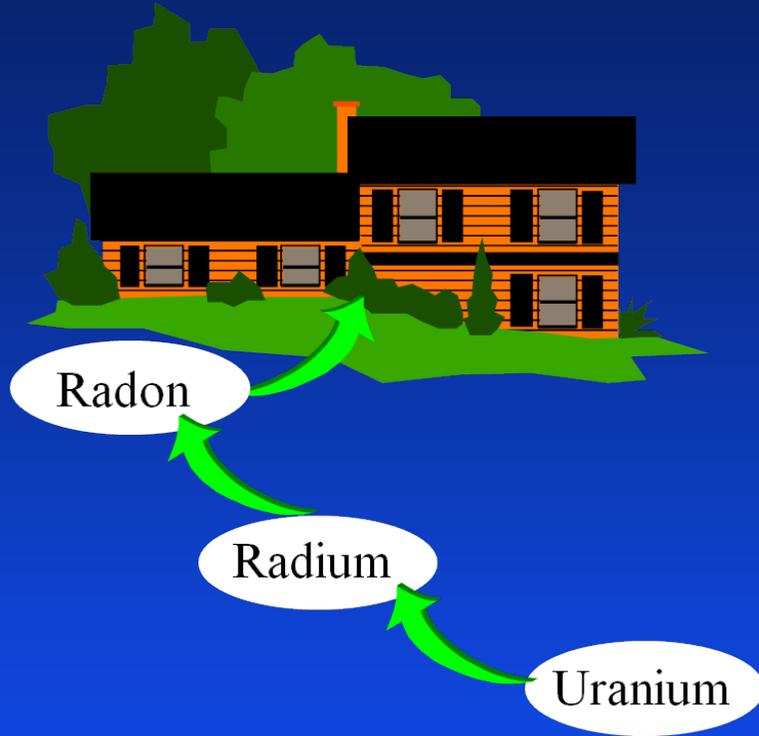
# ACKNOWLEDGEMENT

The majority of the content of this presentation was graciously provided by Mr. Doug Kladder, Director, and Denise Brown, Vice President of Education of the Center for Environmental Research and Technology, Inc. (CERTI), Colorado Springs, CO.

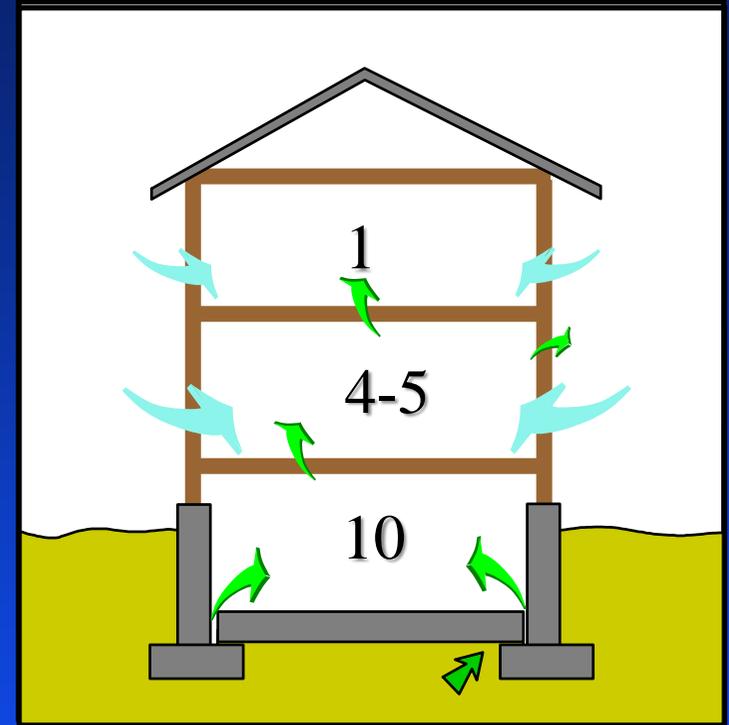
**Let's get technical, for a moment**



# Radon Enters Through Foundation

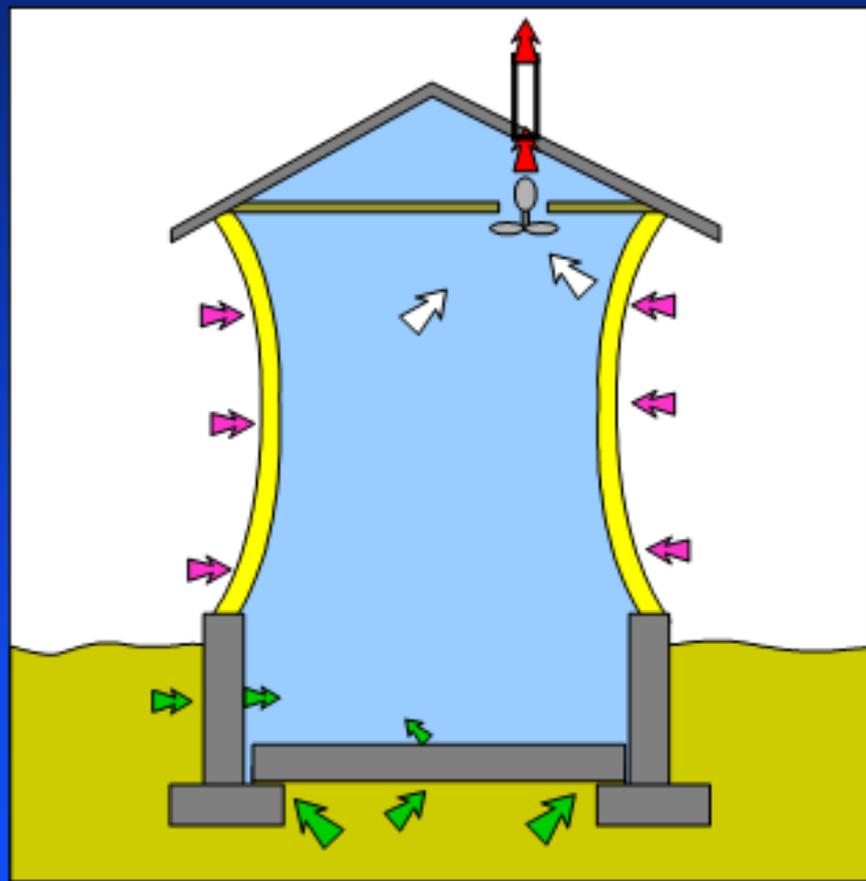


- Radon is a soil gas.
- Drawn in due to pressure differentials
  - Stack effect
  - Exhaust fans



- Highest in lower levels.
- Upper floors not routinely tested

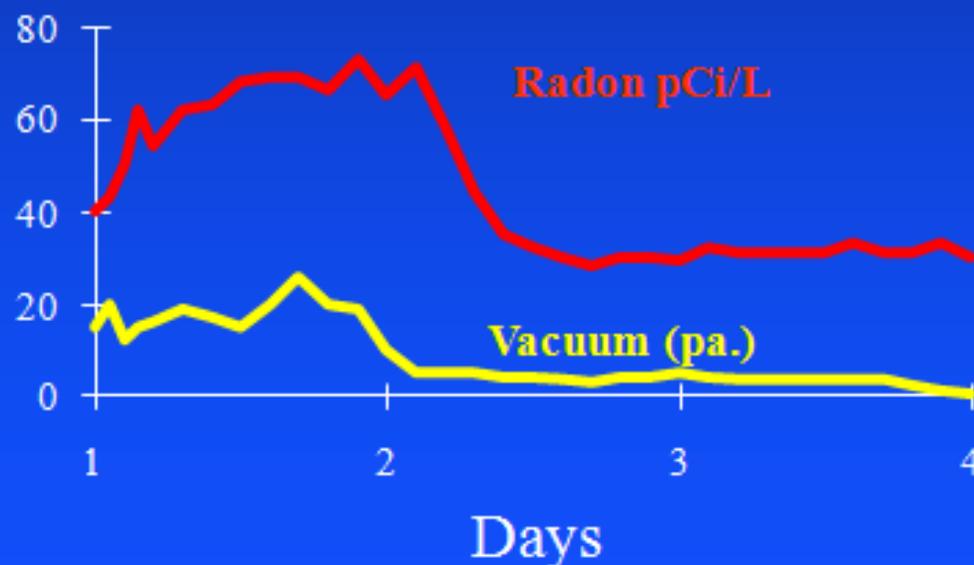
# How Is Radon Drawn Into A Building?



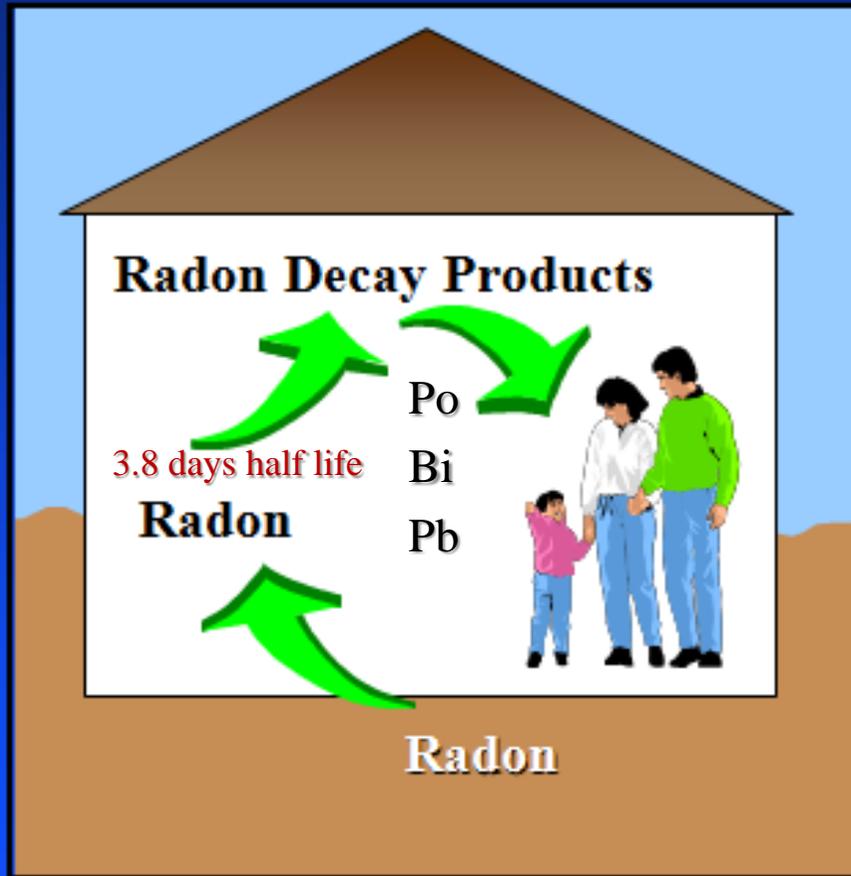
## ■ Vacuum

◆ Exhaust systems

◆ Thermal stack effects

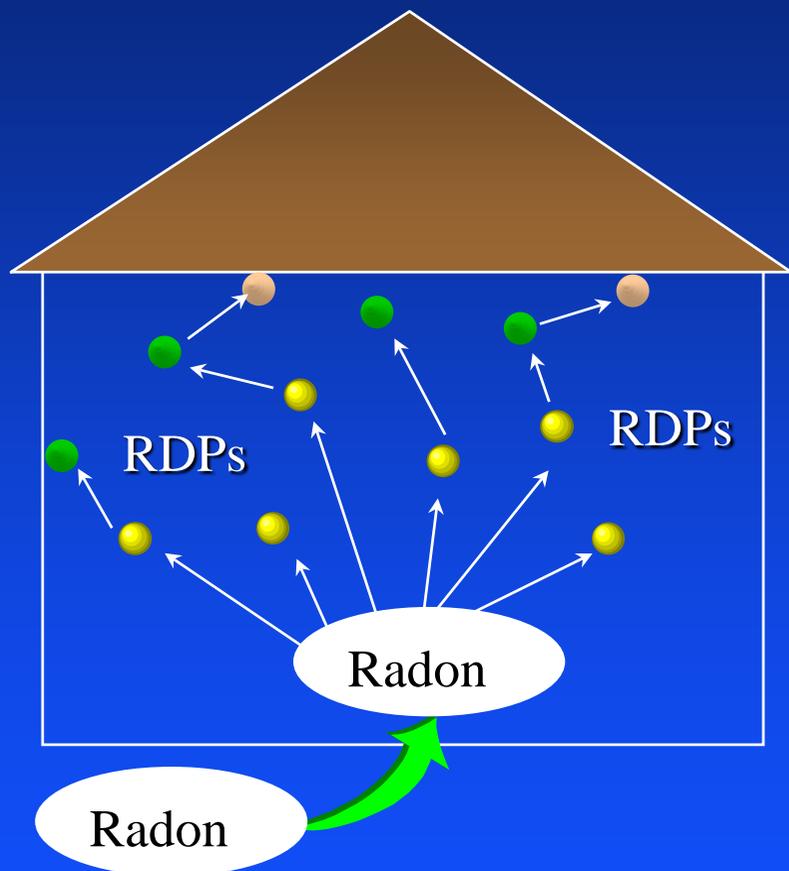


# Why Is Radon A Concern?



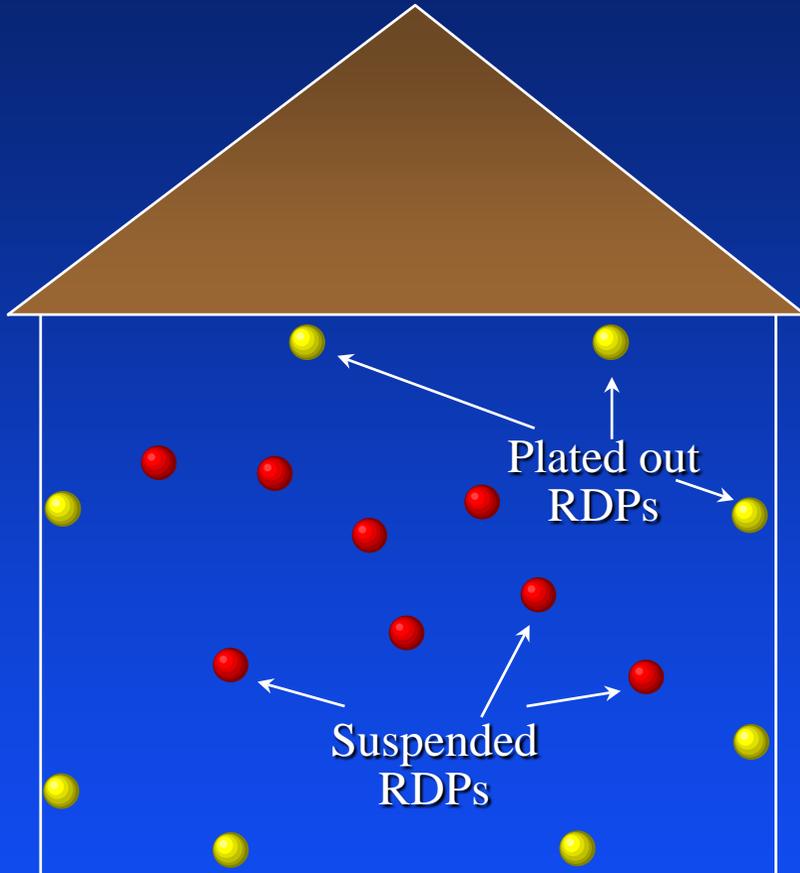
- Radon decays into radioactive particles known as radon decay products.
- These particles are easily inhaled and deposited in the lungs where they can damage sensitive lung tissue.

# What Happens to Radon Decay Products ?



- RDPs have electrostatic charges
- If they come in contact with objects (walls, furniture), they stick to them.
  - This is called “Plate-out”
  - If plated out - no longer a health risk since they cannot be dislodged and reenter the breathing space.
- Degree of plate-out affects actual risk presented by a given amount of radon.
  - Greater the plate-out - Lower the exposure
  - Lower the plate-out - Higher the exposure

# Equilibrium Factor (EF)

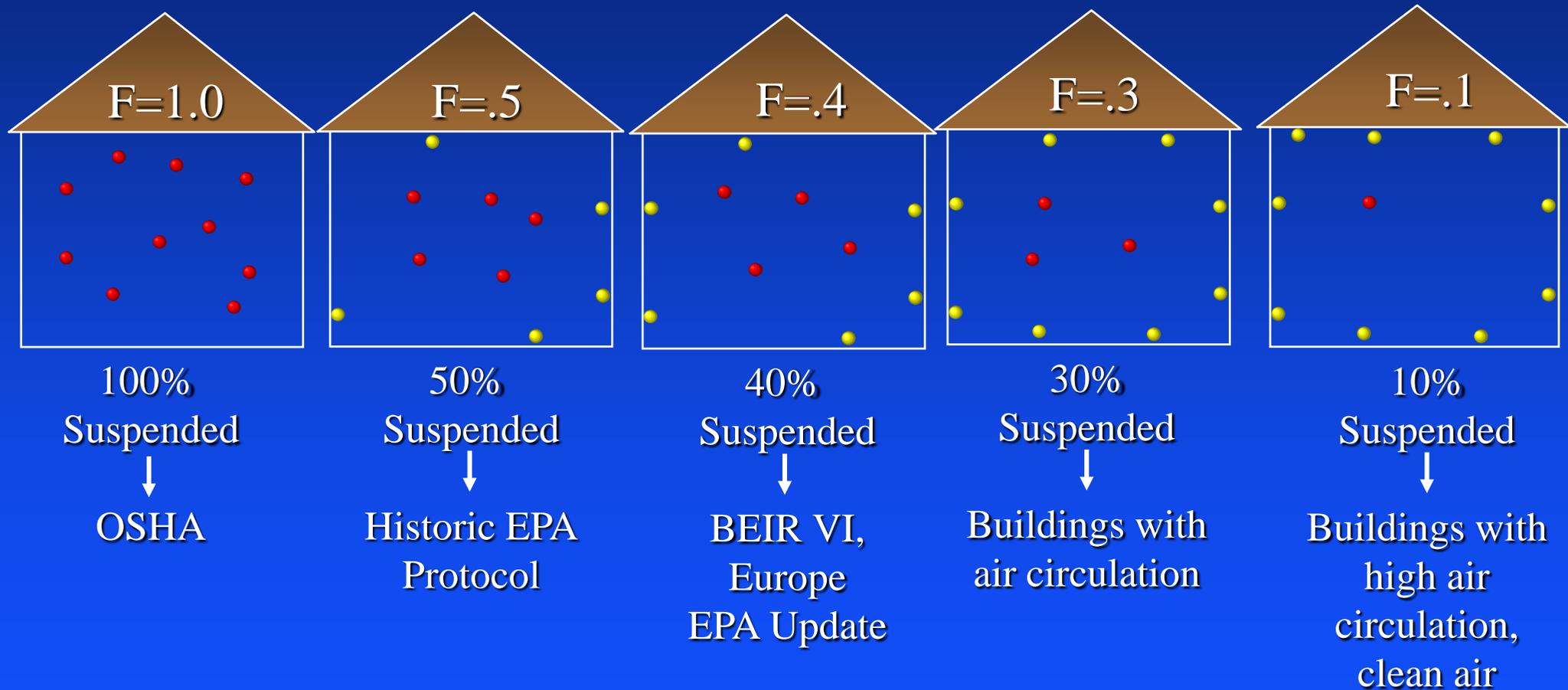


- Equilibrium Factor –  
The fraction (or percentage) of RDPs suspended in the air relative to the total RDPs created.

- $$EF = \frac{\text{Suspended RDPs}}{\text{Total RDPs}}$$

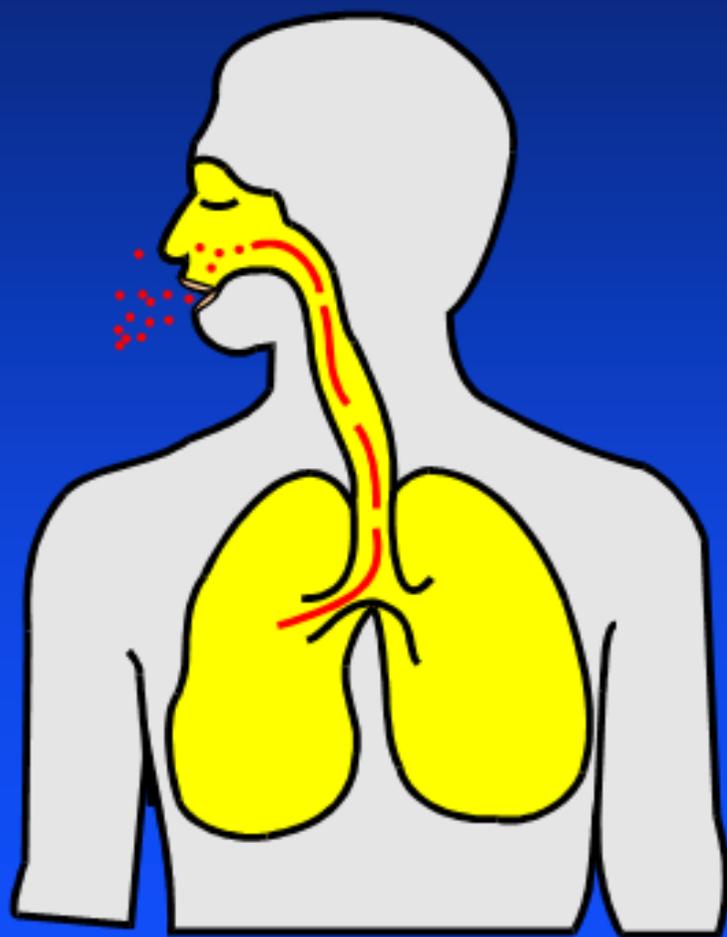
Current EPA Risk Assessments assume  
40% of radon decay products remain airborne

# The Degree of Plate-Out Impacts RDP Exposure from Radon



**F = Equilibrium Fraction**

# Radon Is A Lung Cancer Causing Gas



- Radon decay products inhaled.
- Particles irradiate lungs.
- Irradiation can cause lung cancer.

# Alpha Particles Are Strong Enough To Pit Plastic

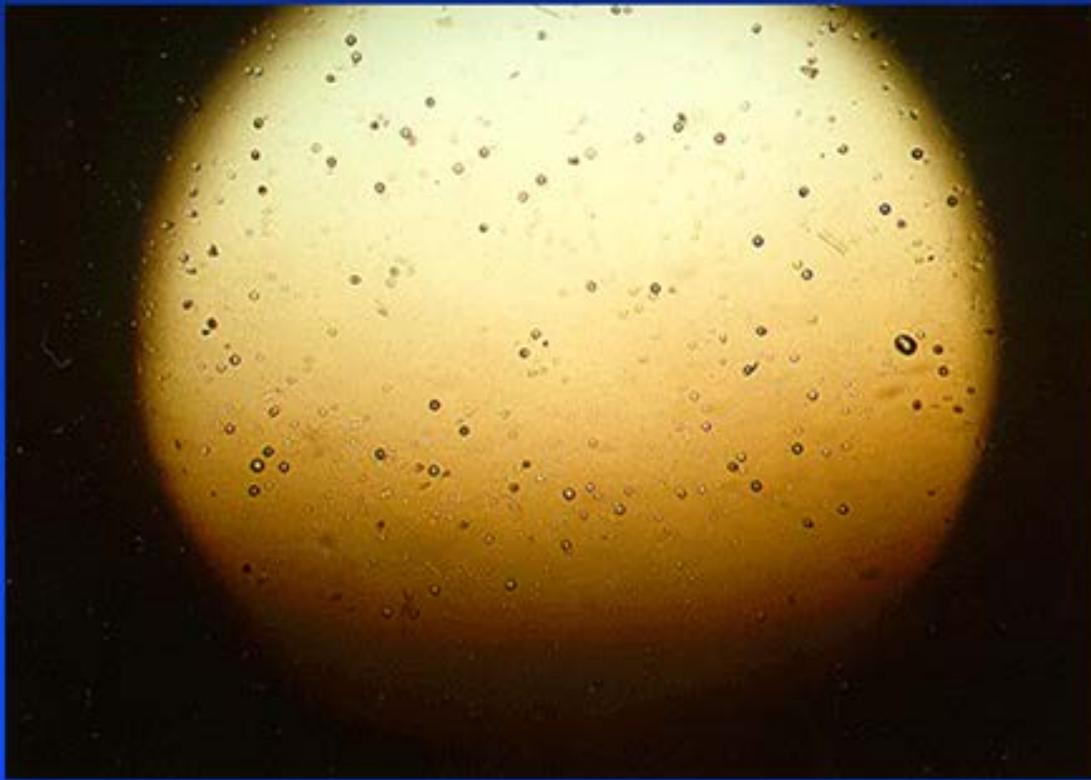
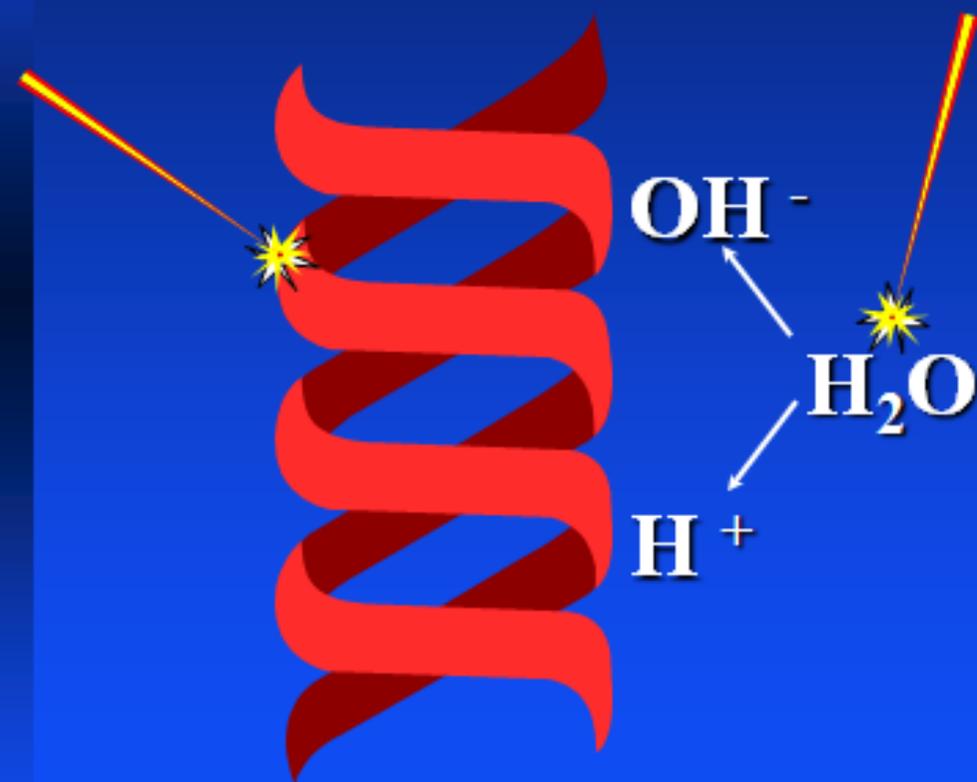


Photo: Dr. J.F. Burkhart

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

# What Happens When Radon Decay Products Are Inhaled?



- Highly radioactive particles stick to lung tissue, where they can irradiate sensitive cells.
- Radiation can alter the cells, increasing the potential for cancer.

Chromosome 6, P53 gene impacted

# Scientific Basis For Radon Risk Estimates

- Studies on miners
  - ◆ Uranium miners in U.S. and other countries
- Studies on residential occupants
  - ◆ On-going and as a group confirm application of miner data to residential exposures
- Studies on laboratory animals

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

WHO: 2.7 pCi/L

Residential Guidance but is  
often applied to workplaces

Indoor average: 1.3 pCi/L

Outdoor average: 0.4 pCi/L



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

The Guide To Protecting  
Yourself And Your Family  
From Radon



# How Does Radon Rank As A Cancer Causing Agent?

- Radon is ranked as a Group A carcinogen
  - ◆ Highest ranking for cancer potential
  - ◆ Known to cause cancer in humans
  - ◆ Tobacco smoke and tobacco products in same category
- Provides basis for regulatory and liability concerns!

# Short And Long-Term Testing Devices Help Determine the Need for, and Effectiveness of, Radon Mitigation

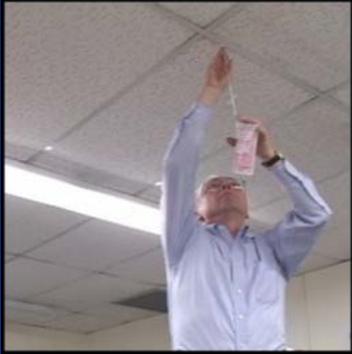


# Follow-Up – Hourly Measurements



- Continuous Monitors
  - Records hourly
  - Runs for 2+ days
  - Provides insight into conditions during occupancy

# Testing Methodologies



## Short-Term

- Minimum 2 day duration
  - Closed 12 hours prior
  - Can be extended if device allows
- Closed building conditions
  - Any test up to 90 days requires closed building conditions
- Indicates radon potential



## Long-Term

- Minimum 91 day duration
  - Can be up to a year
- Normal lived in conditions
  - No closed building requirement
- Can be better average of exposure
  - Not always the case in large buildings

# EPA US Map of Radon Zones

## EPA Radon Zones

with State Information

For radon information in locations outside of the continental United States please use the links below to view that location on the map:

Hawaii  
Guam  
Puerto Rico  
Virgin Islands  
Alaska

### LEGEND

#### State Radon Information



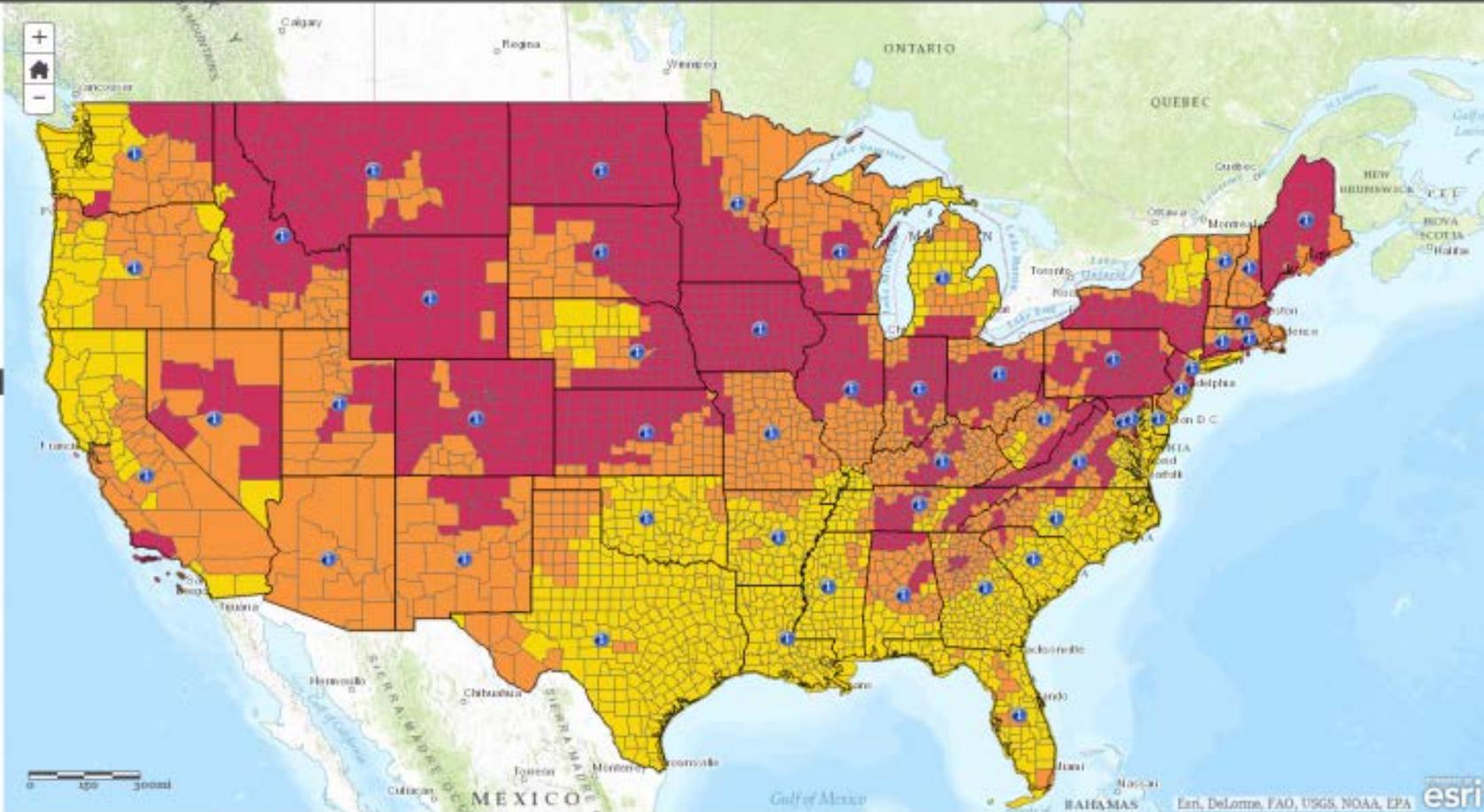
#### USA States Boundaries



#### Radon Zones by County

##### Radon Data

- Zone 1: Counties with predicted average indoor radon screening levels greater than 4 pCi/L
- Zone 2: Counties with predicted average indoor radon screening levels from 2 to 4 pCi/L
- Zone 3: Counties with predicted average indoor radon screening levels less than 2 pCi/L



# California Radon Map

## CALIFORNIA - EPA Map of Radon Zones

<http://www.epa.gov/radon/zonemap.html>

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 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.

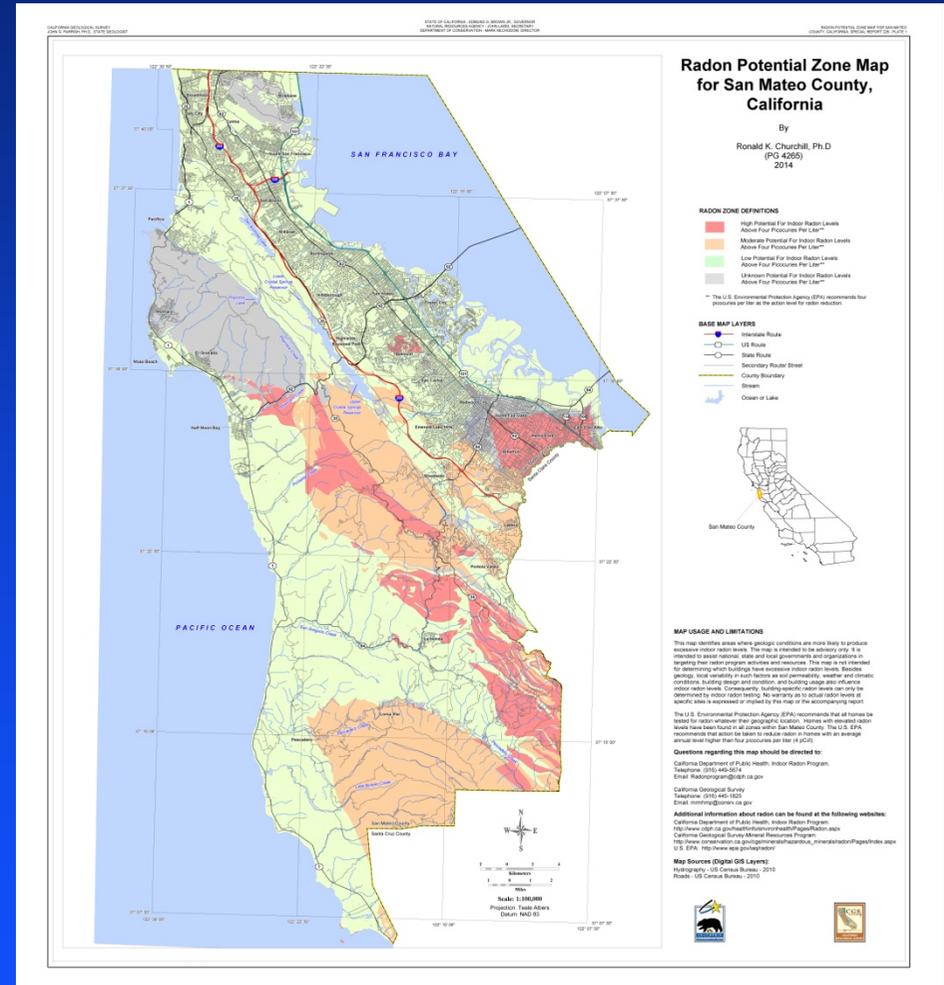
*All homes should be tested, regardless of zone designation.*

**IMPORTANT:** Consult the publication entitled "Preliminary Geologic Radon Potential Assessment of California" (USGS Open-file Report 93-292-1) before using this map. See <http://energy.cr.usgs.gov/radon/rpinfo.html>. This document contains information on radon potential variations within counties. EPA also recommends that this map be supplemented with any available local data in order to further understand and predict the radon potential of a specific area.



# San Mateo Co. Radon Map

- Regional radon maps are being developed by CA-DPH, Indoor Radon Program in collaboration with the California Geological Survey



# Residential Testing



- Single test location depending upon purpose
- No significant differences from room to room on same level of structure

# Large Buildings

- Significant room to room differences can occur
- Random sampling should be avoided

T	2.0	2.6		S		T	0.8	1.0	1.6
			2.1	1.9		S			
2.9	3.6	7.1	7.2	2.4	1.7	1.1	0.6	1.1	
		1.6		1.4					
								1.0	0.9
								1.2	

# Robust HVAC Systems in Large Building Can Dramatically Affect Radon Entry

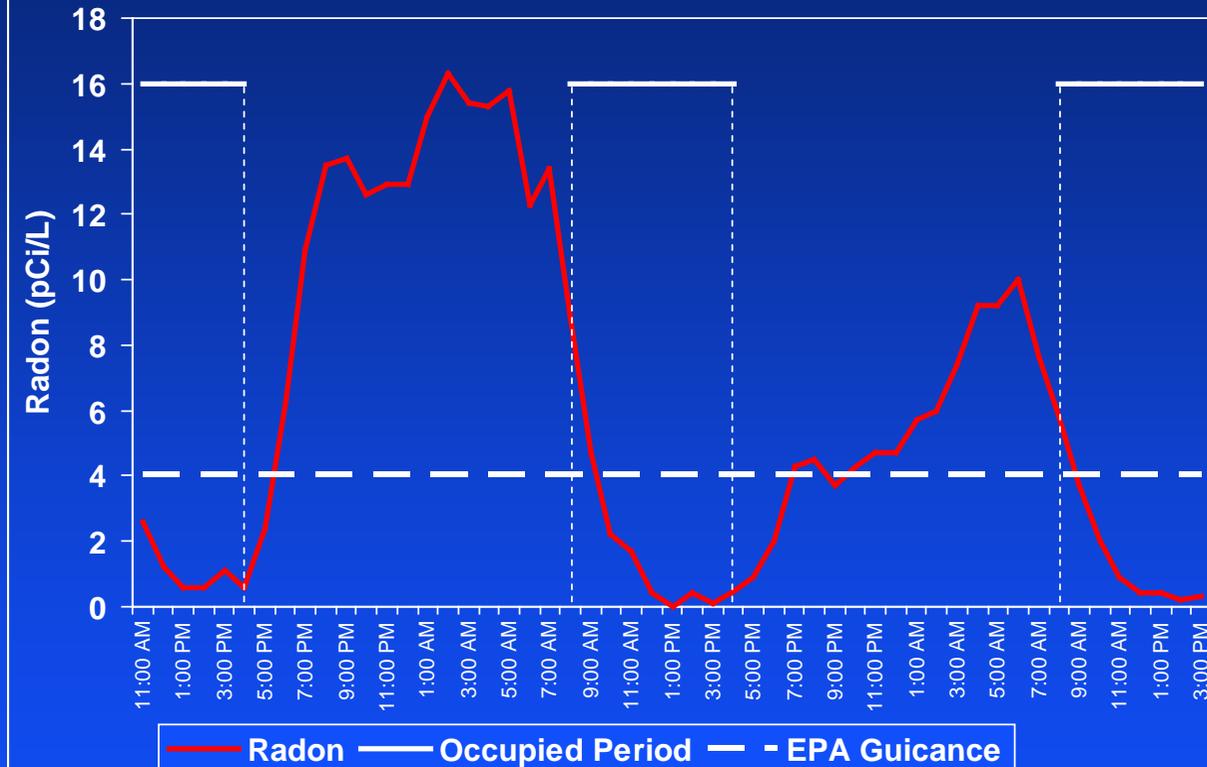


Roof Top HVAC Unit with  
Fresh Air Make-Up

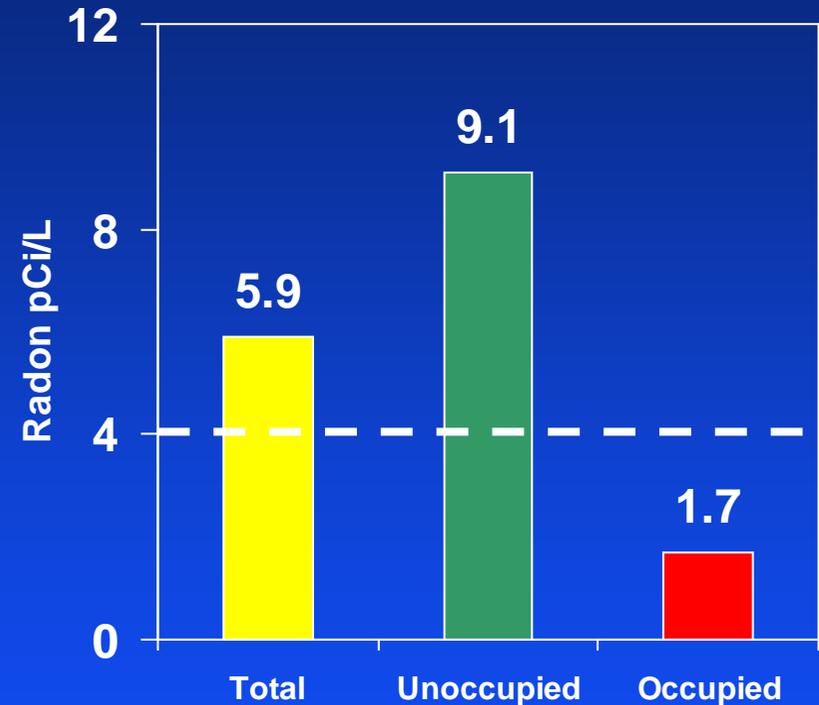
- Pressure differences
  - Stack effect – like homes
  - HVAC Systems
    - Fresh air make-up can reduce radon
    - Unbalanced or poorly maintained systems can increase radon.

# Effect of Outdoor Air

## Hourly Variations

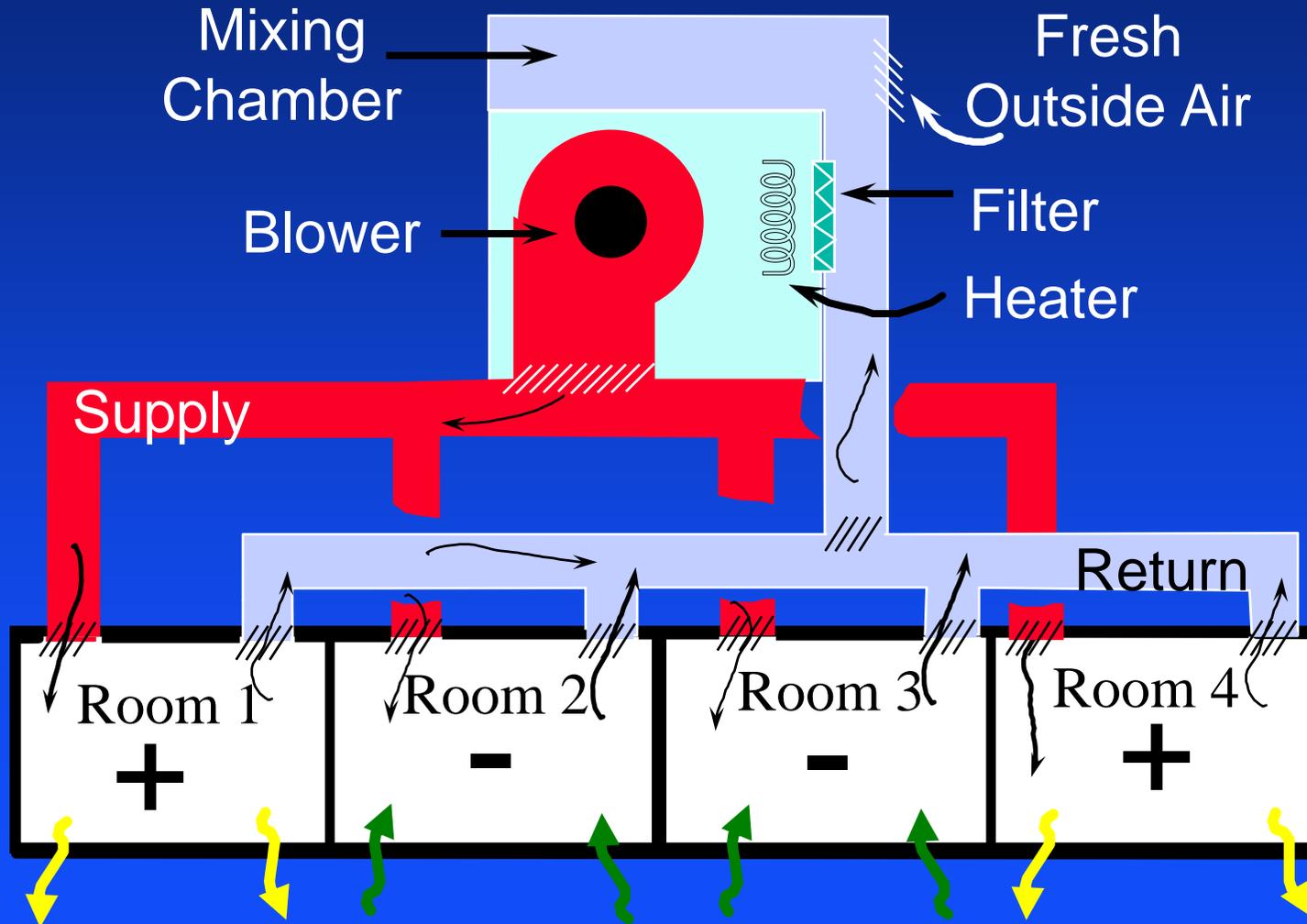


## Averages by Period



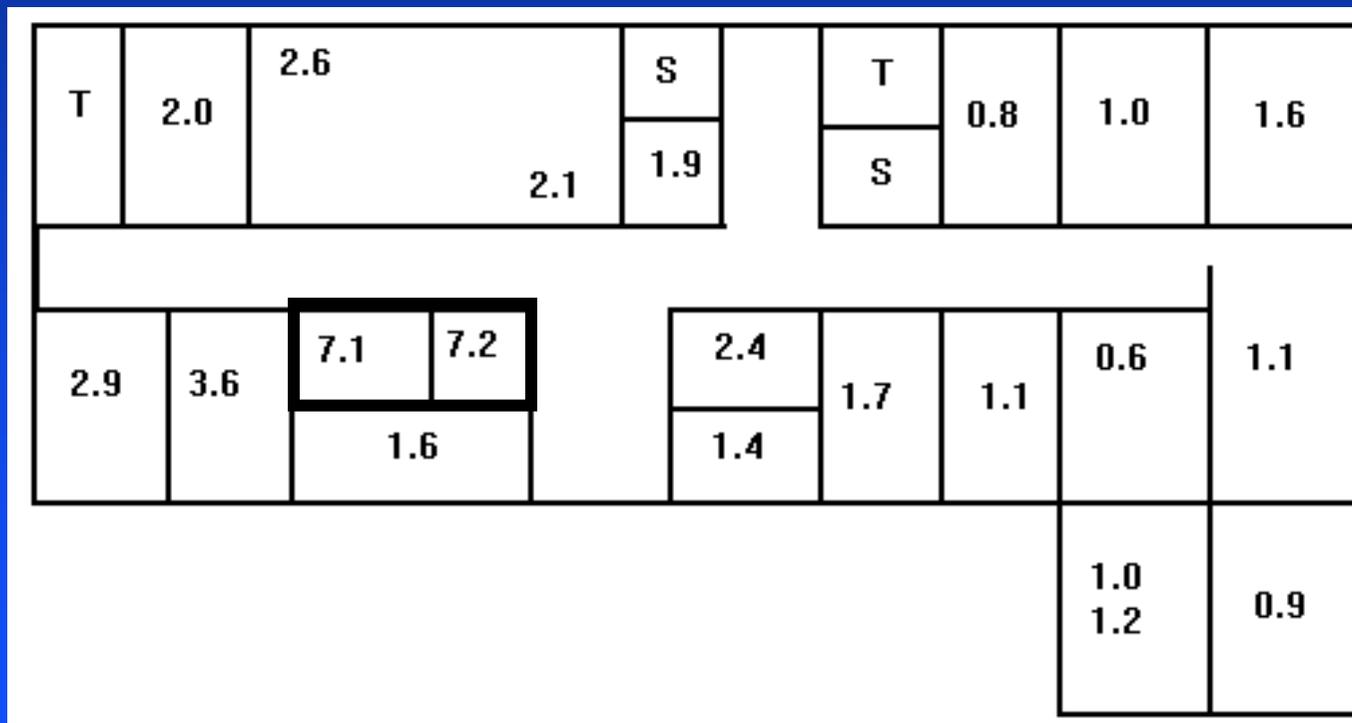
- Occupied periods assumed to be: 7:30 AM to 3:30 AM
- Period: April 18-20, 2007
- Hourly measurements are average for preceding hour test

# Effect of Unbalanced System

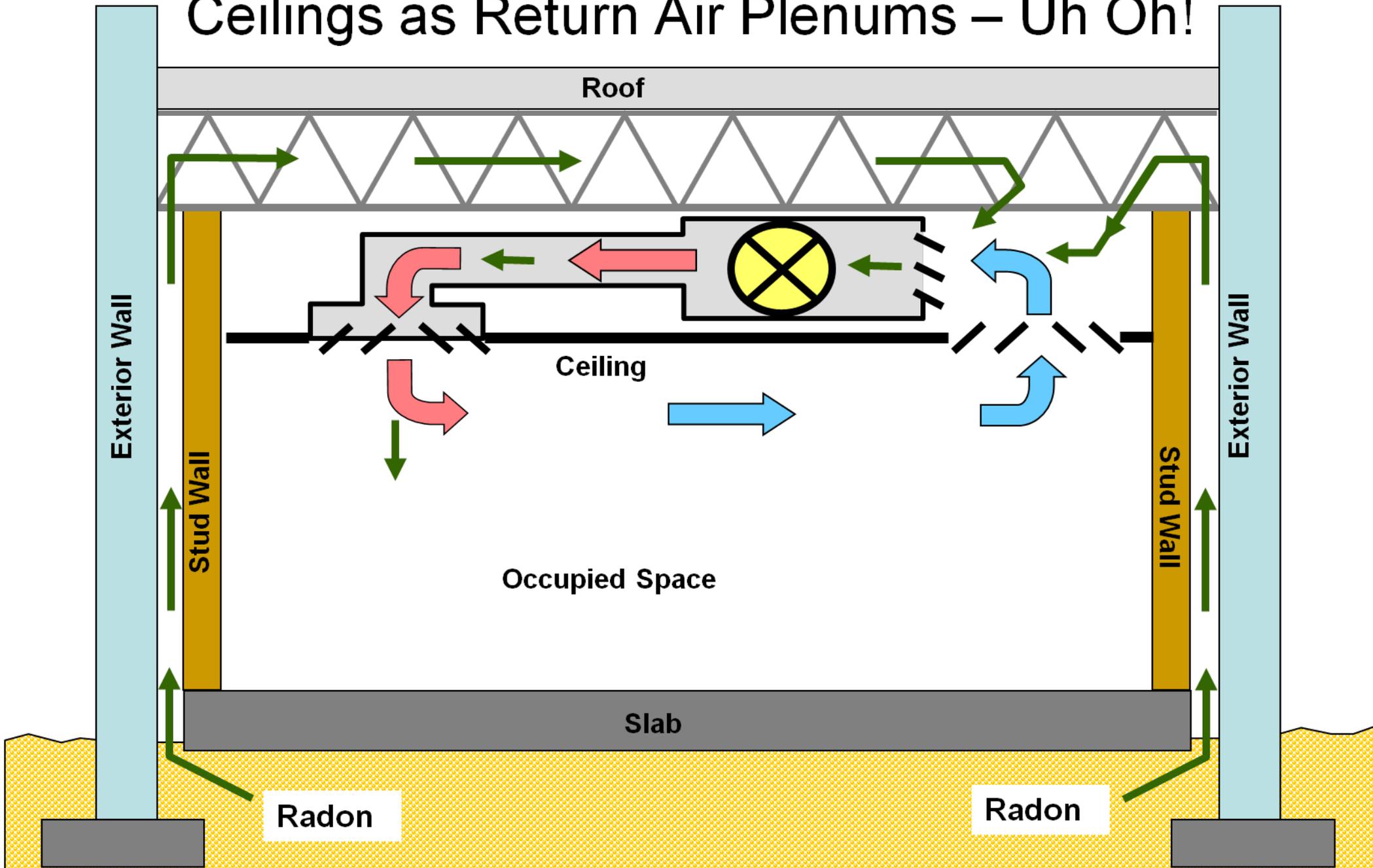


# Example: Unbalanced Ductwork

- Room divider added
  - Supply on one side
  - Return on other side



# Ceilings as Return Air Plenums – Uh Oh!



# The EPA Testing Protocols For Schools

Step 1

Short-Term Test

Equal to, or  
greater than 4 pCi/L?

No

No  
Mitigation  
Recommended

Step 2

ST > 10 pCi/L

Follow-up Test

ST < 10 pCi/L

Repeat Short-Term

Long-Term Test

Average of  
1st and 2nd results  
at or above  
4 pCi/L?

No

No  
Mitigation  
Recommended

Yes

Mitigation  
Recommended

Yes

Results of  
long-term test  
at or above  
4pCi/L?

No

No  
Mitigation  
Recommended

# Planning the Survey – When?

## ■ HVAC System

- When operating normally
- When economizers are not typically in use
- After major building or HVAC modifications

## ■ Schools

- During normal school week (not weekends or holidays)

## ■ Offices

- During work week

## ■ Apartments

- Weekdays (for short-term testing)

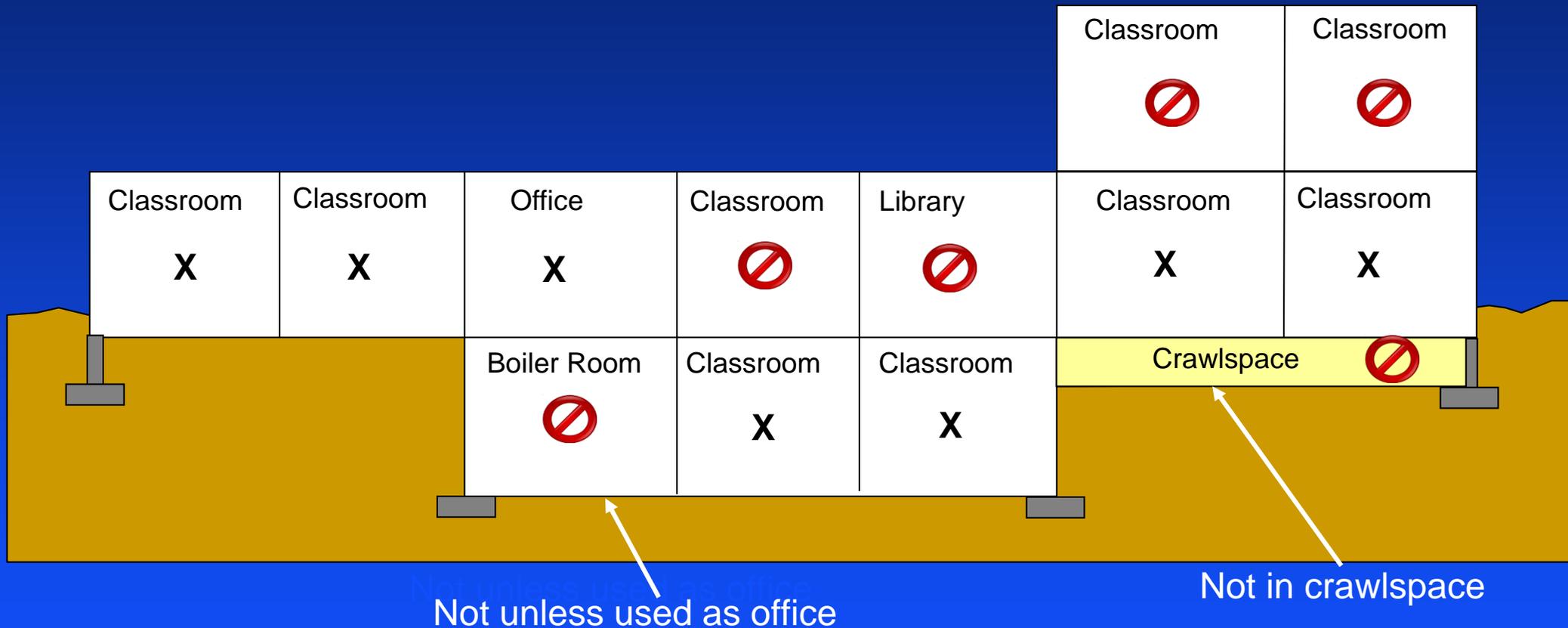


# Where to Test

Take initial measurements using a short-term test. Short-term measurements should be made in **all frequently occupied rooms in contact with the ground** to provide a quick test of whether or not high radon concentrations are present. **All rooms should be tested simultaneously.**

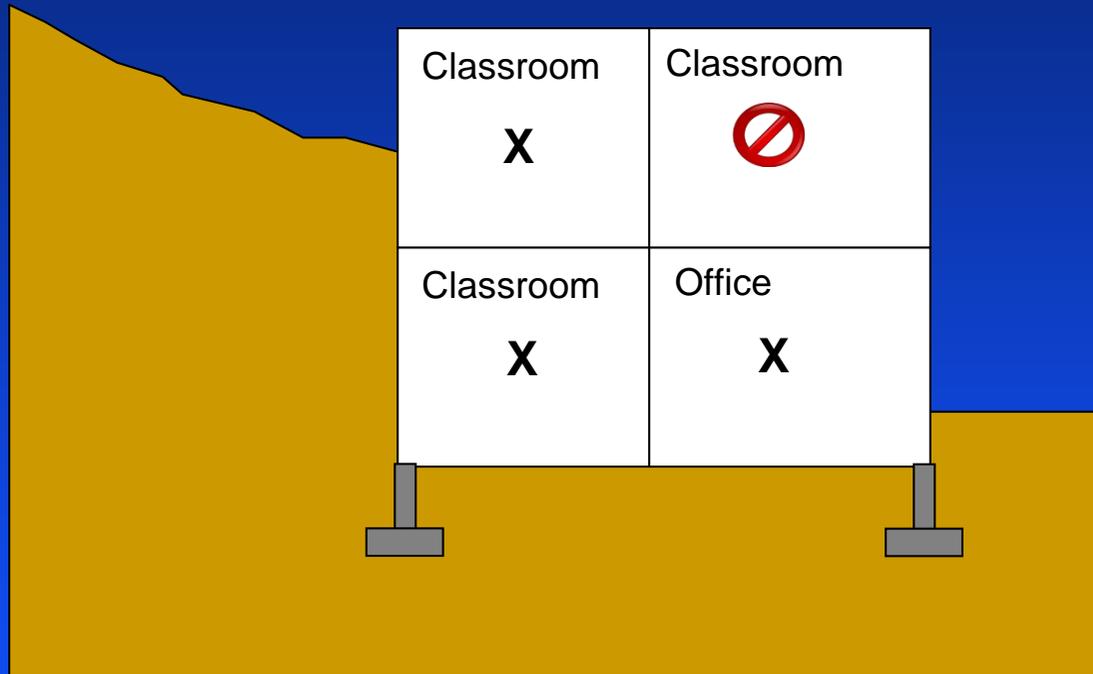
- All frequently occupied rooms in contact with the ground.
  - Frequent???
    - Several governmental agencies determined 1 hour = occupancy
    - Recommendation:
      - If it can be occupied: **Test it!**
      - Office/classroom currently used as storage: **Test it!**
      - Temporary classrooms/facilities
- Test them at the same time
  - Allows comparison

# Lowest Locations in Contact with Soil

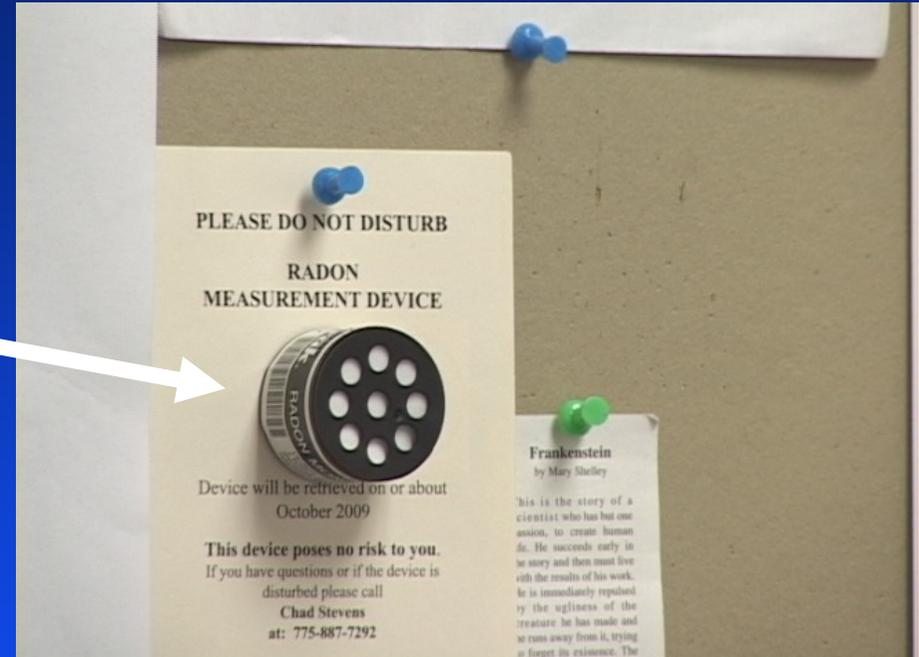
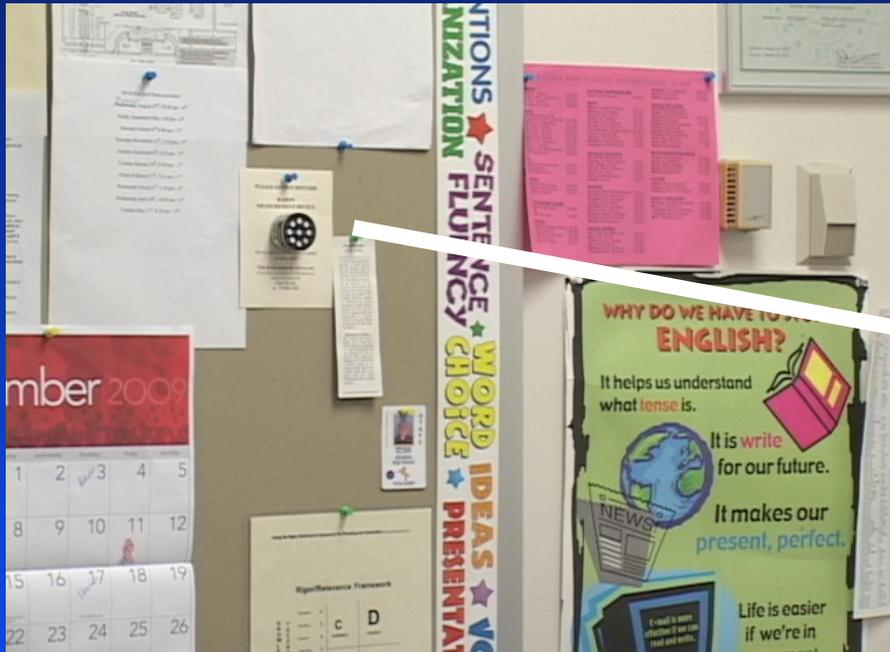


Note: This does not preclude rooms in upper levels being elevated, but short-term test will identify potential concern in building

# Rooms in Contact with Soil



# Long-Term Device Deployment- Wall



- Alpha track device attached to card - attached to wall or bulletin board
  - Explains device
  - Who to call
  - When it will be retrieved

# Long-Term Device Deployment - Ceiling



- Devices can be hung from ceiling
  - Up for several months
  - Does not require closed building conditions
  - Tempting targets
- Insure teacher is notified as to what it is
  - Not a video camera or a listening device!

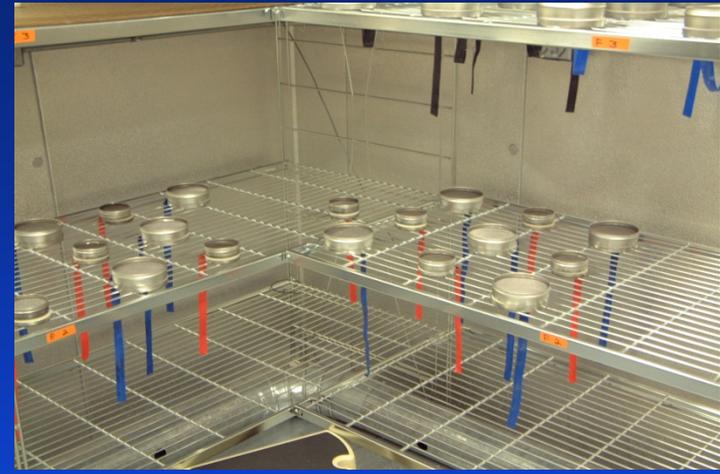
# Quality Assurance and Quality Control Devices



Field Blank



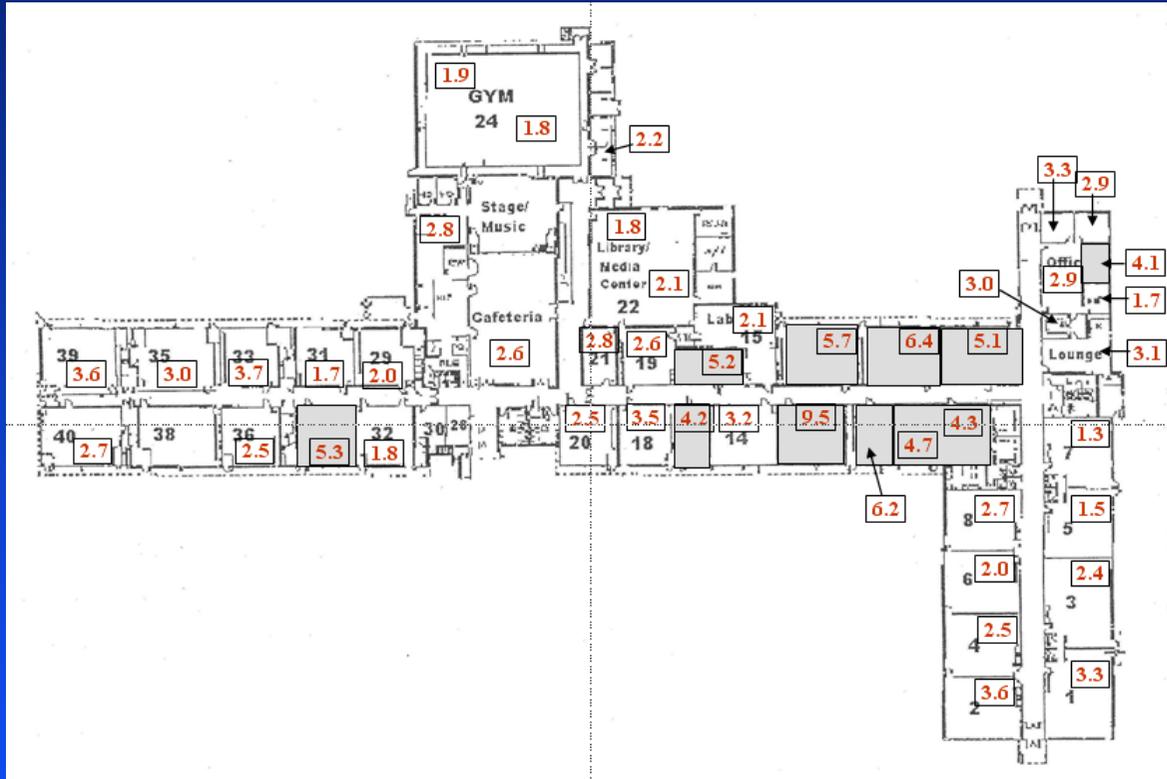
Duplicate



Spikes

- Provides basis for determining confidence in results
  - Duplicates - 10% of locations
    - Avg of RPDs of duplicates (whose averages are above 4.0) < than 25%
  - Blanks - 5% (Should be at LLD of device - typically less than 1.0)
  - Spikes - 3% (Should be at least within 25% of chamber value)

# What Do Short-Term Test Results Mean?



- Every location in building has potential of the highest reading
- If conditions in low rooms become similar to conditions in high rooms - they can become elevated

- Look at entire school
  - Include low rooms in retesting program

# Multi-Family Dwellings



# The AARST-ANSI MAMF-12 Standard

ANSI/AARST Designation: MAMF-2012

An Approved American National Standard

ANSI AARST CONSORTIUM ON NATIONAL RADON STANDARDS

**Protocol for Conducting  
Radon and Radon Decay Product Measurements in  
Multifamily Buildings**

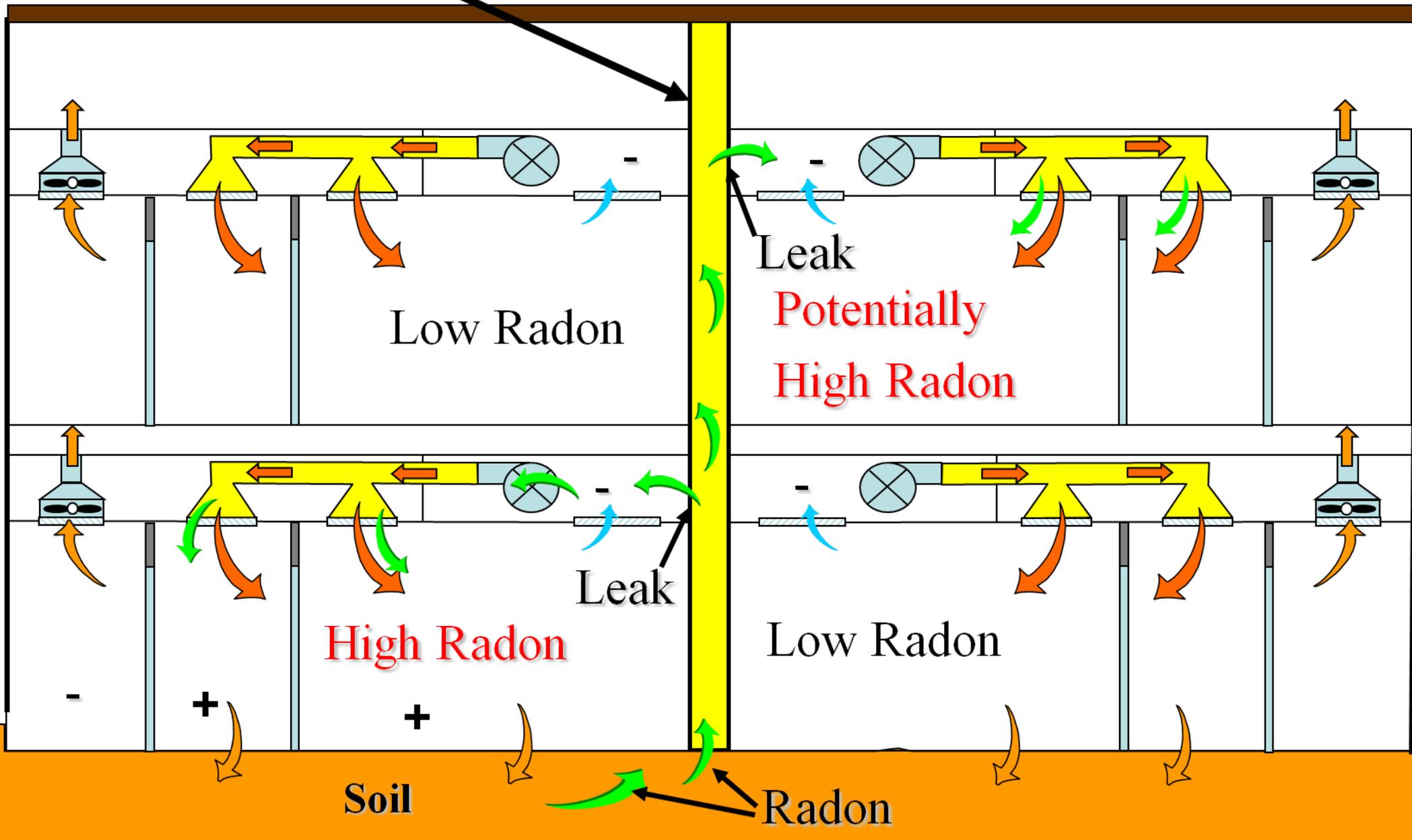
*For Residence Managers and Measurement Professionals*

AARST CONSORTIUM ON NATIONAL RADON STANDARDS  
www.radonstandards.us  
standards@aarst.org

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- This standard specifies procedures, minimum requirements and general guidance for measurement of radon and radon decay product concentrations in Multifamily buildings comprised of more than three attached dwellings.
- Specific testing protocols that include instructions on where to test, strategies for conducting reliable tests, reporting and associated quality control measures.

Pipe Chase open to dirt



# Multi-Family

- Test each ground floor unit
  - At least one location within apartment
    - Bedroom or living room
- AARST ANSI MAMF-2012 suggests additional 10% of upper floor units
  - Due to radon moving through vertical utility chases
- Test simultaneously
  - Long-term as initial approach easier due to difficulty for tenants to maintain closed building conditions.



# Case Study: Apartment Complex

# How would you conduct a survey here?



- 18 Buildings + clubhouse
- 332 Units
  - 116 1<sup>st</sup> floor
  - 108 2<sup>nd</sup> floor
  - 108 3<sup>rd</sup> floor

# What the Consultant Did

- Conducted short-term test in one ground floor apartment in 8 of the 16 buildings.
  - 7% sampling of ground floor units
  - 2% of all units
- Results
  - 1 out of 8 locations were elevated (25.6 pCi/L)
  - Recommendation: Mitigate the one unit that was elevated

**But what about the rest?**

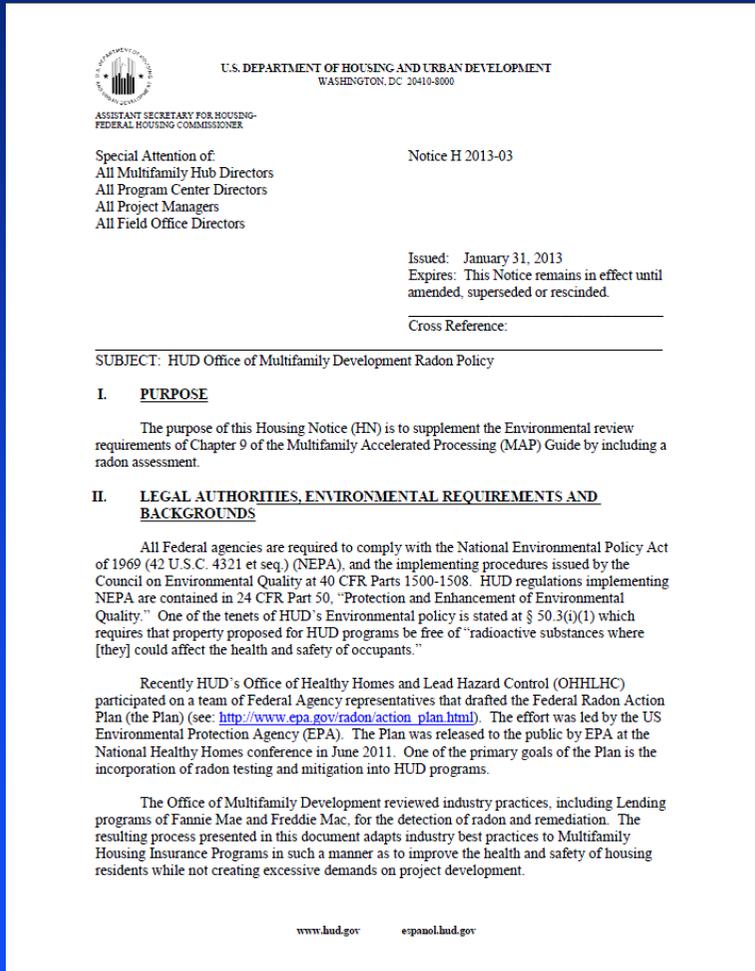
# Summary: Large Building vs. Single Family Dwelling Approaches

- Common to both
  - Use of approved measurement devices
  - Placement and retrieval protocols
  - QA/QC
- Additional Elements for Large Buildings
  - Multiple locations tested
  - Communication plan
  - Survey based QA/QC
  - More complex interpretation and reporting of results
  - Highly dependent upon HVAC system



# HUD & Radon in Multifamily Complexes

# HUD Radon Policy - January 31, 2013



- Requires Radon Testing in Multi-Family
  - 5 or more units
  - High Radon Areas
  - Rehab properties
    - Exception: Rehab is minor and located in low radon area
    - Exception: Refinance only
- Mitigation required if elevated levels found
  - 4 pCi/L Guidance
- Radon mitigation designed into new buildings
  - Zone 1: Passive
  - Zone 2 & 3: Radon Ready

# Radon Services Certification in California

## California Health and Safety Code:

California Health and Safety Code Section 106750-16795 states:

(a) Except as provided in Section 106790, no person may provide radon services for the general public, or represent or advertise that he or she may provide radon services unless that person meets both of the following requirements:

(1) Successfully completes the National Radon Measurement Proficiency Program of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board Certified Radon Professional Program.

(2) Submits to the department a copy of certificate demonstrating successful completion of either program.

# Radon Services Certification in California

- (b) Persons certified to provide radon services shall successfully complete and submit to the department proof of completion of the National Radon Measurement Proficiency Program of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board Certified Radon Professional Program every two years after initial certification.
- (c) A copy of the current certificate of completion shall be submitted to the department at least 14 days prior to conducting radon services within the state.

# Radon Services Certification in California

## Exceptions:

- Property owners can measure and mitigate
- New construction – many architectural firms are now aware of “radon resistant” construction
- Research purposes
  - Person doing the research informs building occupant that he/she doesn't hold certification
  - Inform building occupant that results are not certified and cannot be used for legal purposes
  - Mitigation methods suggested are considered experimental

# AARST – NRPP Certification

## Residential \*Measurement Provider Qualifications:

- Attend a NRPP approved entry level measurement course (usually 16 hours; available online)
- Pass a NRPP radon measurement exam in the last 12 months previous to application
- Develop a simple QA/QC plan which includes the use of duplicates, blanks and spikes as described in US EPA radon in air measurement protocols

*\*A large/multiple building certification is in development*

# AARST – NRPP Certification

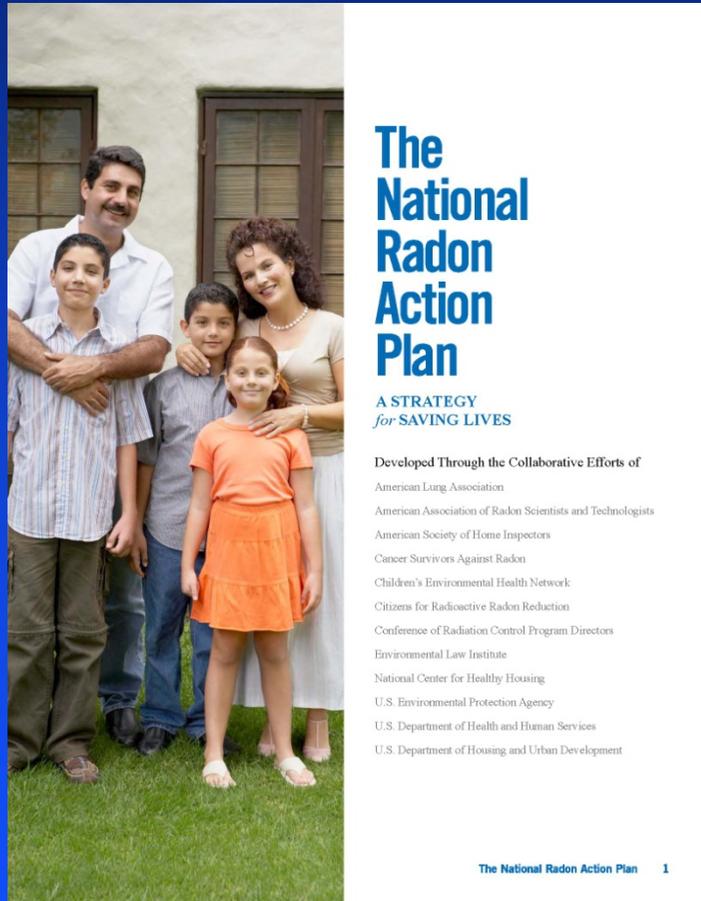
## Residential Measurement Providers Using Field Analytical Devices (CRM, CWLM, and E-PERM)

- Follow an approved QA/QC plan for the device
- Provide proof of calibration(s) prior to use of the device(s)
- Pass an initial performance test of the device

# AARST – NRPP Certification

- Certification is given for a two-year period
- Re-certification requires 16 hours of continuing education credits that can be achieved in several ways.
- Code of Ethics

# The National Radon Action Plan



- The (2015) National Radon Action Plan presents a long-range strategy for eliminating avoidable radon-induced lung cancer in the United States.
- The Plan's near-term goals are to reduce radon risk in 5 million homes and to save 3,200 lives by 2020.

# Radon Information Resources

- [www2.epa.gov/radon](http://www2.epa.gov/radon)
- [http://www.who.int/ionizing\\_radiation/env/radon/en/](http://www.who.int/ionizing_radiation/env/radon/en/)
- <http://www.cdph.ca.gov/healthinfo/environhealth/Pages/Radon.aspx>
- [www.aarst.org](http://www.aarst.org)
- [www.certi.us](http://www.certi.us)