ANS® EDUCATOR TRAINING

K-12 Classroom Investigations

Exploring Background Radiation

Thursday, May 16

This event is presented by ANS in partnership with the Department of Energy, Office of Nuclear Energy.

Exploring Background Radiation
Collecting Radioactive Particles from the Air

Candace Davison
Zachary Van Horn
Pennsylvania State University

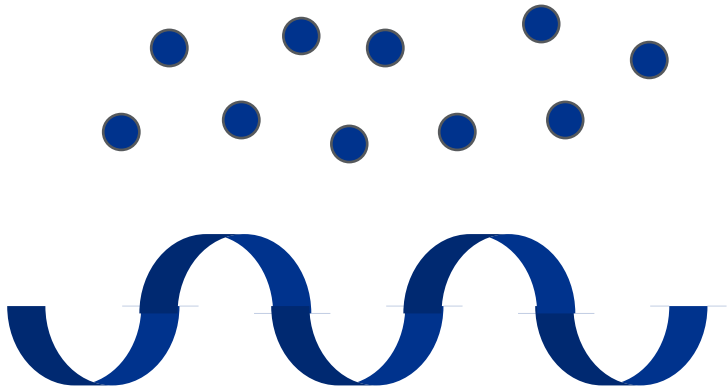
What is radiation?

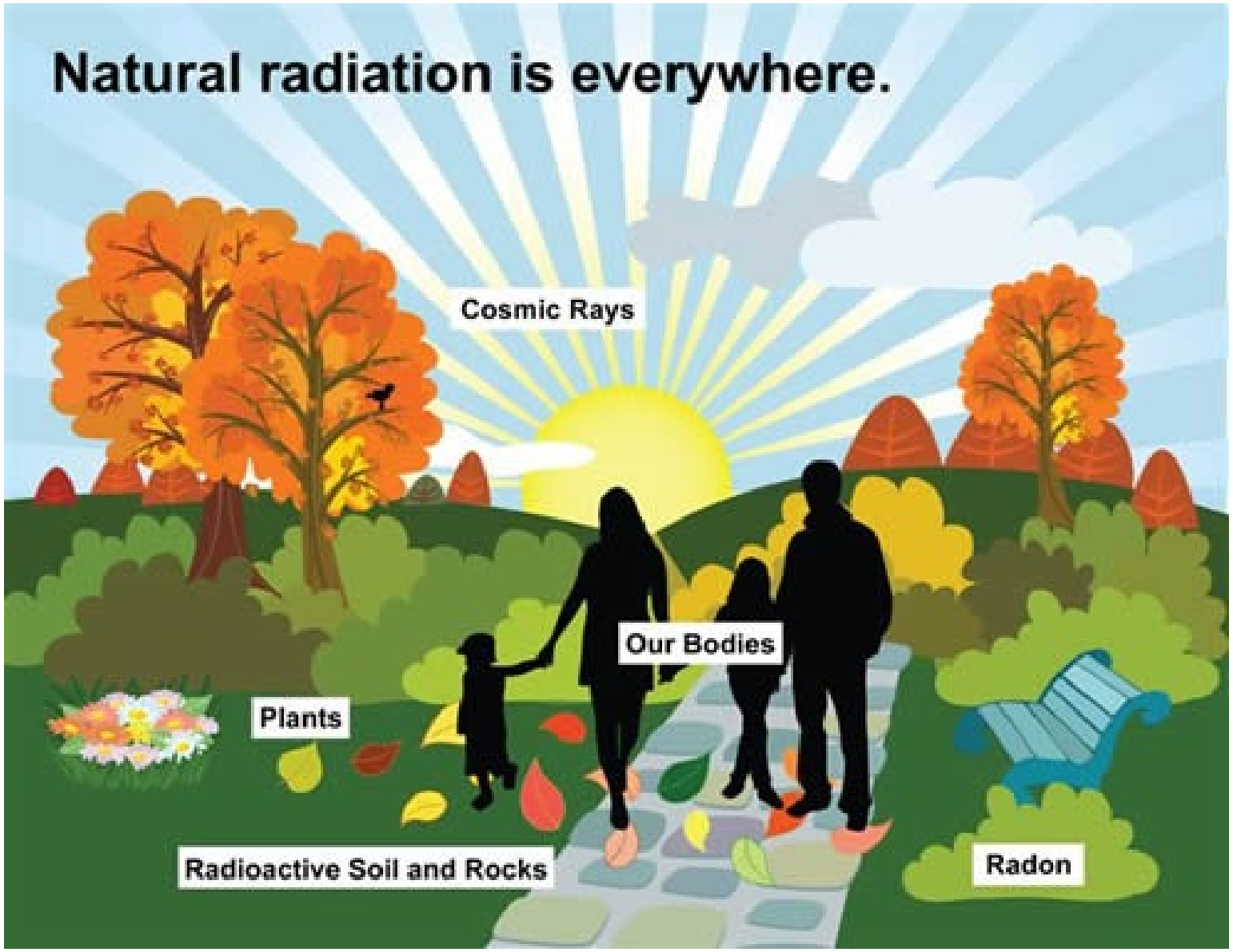
Transmission of Energy via

Particles

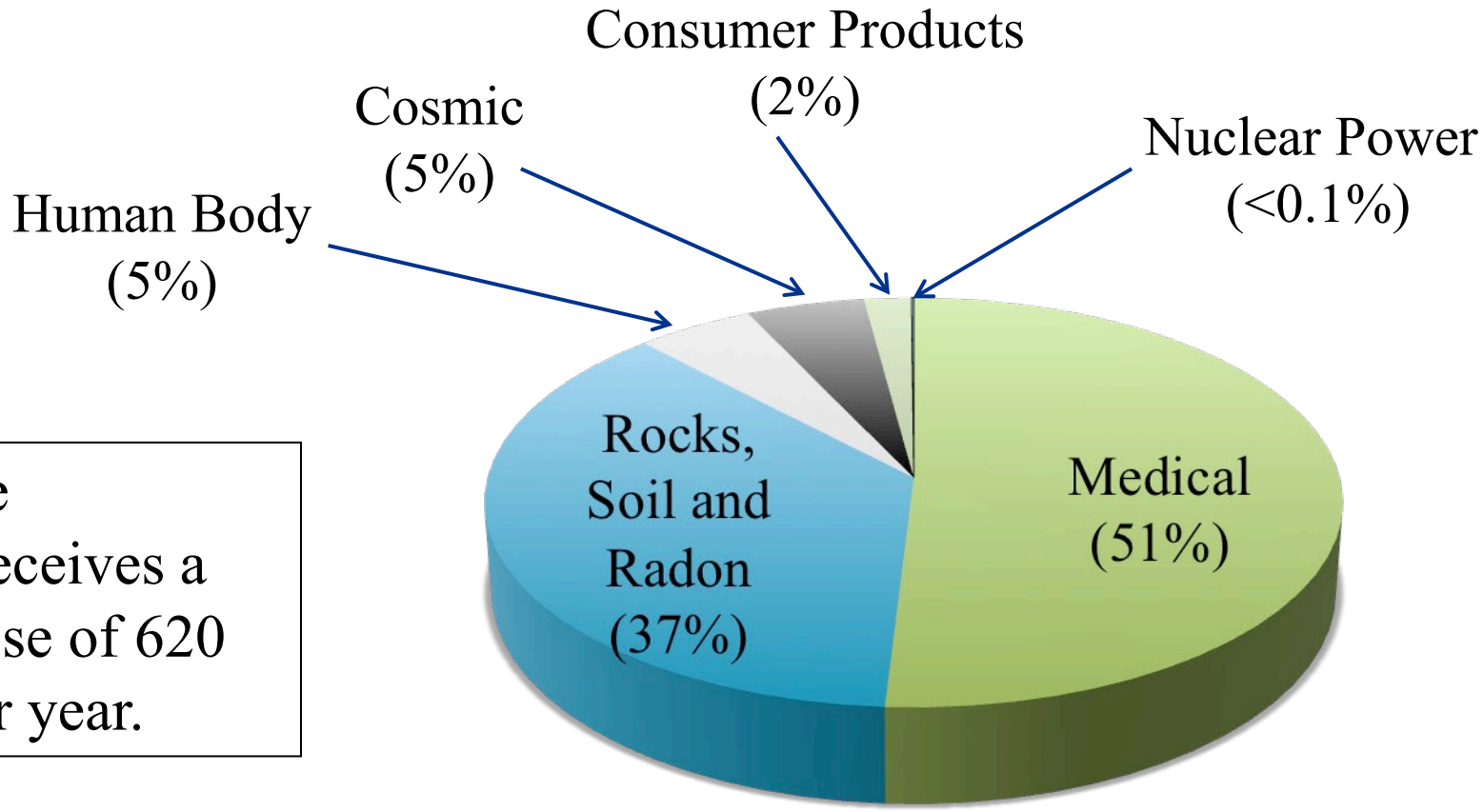
or

Waves



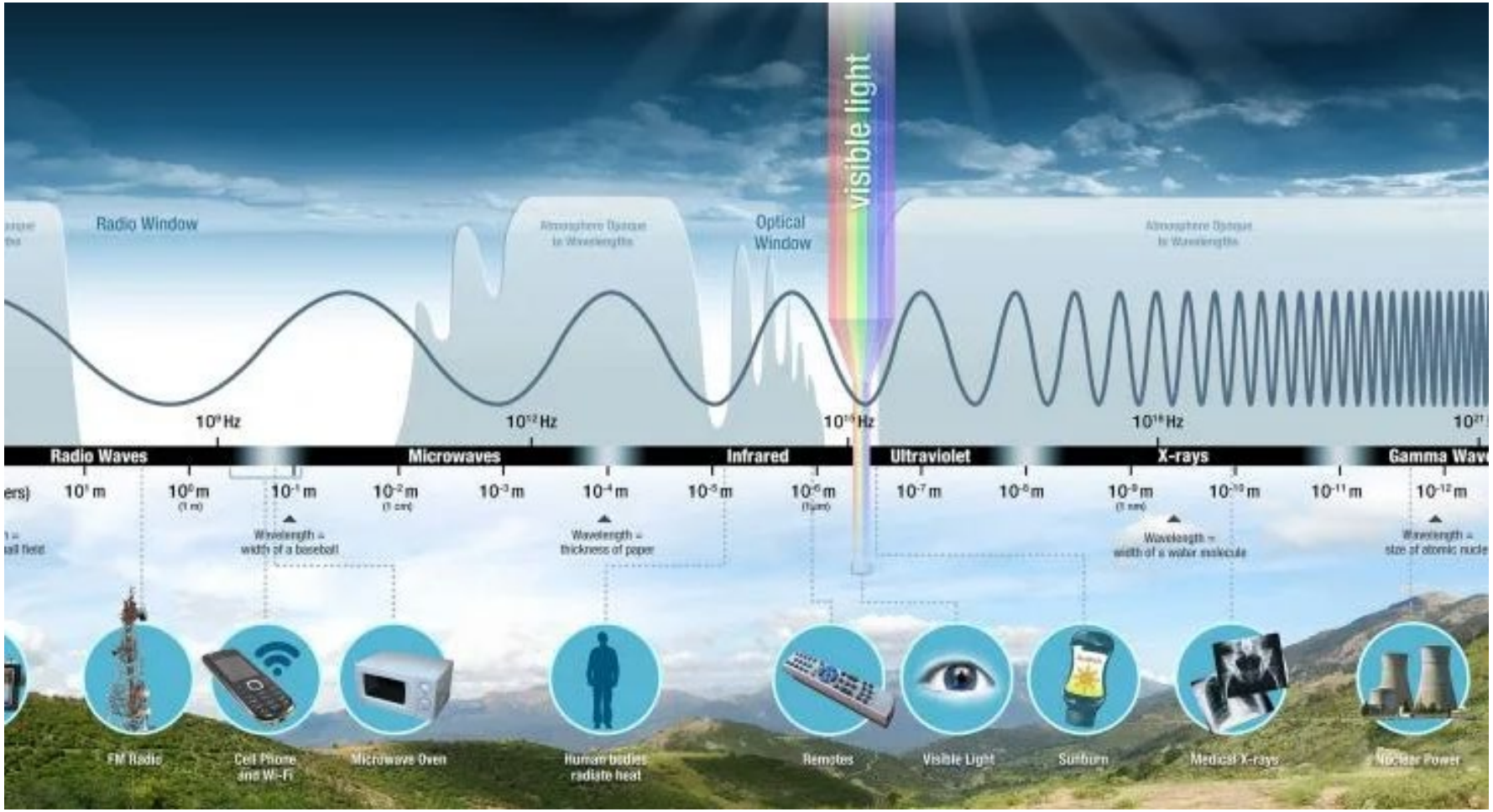

Natural radiation is everywhere.
Cosmic Rays
Our Bodies
Plants
Radioactive Soil and Rocks
Radon

Sources of average radiation dose in the US



The average American receives a radiation dose of 620 millirem per year.

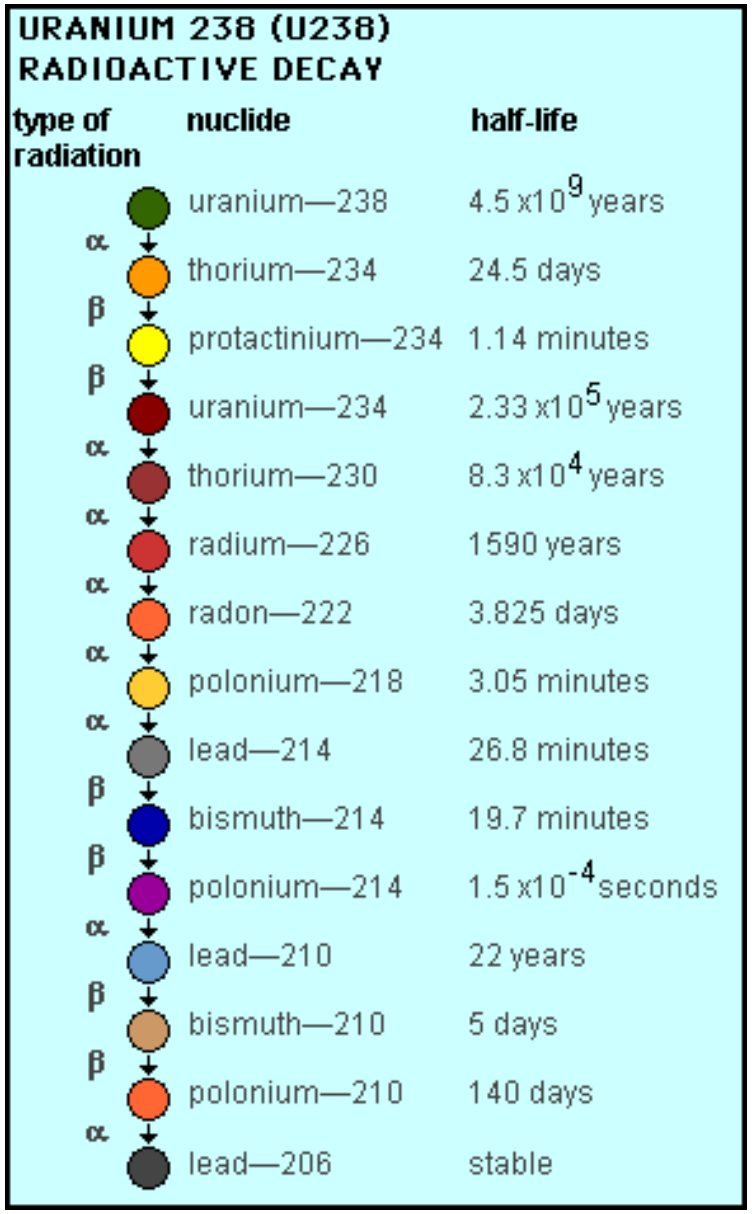
Electromagnetic Spectrum



Radiation detected

- Radiation detected on hands of Los Alamos National Lab workers who did not work with radioactive material.
- Investigation revealed workers played racquetball
- “Natural radioactivity collection by racquetballs” Investigation report HSE 84-4, May 1984 LANL, Los Alamos, NM

Any ideas?



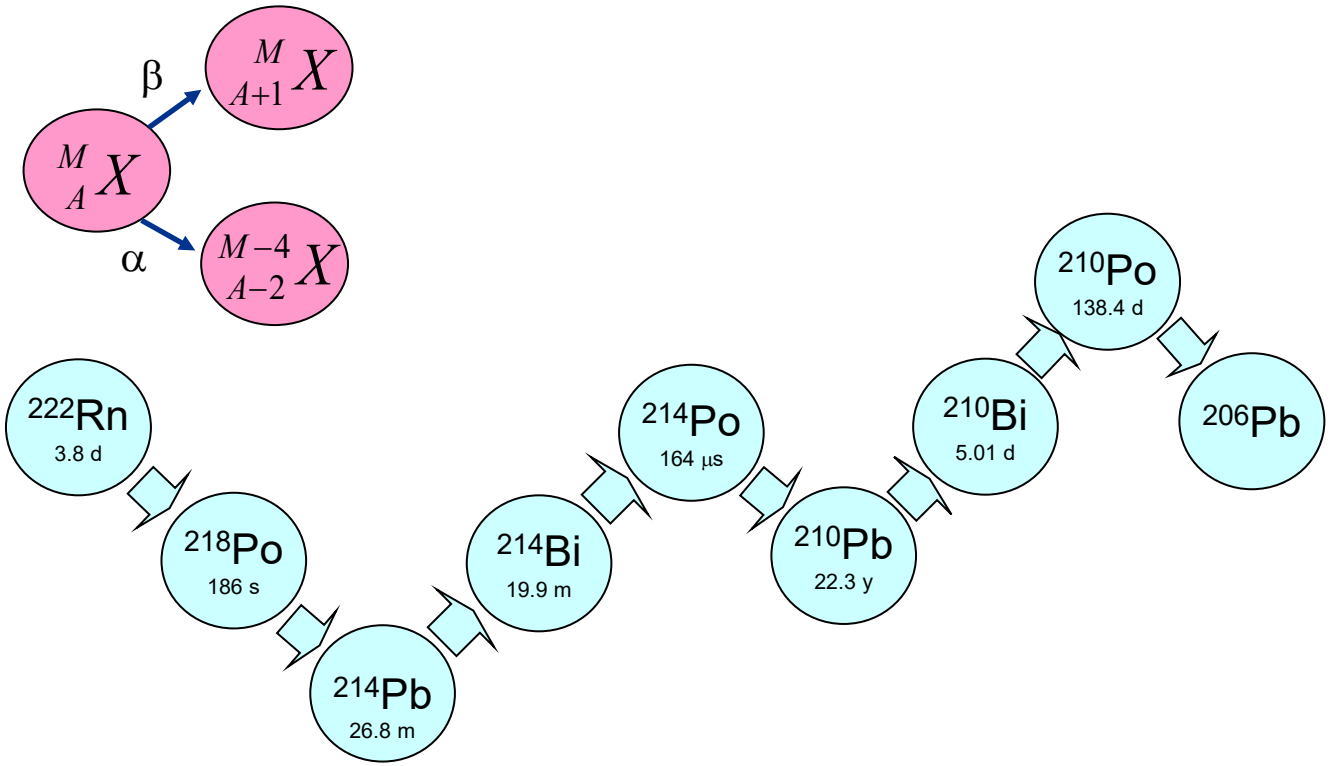
Uranium decay

Radon gas is produced by the decay of naturally occurring uranium in soil and water

What is radon?

- Radon is a colorless, odorless, tasteless and invisible “noble” gas
- Radioactive gas
- Gas moves through rock and soil into atmosphere
- Radon can “collect” in enclosed spaces

Radon decay products



Collecting radioactive particles from the air

1) Vacuum cleaner with coffee filter or medical gauze

2) Bouncing Racquetballs – Source: The Physics Teacher, “Radioactiveball” Vol. 30, January 1992

3) Air filter from air purifier

Activity

Materials Needed:

1) Timer
2) Electricity
3) Vacuum cleaner
4) Filter paper, coffee filter, medical gauze, etc. Note: keep in sealed plastic bag or envelope until ready to use
5) Radiation detector – pancake probe or scalar preferred

Activity

Experiment

1) Use radiation detector to assess background radiation
2) Remove filter from envelope/bag and check for radioactivity
3) Place filter paper over vacuum inlet hose
4) Run vacuum for at least 5 minutes (note time)
5) Turn off vacuum and remove filter paper – observe particle dirt/dust on filter
6) Use radiation detector to assess radiation level

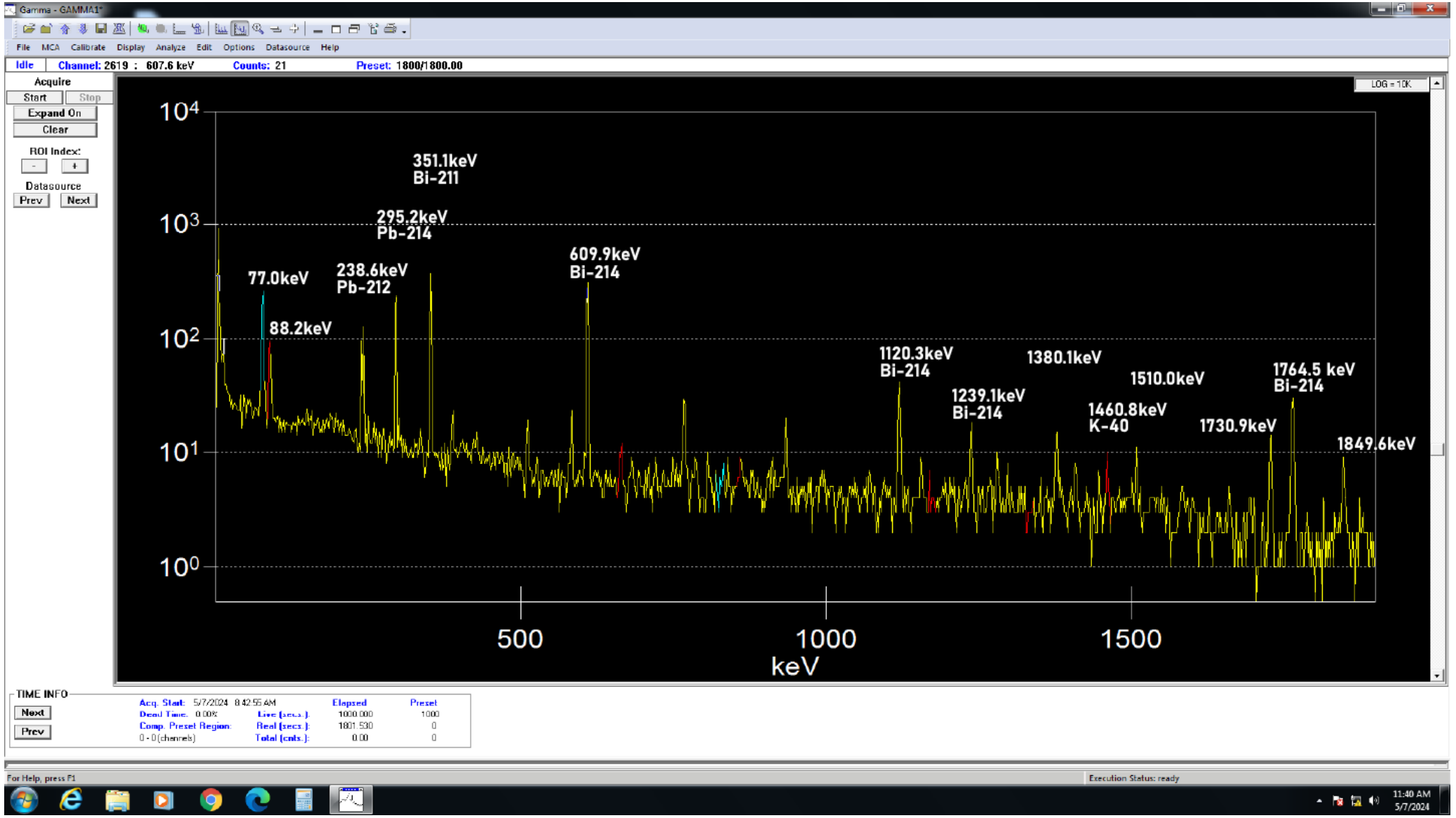
Activity

Data/Observations

1) Record initial radiation level
2) Take 1 minute readings every 5-10 minutes, record data
3) Describe observations

Experimental challenges

1) Radon levels vary over time and season
2) High humidity can reduce radon levels thus reducing decay product collection
3) The best collection areas for radon gas and decay products are sub-level or ground level. Upper floors tend to have lower radon concentrations.


Gamma - GAMMA1*
File MCA Calibrate Display Analyze Edit Options Datasource Help
Idle Channel: 2619 : 607.6 keV Counts: 21 Preset: 1800/1800.00
Acquire
Start Stop
Expand On
Clear
ROI Index:
Datasource
Prev Next
LOG = 10K
10^4
10^3
10^2
10^1
10^0
351.1keV
Bi-211
295.2keV
Pb-214
77.0keV
238.6keV
Pb-212
88.2keV
609.9keV
Bi-214
1120.3keV
Bi-214
1239.1keV
Bi-214
1380.1keV
1510.0keV
1460.8keV
K-40
1730.9keV
1764.5 keV
Bi-214
1849.6keV
500
1000
1500
keV
TIME INFO
Next
Prev
Acq. Start: 5/7/2024 8:42:55 AM
Dead Time: 0.00%
Comp. Preset Region:
0 - 0 (channels)
Live (secs.):
Real (secs.):
Total (cnts.):
Elapsed
Preset
1000.000
1000
1801.530
0
0.00
0
For Help, press F1
Execution Status: ready
11:40 AM
5/7/2024

Pennsylvania radon in homes

Pennsylvania's Role In The Discovery Of Radon Dangers

January 27, 2015 by admin

Limerick Nuclear Power Plant

In December 1984 Stanley J. Watras was a construction engineer at the Limerick nuclear power plant in Pottstown, Pennsylvania. Workers at the site were subject to radiation screening as they left the plant on a daily basis. One day Mr. Watras happened to enter the plant through the EXIT portal and set off the radiation alarms of the monitoring devices.

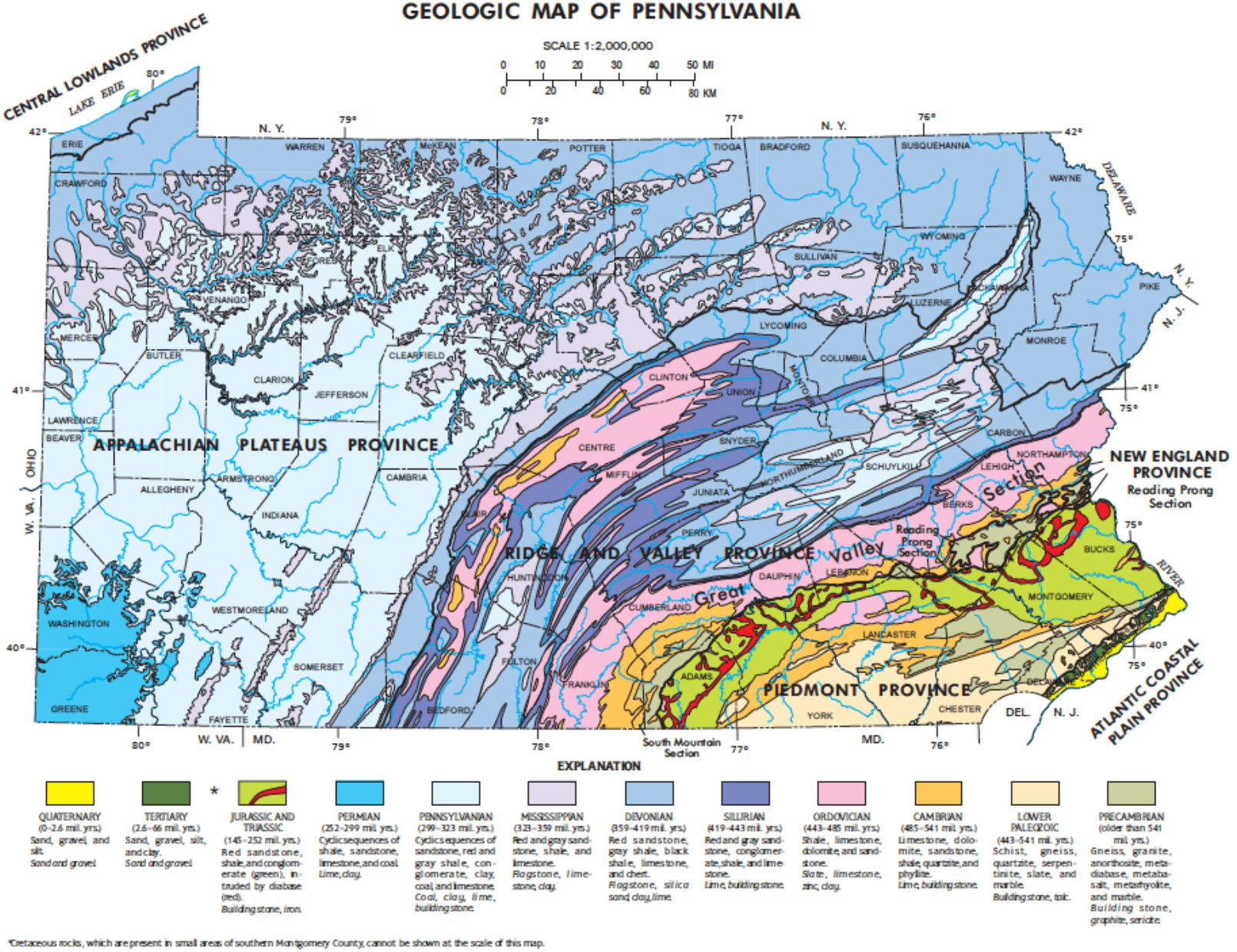
At that time the Environmental Protection Bureau (EPA) Bureau received a telephone call from the Health Physicist at the Limerick site informing the EPA that a construction worker at the plant under construction, that housed no radioactive material yet, was setting off alarms when he attempted to *enter* the plant. Mr Watras was indeed radioactive but it was not from exposure at the plant.

Question

The Radon problem in homes was discovered by "accident" when a nuclear power plant worker set off radiation detector alarms.

- True
- False
- ANSWER
- True

GEOLOGIC MAP OF PENNSYLVANIA



*Cretaceous rocks, which are present in small areas of southern Montgomery County, cannot be shown at the scale of this map.

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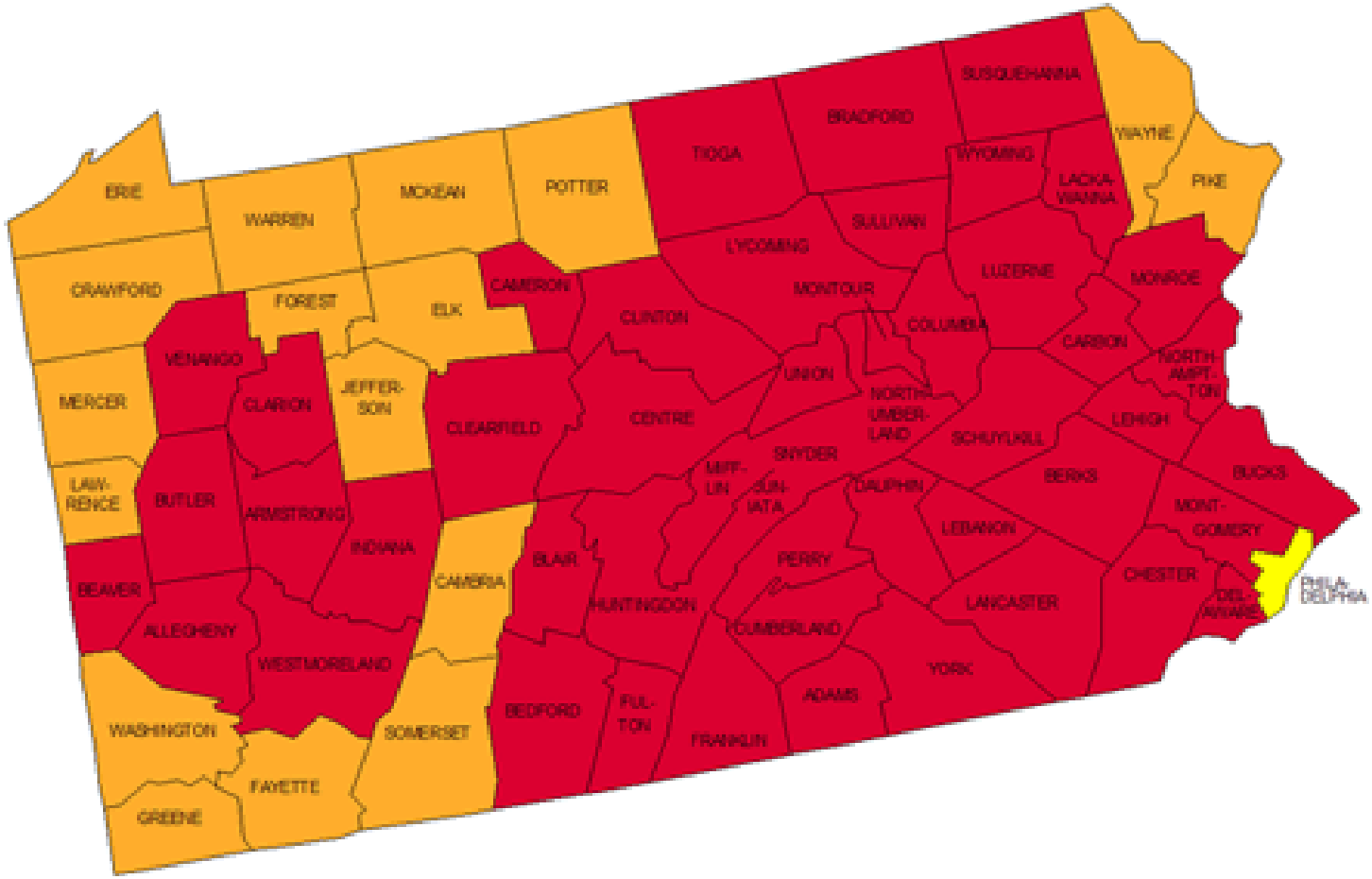
Over 40% of Pennsylvania homes have radon levels above the action limit (4 pCi/l)



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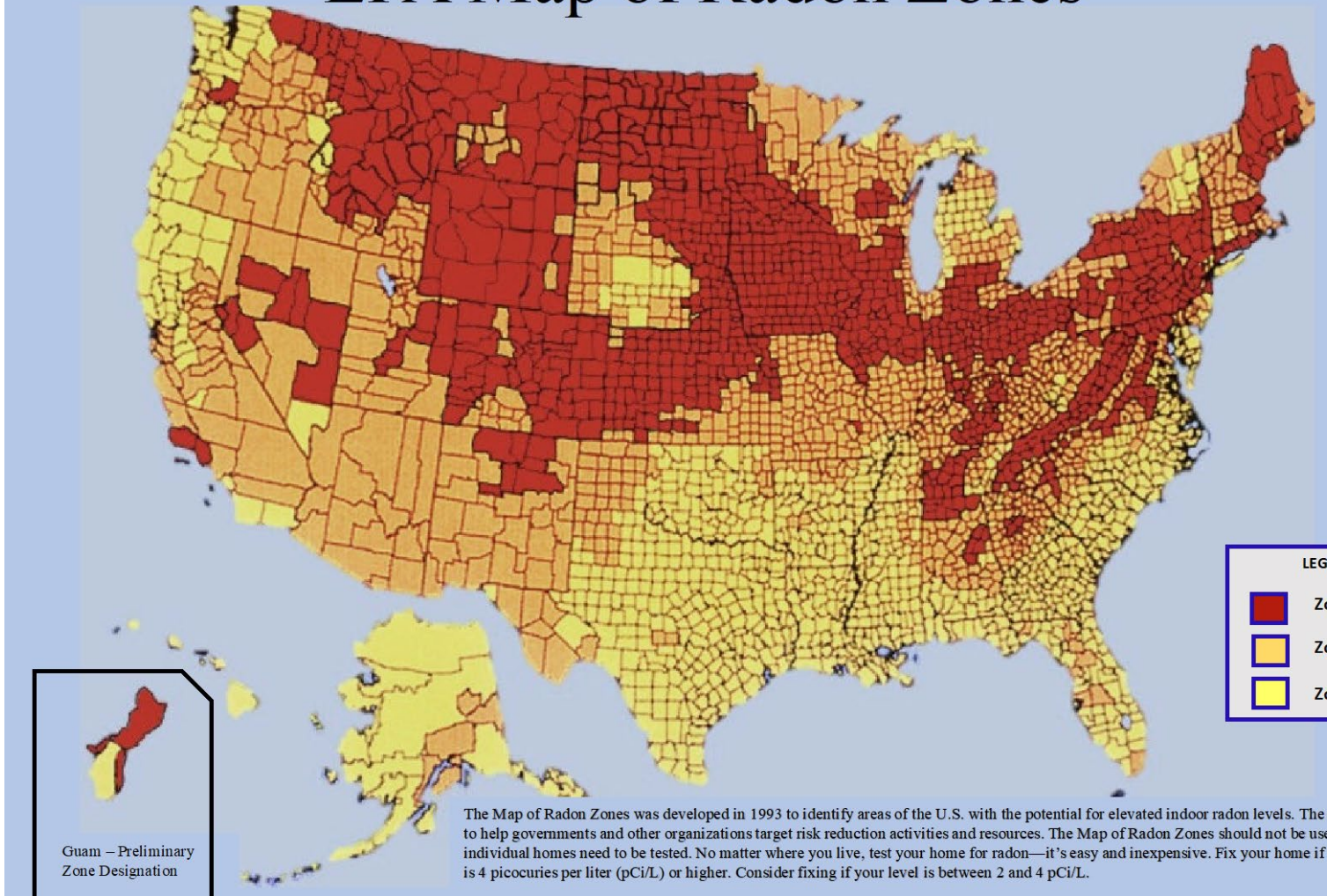
EPA Map of Radon Zones



The Map of Radon Zones was developed in 1993 to identify areas of the U.S. with the potential for elevated indoor radon levels. The map is intended to help governments and other organizations target risk reduction activities and resources. The Map of Radon Zones should not be used to determine if individual homes need to be tested. No matter where you live, test your home for radon—it's easy and inexpensive. Fix your home if your radon level is 4 picocuries per liter (pCi/L) or higher. Consider fixing if your level is between 2 and 4 pCi/L.

The Map of Radon Zones was developed using data on indoor radon measurements, geology, aerial radioactivity, soil parameters, and foundation types. EPA recommends that this map be supplemented with any available local data in order to further understand and predict the radon potential for a specific area.

402-F19-004

Health risks

- The world Health organization and EPA have identified Radon Gas as the leading cause of lung cancer for non-smokers
- https://www.epa.gov/radon/health-risk-radon
- Watras house - 2,700 Pico-curies/liter
- EPA – recommends <4 Pico-curie/liter

Question

If Radon gas decayed directly into a non-radioactive element we would not be as concerned about radon in homes/buildings.

True False

ANSWER

True

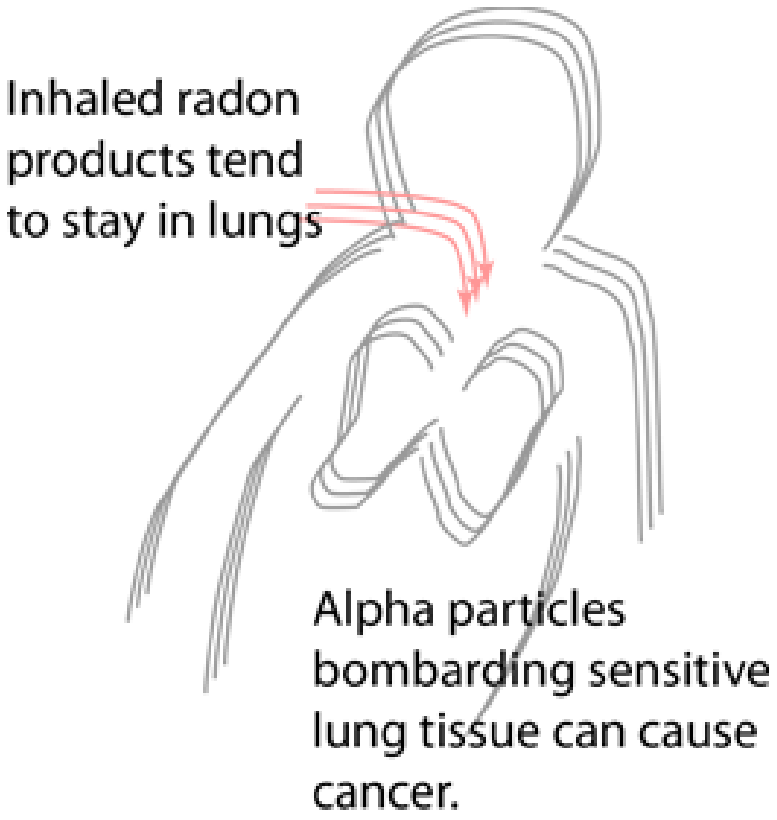
Health risks final question

The health effects of Radon gas are really due to the solid radioactive decay particles

True

False

Solid radioactive decay products that stay in the lungs are the health hazard



When is National Radon Action Month?
When is Radon Action Week?

- January is National Radon Action Month. The aim of National Radon Action Month is to increase the public's awareness of radon, promote radon testing and mitigation, and advance the use of radon-resistant new construction practices.

- Radon Action Week is the third week in October. Some communities might observe Radon Action Week with other indoor air quality topics during the remaining weeks in October.

- You can use any of the materials on our Radon Media Resources Webpage to spread awareness about the health risks of radon through your social network and educate others.

Questions?

Question

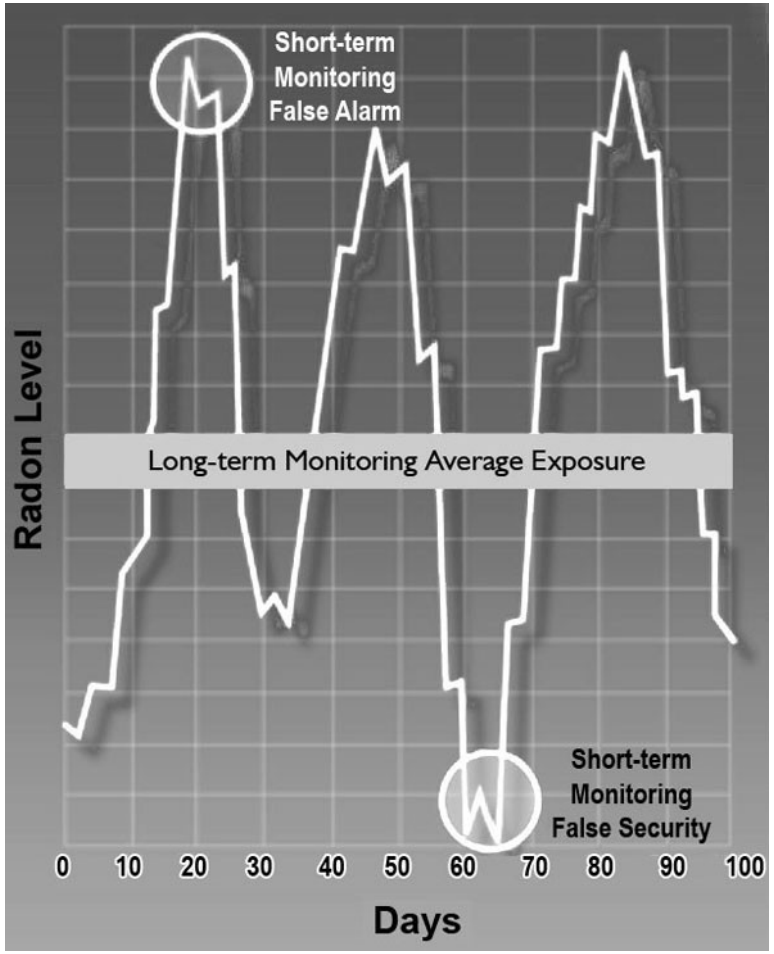
What is the main way that radon gas gets into the home?

- Through cracks, gaps and openings in the ground floor and walls of the home
- Through open windows
- By emissions from Granite countertops and consumer products

Radon entry points

- Soil and well water
- Chimney effect
- Negative pressure
- Ventilation/Exhaust fans

Radon testing and variation



Question

Which type of test would provide a better estimate of radon concentration in the home?

Short-term test

Long-term test

- Day/night variation
- Seasonal variation
- Weather

Mitigation strategies

- Watras House – test case
- Prevent gas from entering home
- Seal exterior and penetrations, cracks, etc. – retested and determined – not successful
- Sub-slab suction system collects gas before it enters the home – vented at the ground
- Gas – re-entrained (re-entered)
- Recommend Vent gas above roof

Mitigation strategies

Note: This diagram is a composite view of several mitigation options. The typical mitigation system usually has only one pipe penetration through the basement floor; the pipe may also be installed on the outside the house.

- Seal walls, penetrations, cracks, etc.
- Sub-slab suction system collects gas before it enters the home
- Vent gas above roof
- Discuss down-draft

“Deadly” radon gas

Radon and Smoking – significantly increases risk

Protect family by Testing?

Testing is the first step, but if levels are above 4 pCi/l then you need to take action

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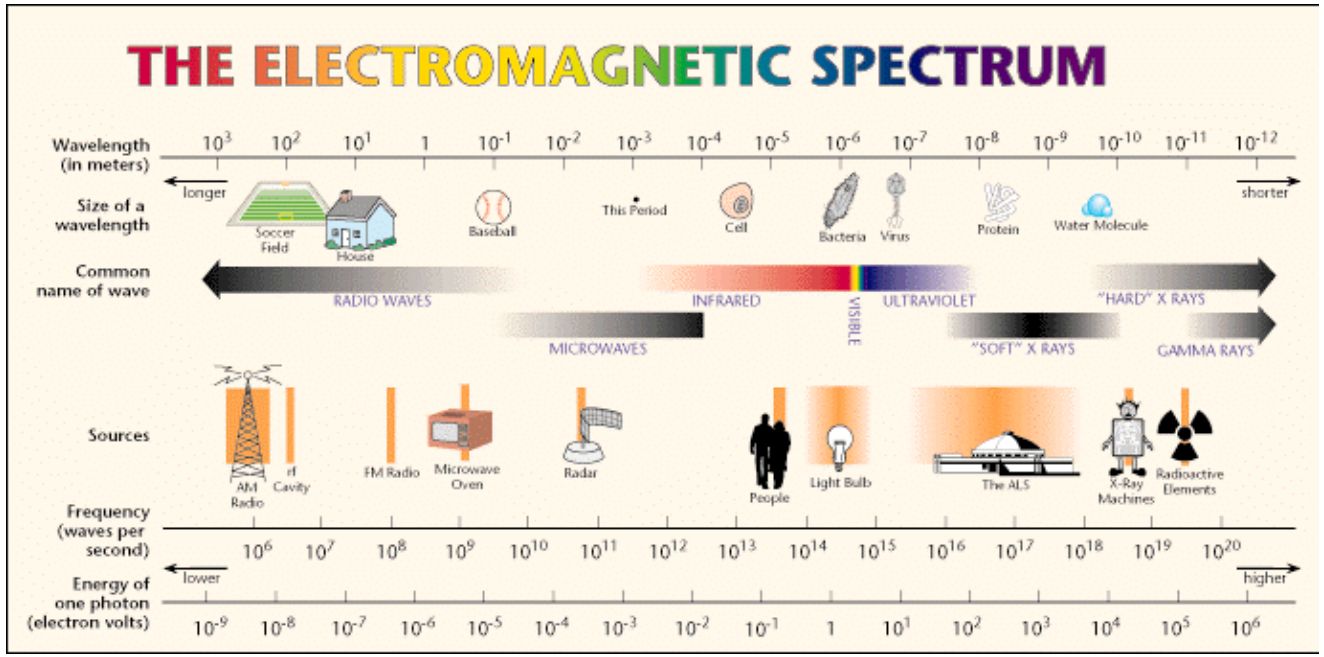
Radon test kits

Charcoal Short-term Radon Test Kit
$17.50
RadonZone.com

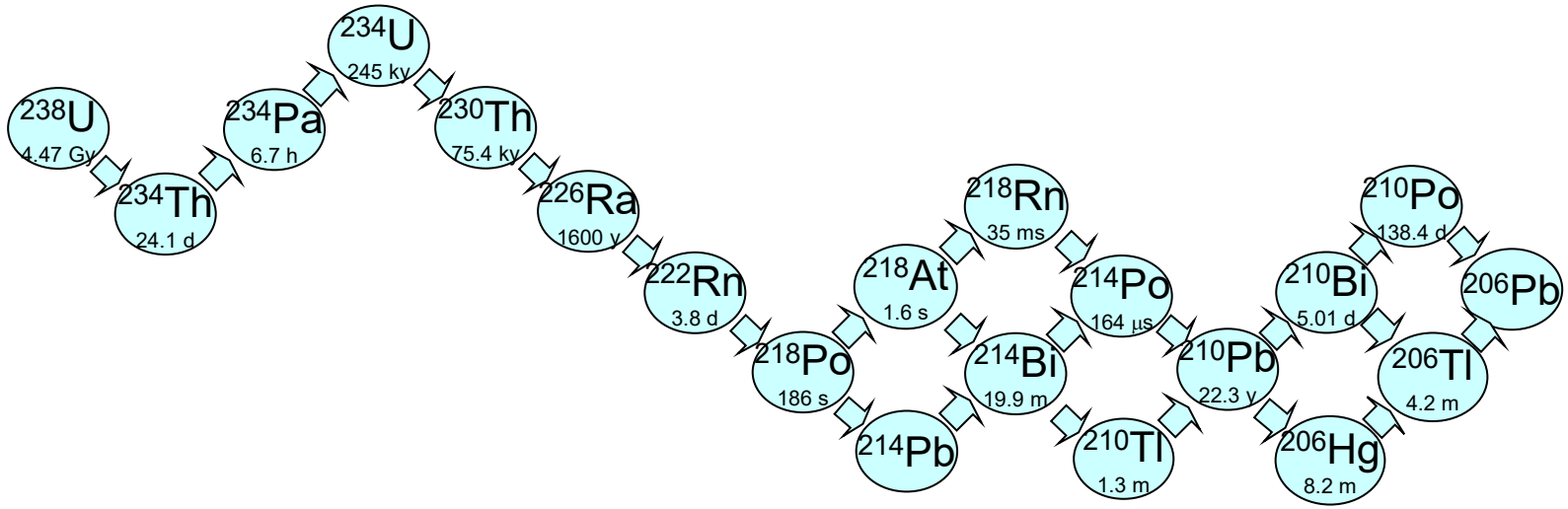
Alpha Track Long-term Radon Test Kit
$39.50
RadonZone.com

First Alert Radon Gas Test Kit, RD1
$14.98
Amazon.com

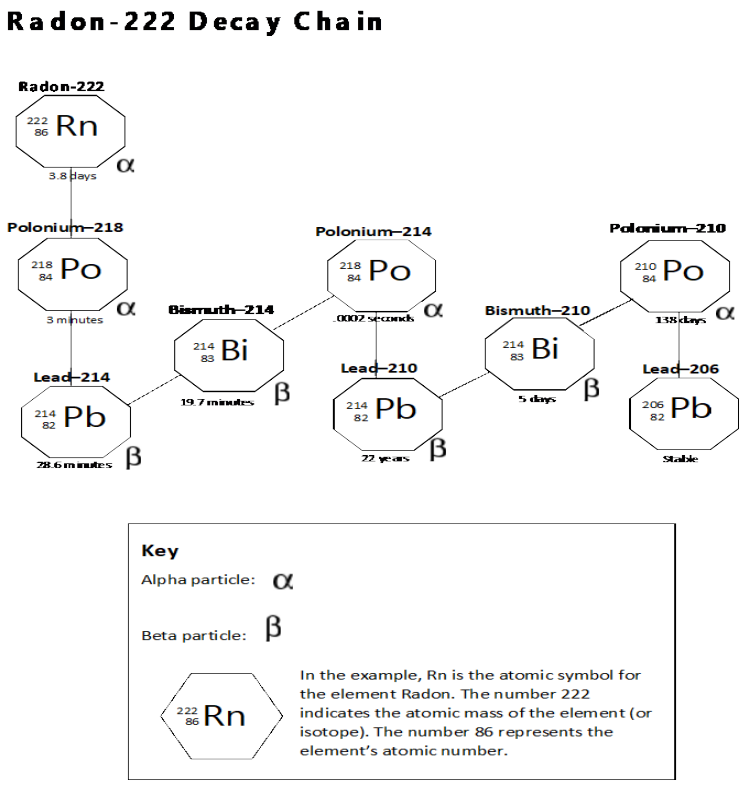
Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
0.4 pCi/L		(Average outdoor radon level)	


THE ELECTROMAGNETIC SPECTRUM
Wavelength (in meters)
10^{3} 10^{2} 10^{1} 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}
longer
shorter
Size of a wavelength
Soccer Field
House
Baseball
This Period
Cell
Bacteria
Virus
Protein
Water Molecule
Common name of wave
RADIO WAVES
INFRARED
VISIBLE
ULTRAVIOLET
"HARD" X RAYS
MICROWAVES
"SOFT" X RAYS
GAMMA RAYS
Sources
AM Radio
rf Cavity
FM Radio
Microwave Oven
Radar
People
Light Bulb
The ALS
X-Ray Machines
Radioactive Elements
Frequency (waves per second)
10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20}
lower
higher
Energy of one photon (electron volts)
10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6}

Uranium-238 Decay Chain



Radon decay products



Have you had your home tested for radon?

Should Every Home Inspection Include Radon?

by Inspection News | Oct 2, 2017 | News |

Old houses are risky, but there's no way that a new-construction house could have a radon problem, right? Nope. Although it's a common misconception, the age of a home has nothing to do with whether or not radon is seeping up into the living spaces. In fact, some older homes might be safer because construction isn't as tight as a new house.