

# A Brief Review of Indoor Radon Gas

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K-State Radon Programs

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## generalities

Behavior changes are hard...

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## Radon

- Invisible, odorless, tasteless, colorless, inert, **radioactive** gas
- Occurs from the **natural** breakdown of Uranium
- **Travels** through soil
- **Enters** homes, schools, other buildings
- Elevated indoor levels found in **every** state

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## General Radon Entry Pathway

**0.4 pCi/L \* U.S. annual average outdoors** – about 15 Bq/m<sup>3</sup>

100s - 100,000s pCi/L  
1,000s - 1,000,000 Bq/m<sup>3</sup>

**1.3 pCi/L \* U.S. annual average indoors in homes (living areas)** – about 50 Bq/m<sup>3</sup>

pCi/L is a unit of radon radioactivity (or 'activity') concentration

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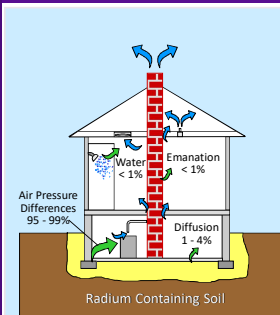
## Indoor Radon Levels Depend On:

### Five Factors

- **Source strength** of the radon in the soil
  - Ease of movement of the radon thru the soil
  - Foundation connections between the soil and the indoor environment
- Amount of **vacuum** the house puts on the soil
  - Inflow of outdoor air into the home

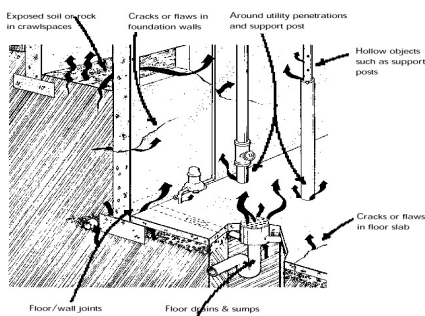


## What Contributes Radon to Indoor Air?



- The movement of **soil gas** into a home is the predominant entry route
  - These are averages and a particular home can be different, e.g.,
- As soil gas entry is reduced, emanation and diffusion can become more important

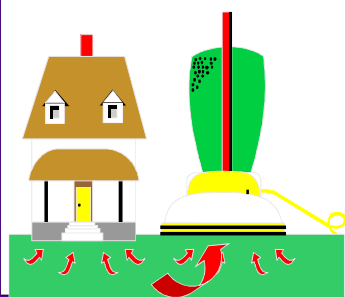
## How Radon Enters Your Home



## Entry Points Seen and Unseen

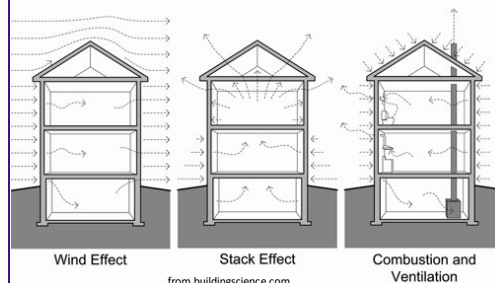


### Buildings Generate Vacuum



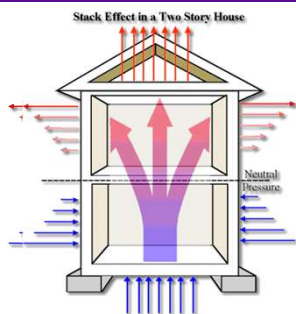
- Buildings can create vacuums that will draw in soil gas
- These vacuums may be very small and are referred to as air pressure differentials

### Air Pressure Variables



### The Stack Effect and Negative Pressure

- ACH is an acronym for Air Changes per Hour and is a measurement of air infiltration. It is the total volume of air in a home that is turned over in one hour.
- Tightly constructed homes may have an ACH of 0.25 to 0.35 ACH,
- A typically built new home may have an ACH of around 1 ACH. Older poorly weather-stripped and sealed homes may have higher than 2 ACH.



Is it reasonable to assume climate impacts radon concentrations?

The answer depends on your definition of 'reasonable'...

### EPA Has Defined Radon Zones

Each of 3100 counties in the U.S. classified as:

**Zone 1** - expect 4.0 pCi/L or greater

**Zone 2** - expect 2.0 to 4.0 pCi/L

**Zone 3** - expect 2.0 pCi/L or less

Zone designations based on five factors: indoor radon measurements, geology, aerial radioactivity, soil parameters, and foundation type.

### U.S. Radon Zone Map



### Climate and HVAC Days

<b>4 Mixed</b>	NYC, PA, NJ, VA, KT, TN KS, MO, Seattle WA, and Portland OR.	Kansas City 54° F (12 C)
<b>5 Cool</b>	MA, NY, OH, MI, IN, IL, IA, NE, CO, UT and NV.	Chicago 49° F (9 C)
<b>6 Cold</b>	ME, NH, VT, WI, MN, ND, WY, SD and ND.	Montreal 43° F (6 C)
<b>7 Very Cold</b>	Minot, ND; Anchorage, AK; Winnipeg, Canada	Winnipeg 36° F (2 C)
<b>8 Subarctic</b>	Fairbanks Alaska; Cambridge Bay, Canada	Fairbanks 26° F (-3 C)

### Climate and HVAC Days

**REPORTING REQUIREMENTS FOR BUILDING OPERATING CONDITIONS**

**TEMPERATURE ZONES**  
as designated in ASHRAE standards 90.1 and 90.2  
(The American Society of Heating, Refrigerating and Air-Conditioning Engineers) <https://www.ashrae.org>

Climate Zone	Example North American States or Cities	Average Annual Temperature
<b>1 Very Hot</b>	Southern Florida and Hawaii	Miami 76° F (24 C)
<b>2 Hot</b>	Florida, New Orleans, Houston, Mexico	New Orleans 68° F (20 C)
<b>3 Warm</b>	North Carolina to Southern California	Atlanta 61° F (16 C)

## Climate and HVAC Days

<b>Heating Systems</b>	In response to needs for indoor comfort: Heating systems will often activate when outdoor temperatures drop to below about 65° F (18° C).																																																																																																																																																																																																																																																																																																																																																																		
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## But, what if?

What if what?

## What If My House Has...?

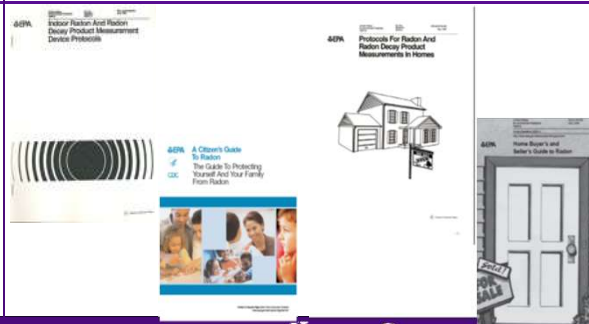
You **CANNOT** predict radon levels based on:

- Heating System
- Foundation Type
- Age of Structure
- Air-tightness
- Style of House
- Presence of Sumps, Cracks or Other Features

You just have to **TEST** to find out!

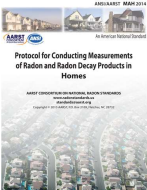



## EPA Radon Measurement Protocols and Parallel Consumer Documents



### AARST Radon Measurement Protocols

- AARST Protocol for Conduction Measurements of Radon and Radon Decay Products in Homes
- AARST Protocol for Radon Measurement in Multi-family Buildings
- AARST Standards Website
  - <https://standards.aarst.org/>

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### Common Testing Durations

#### How long does radon testing take?


- Long Term - greater than 90 day exposure
  - No behavioral restrictions on building operation
  - Reflects building annualized radon concentrations
- Short Term - typically 2 - 7 day exposure
  - Short Term cannot be less than 2 days
  - Closed building conditions required
  - Reflects building winter radon concentrations

*94% of the time Short Term tests provide the same mitigation decision as a Long Term test*

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### Devices

- Charcoal canisters and bags
- Alpha Track detectors
- Electret Ion Chambers
- Continuous Radon Monitors



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### Test Location Depends On Purpose

Real Estate	Non-Real Estate
Lowest level suitable for occupancy w/o renovation	Lowest lived-in level determined by occupant

*Important!*

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# So What do we do?

Rocket Science™!

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# Radon Mitigation

- **Active Soil Depressurization (ASD)** is the most common approach
  - Employs a method for creating a vacuum beneath the foundation greater in strength than the vacuum applied to the soil by the building
  - Caulking and sealing has not been shown to be an effective stand-alone radon reduction process
    - However extensive sealing can radically increase the efficiency of ASD systems
- **Ventilation** approaches have proven more costly and less effective

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# Mitigation System Design Criteria

- Lowest indoor radon concentrations
  - Active Soil Depressurization = up to 99% reduction
  - Expect less than 2 pCi/L ~ U.S. EPA's *Citizens Guide*
- Safe and does not create other problem
- Durable
- Able to perform system monitoring
- Economical to install and operate
- Quiet and unobtrusive

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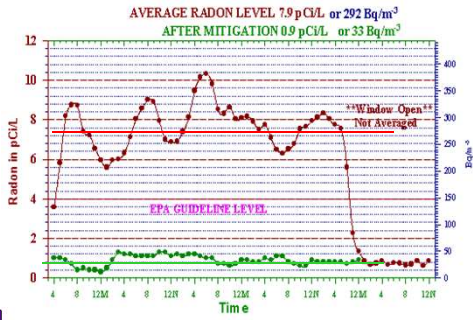
# Types of ASD Systems

- Depends on type of house foundation
  - Basement with and without groundwater control systems
    - Drain Tile: Drain Tile Depressurization (DTD)
      - Sump: Sump Depressurization (considered under DTD)
    - Baseboard Drainage: Baseboard Depressurization (rare)
    - Concrete Block Walls: Block Wall Depressurization (rare)
    - None of the above: Subslab Depressurization (SSD)
  - Crawl space: Submembrane Depressurization (SMD)
  - Slab on grade:
    - Subslab Depressurization (SSD)
    - Stem Wall Depressurization

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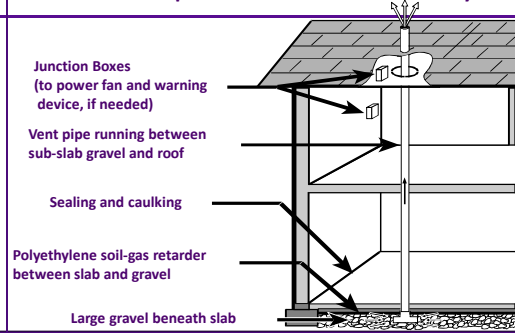


### The Systems Work!



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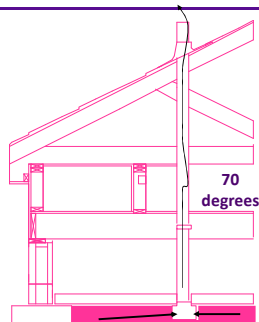
### Basic Components of Passive System



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### How Does it Work?

- The pipe is warmed by house air creating a stack effect draft in the pipe
- The warmed air in the pipe rises, creating a slight vacuum on the cooler soil gas



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### Cost Comparison

<u>New Home Construction</u>	<u>Mitigate Existing Home</u>
\$750-\$1,000 per Home (Labor and Materials)	\$1,500 - \$3,000 per Home (Labor and Materials)

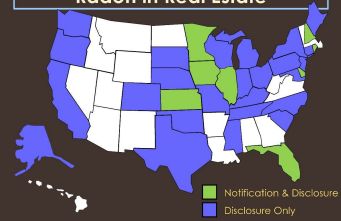
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So which states have paid attention?



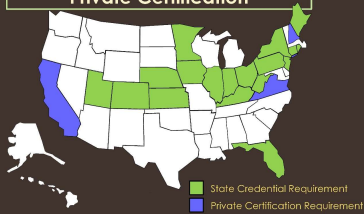
### Radon Disclosure During Real Estate Transactions

#### Homebuyers Protections: Radon in Real Estate



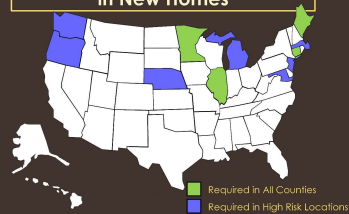
### State Licensing/National Proficiency Requirements

#### State Credentials & Private Certification

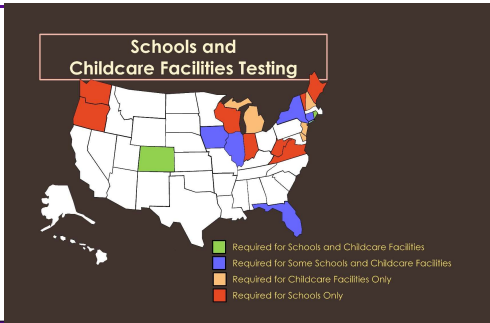


### Radon Resistant New Construction

#### Radon System Required in New Homes



## School & Daycare Testing



## Who are these guys?

Why is this bald guy from Kansas State blathering at us?

## We're From the Government, We're Here to Help

National Radon Program Services

[www.sosradon.org](http://www.sosradon.org)

Kansas Radon Program

[www.kansasradonprogram.org](http://www.kansasradonprogram.org)

K-State Radon Training

<https://radoncourses.com/>

K-State Radon Chamber

[www.ksuradonchamber.org](http://www.ksuradonchamber.org)

Kansas State University

## National Radon Program Services

— increasing public knowledge of radon and the need to test and fix homes


National Radon Program Services (NRPS)

- <https://sosradon.org/>
- 800.SOSRADON (800.767.7236)
- NRPS Activities
  - U.S. EPA Cooperative Partner
  - National direct public technical assistance
  - Regional radon stakeholders meeting coordination and training
  - Outreach activities to radon stakeholders

## KANSAS RADON PROGRAM

Kansas Radon Program (KRP)

- <https://kansasradonprogram.org/home>
- 800.693.5343
- State-wide Radon Activities
  - Public education and technical assistance for Kansas residents
  - Professional education for radon stakeholders
  - Outreach activities to radon stakeholders



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Radon  Courses

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K-State Radon Training Options

- <https://radoncourses.com/>
- In-person, Webinar & Online Self-Paced
  - Full measurement/mitigation courses
  - Professional Continuing Education
  - Contract training for organizations
  - EPA Regional Stakeholders meetings

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Radon Chamber

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K-State Radon Chamber

- <https://ksuradonchamber.org/>
- Services
  - Device Performance Testing (DPT)
    - Necessary for initial NRPP certification and an option during re-certification
  - Device Spiking Services
    - CAD's, ATD's and EIC's
    - Minimum order of 3 spikes
  - Ecosense Radon Eye Pro Calibration
    - Currently only CRM our lab will calibrate

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## Questions?

Cause, boy do I have answers...

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## Contact Info

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- 785.532.4996 (direct)
- [bhanson@ksu.edu](mailto:bhanson@ksu.edu)

### NRPS & KRP Contact

- [radon@ksu.edu](mailto:radon@ksu.edu)

### KSU Radon Training

- [radoncourse@ksu.edu](mailto:radoncourse@ksu.edu)

### KSU Radon Chamber

- [radonchamber@ksu.edu](mailto:radonchamber@ksu.edu)