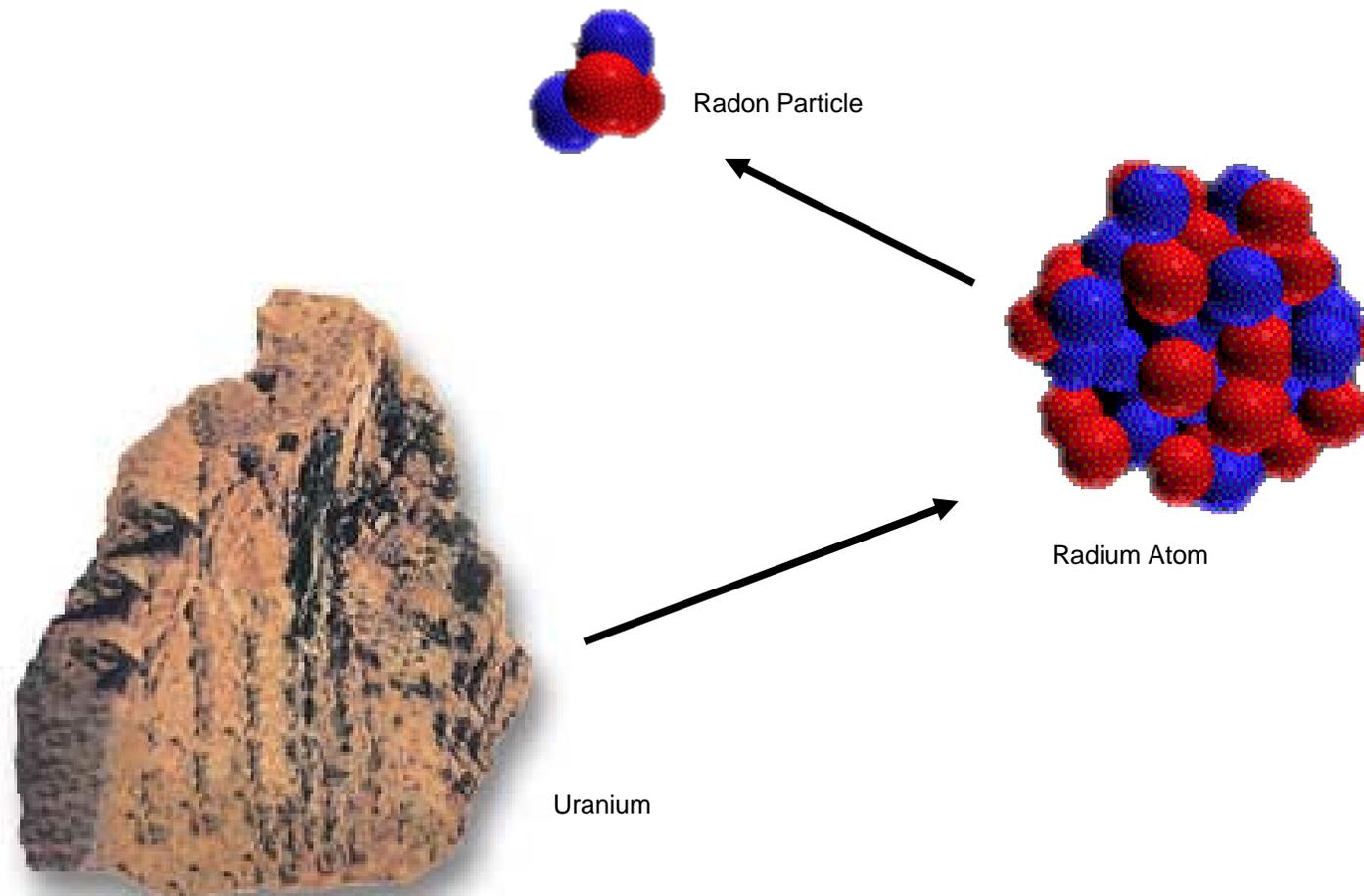


# Radon Control Methods



## What About the Health effects of Radon and Moisture?

Why do we need to be concerned?

Radon Is An Equal Opportunity Hazard!

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- Radon concerns are not dependent upon the age of a home.
- **Radon concerns affect expensive and affordable homes alike.**

**Radon**

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  - **Minnesota especially high**
    - **Geology**
    - **Climate**
    - **Housing stock**

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- Colorless, tasteless and odorless gas
- **Radon comes from radioactive breakdown (decay) of uranium in soil and rock.**

## Radon

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  - **Pressure differences**
  - **Stack effect**

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- Radon can get into any type of building, including homes, offices, and schools.
- **Testing is the only way to know if you or your family is at risk.**

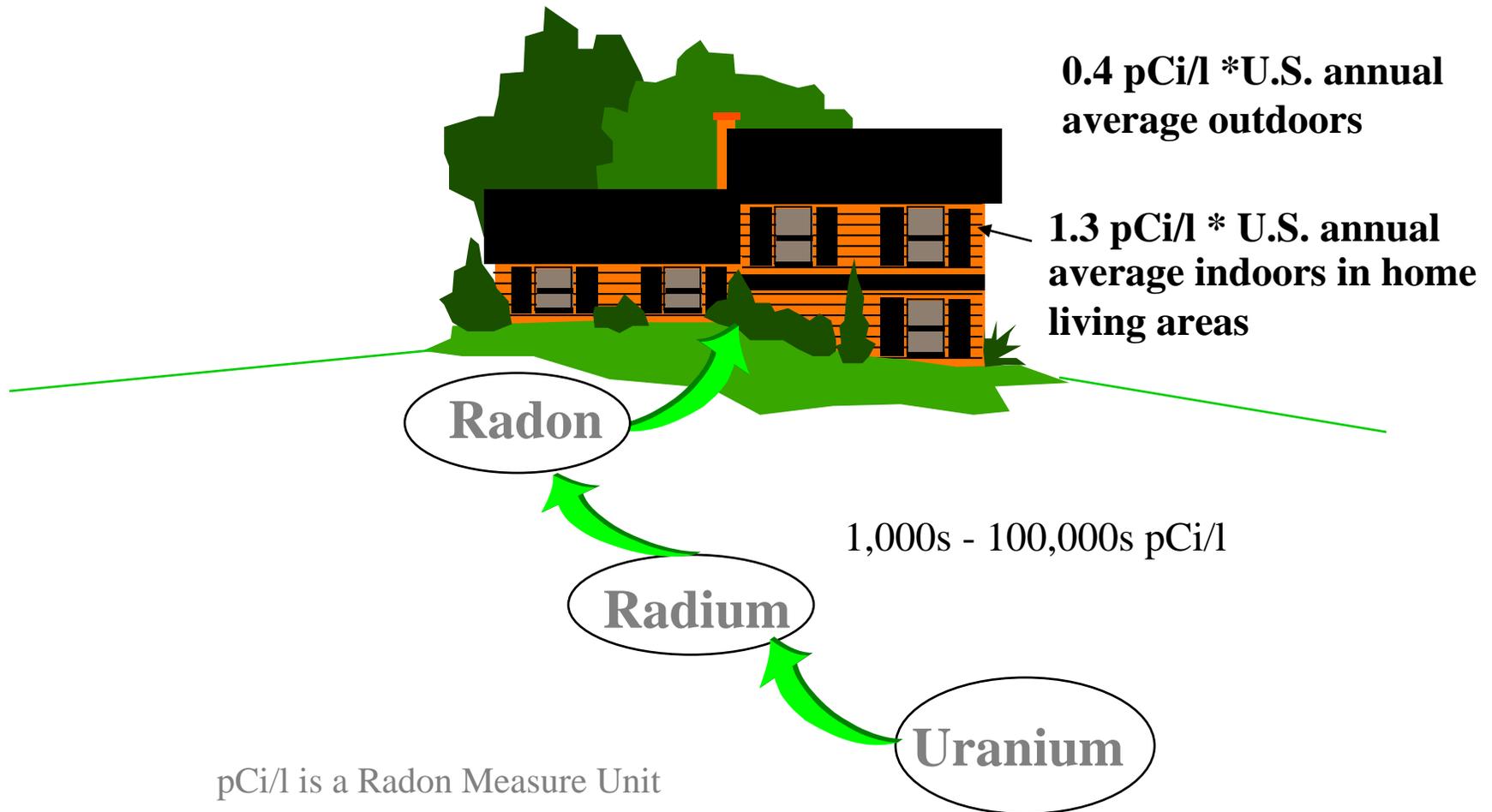
## National Average Radon Levels

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- **Indoor-**  
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- **Minnesota-**
  - **About 4.0 pCi/L**
    - **Long-term average**

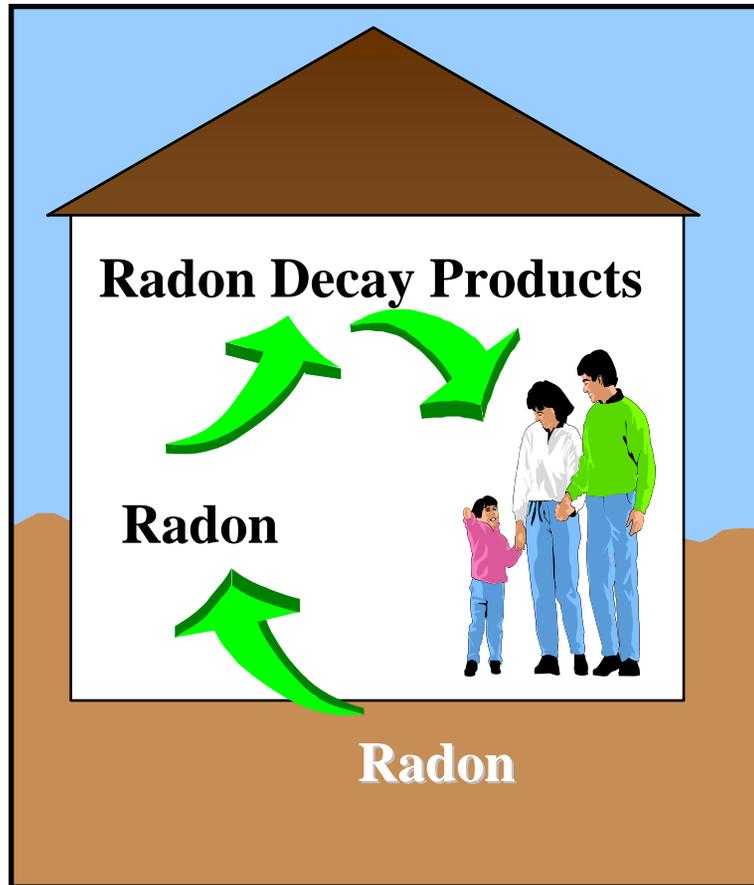
## Radon Entry



pCi/l is a Radon Measure Unit

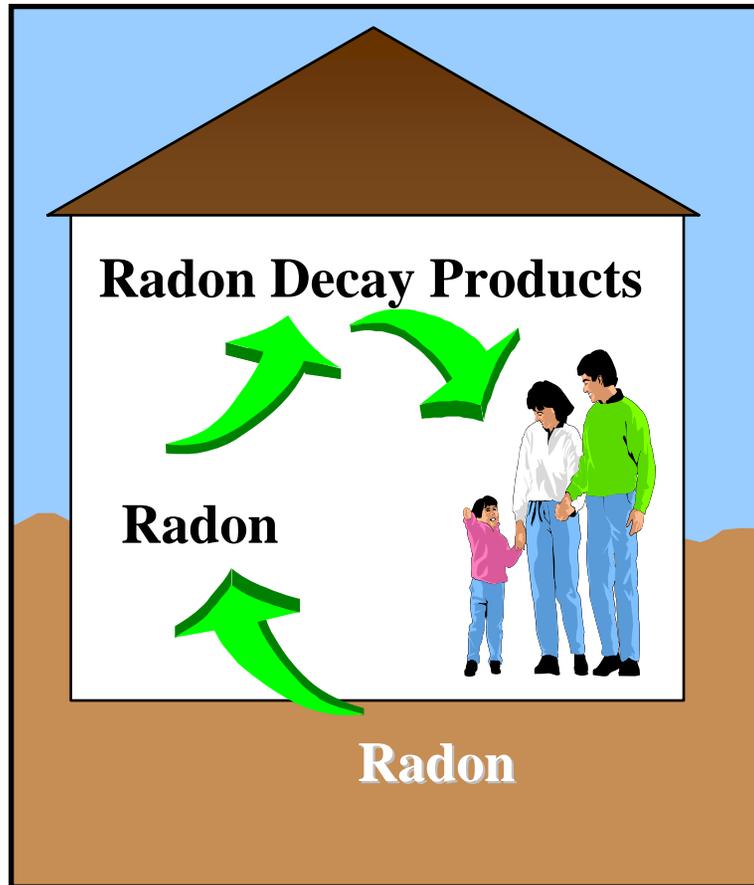
**NOTE: Minnesota has the fourth highest portion of homes above EPA's 4 pCi/l Threshold for Action**

## Why Is Radon a Concern?



- Radon decays into radioactive particles known as radon decay products.

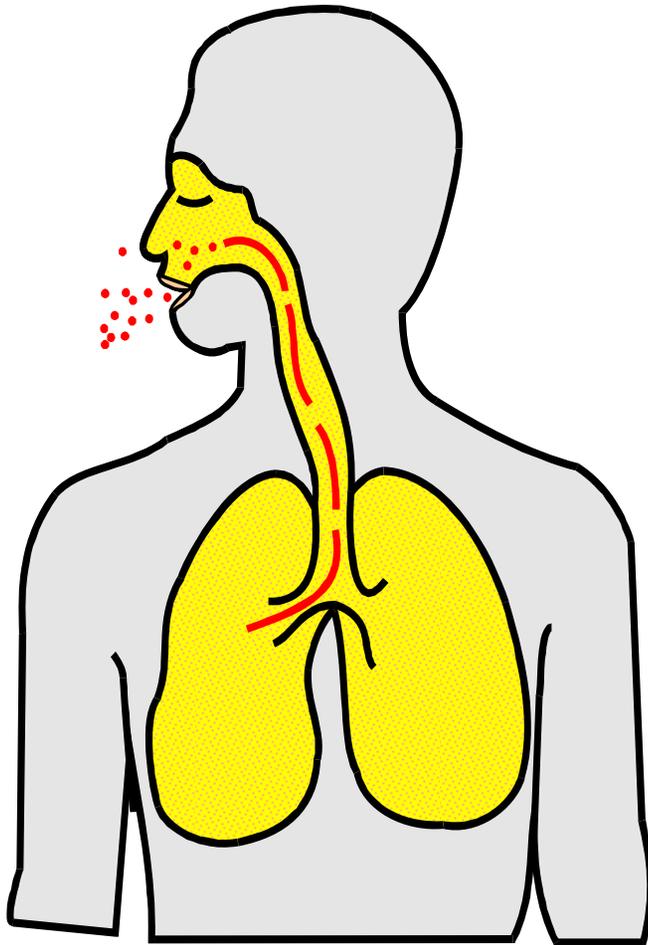
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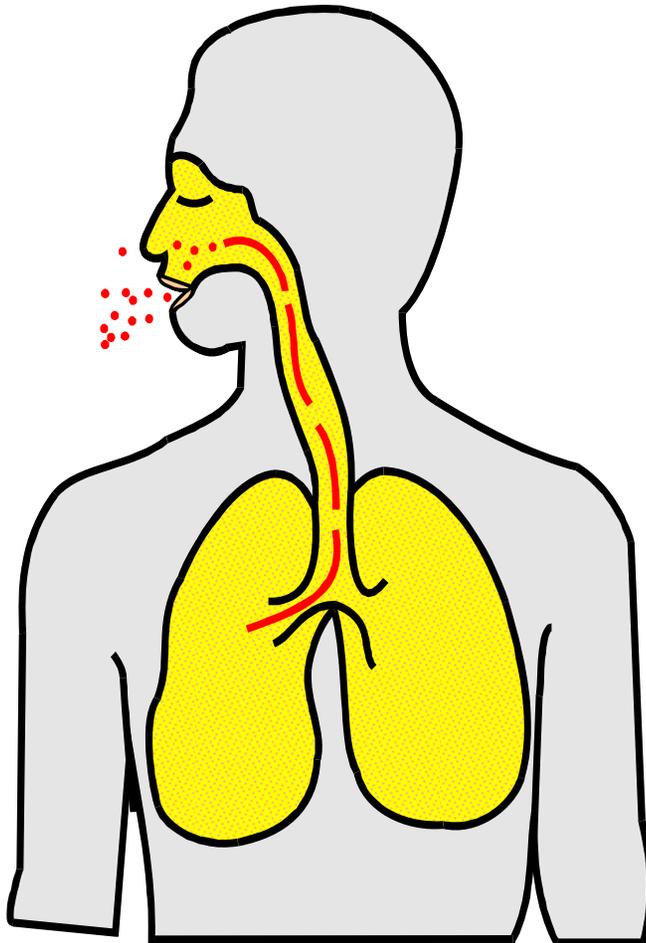
- Radon decays into radioactive particles known as radon decay products.
- These particles are easily inhaled and deposited in the lungs where they can damage sensitive lung tissue.

Radon

# Radon Is A Lung Cancer Causing Gas

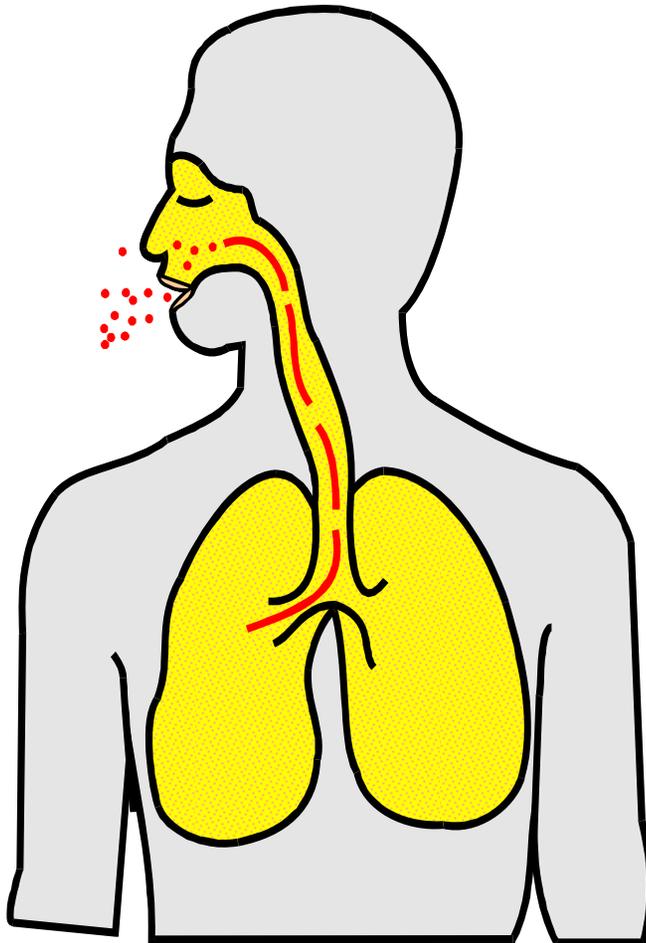


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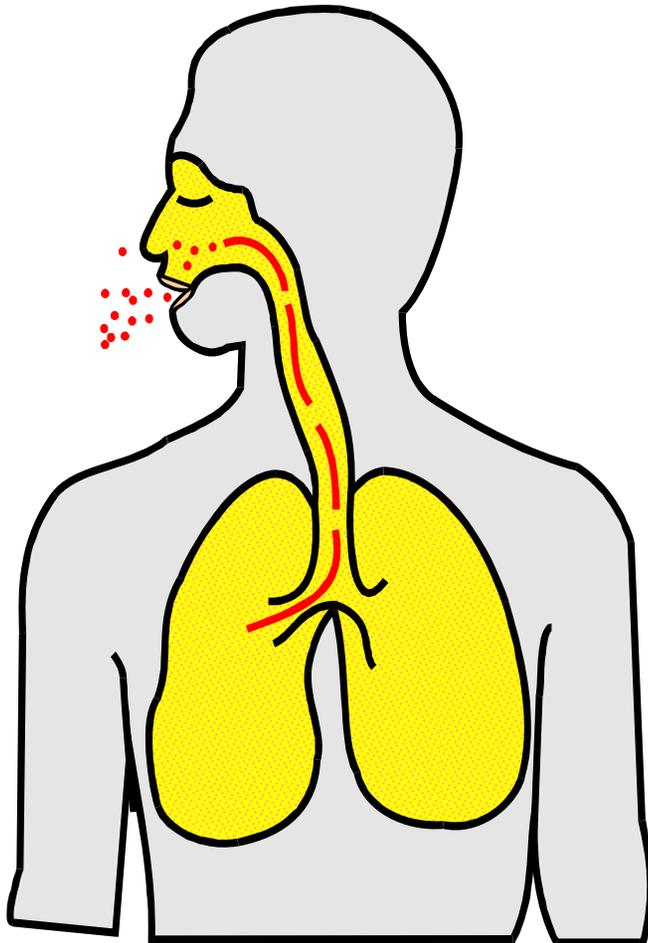
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## Radon Is A Lung Cancer Causing Gas



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

Radon  
**Alpha Particles Are Strong Enough To Pit  
Plastic**

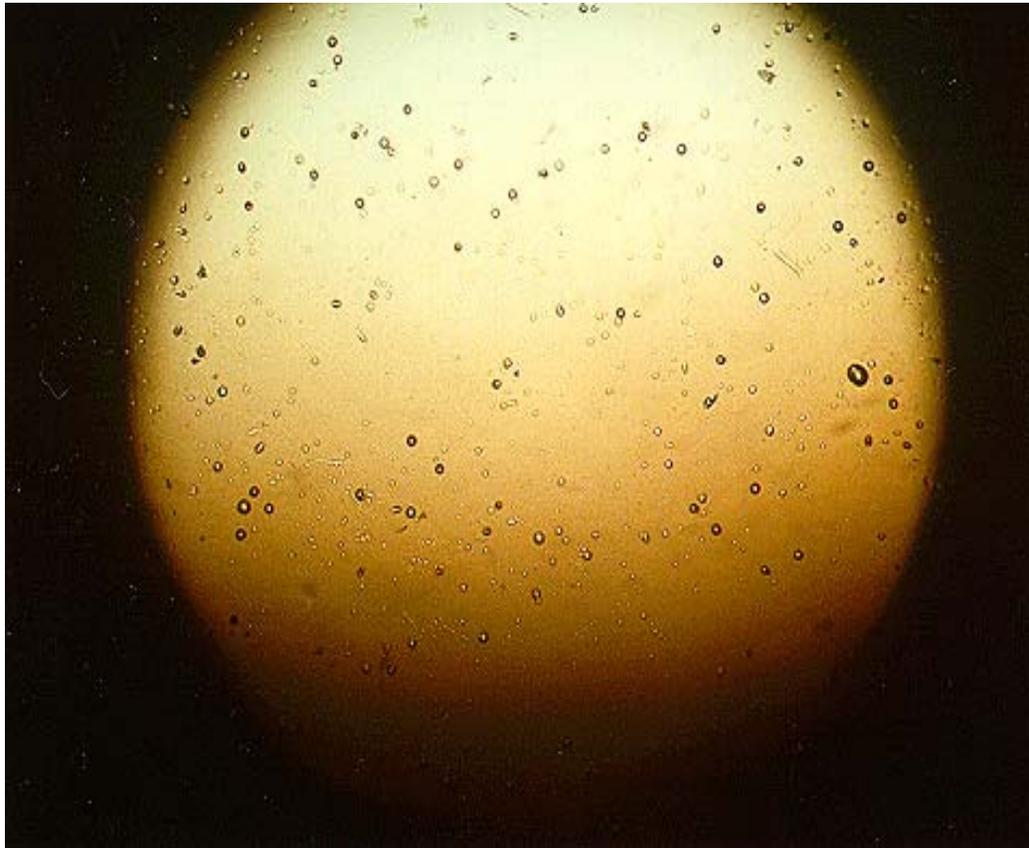
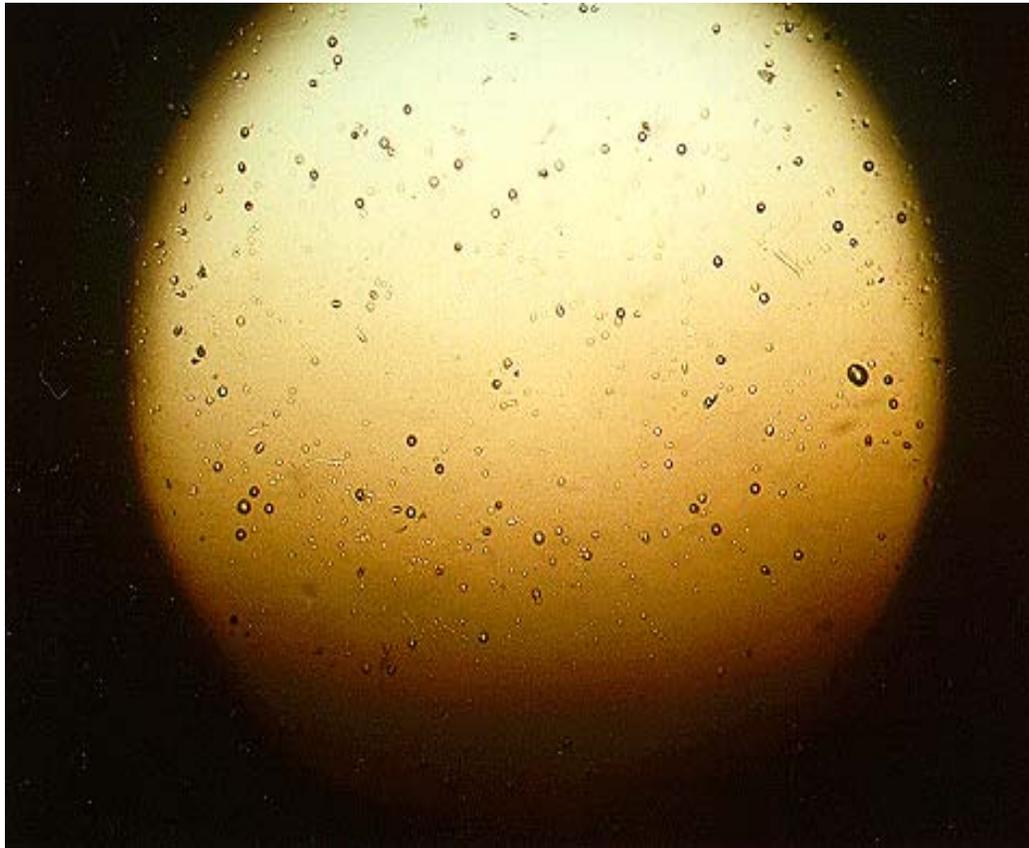


Photo by Dr. J.F. Burkhardt

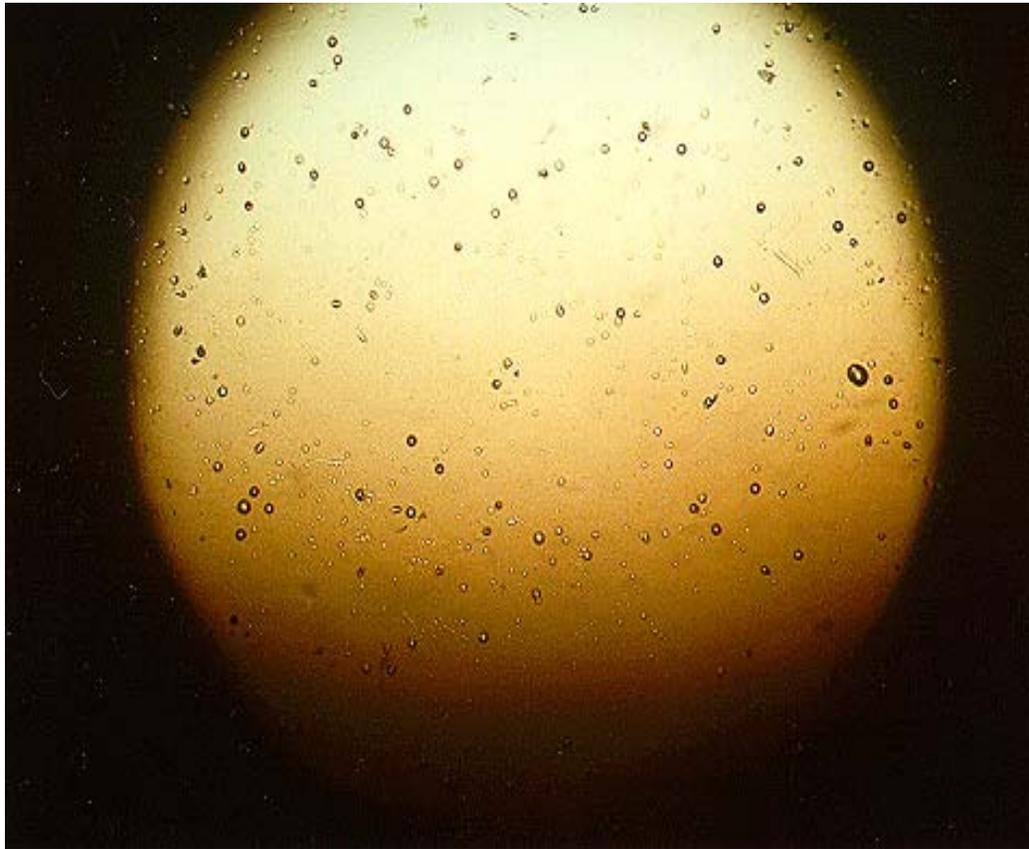
# Radon Alpha Particles Are Strong Enough To Pit Plastic



- Plastic chip from passive radon test (alpha track).

Photo by Dr. J.F. Burkhart

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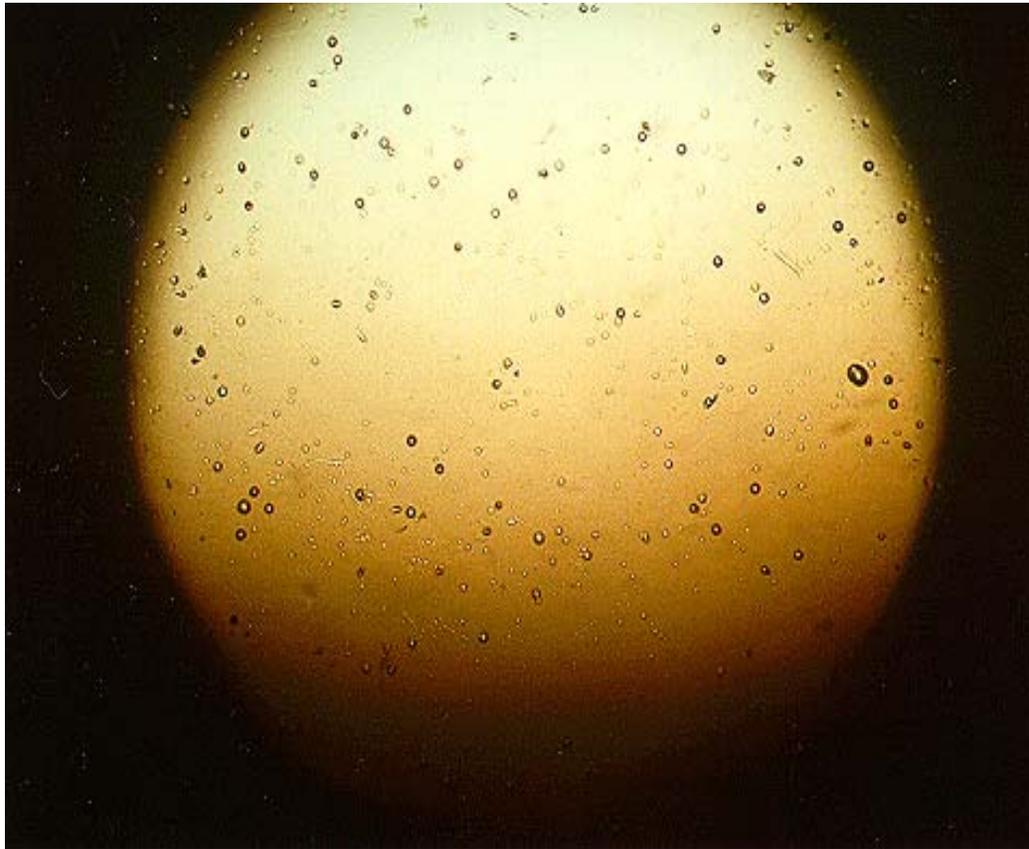
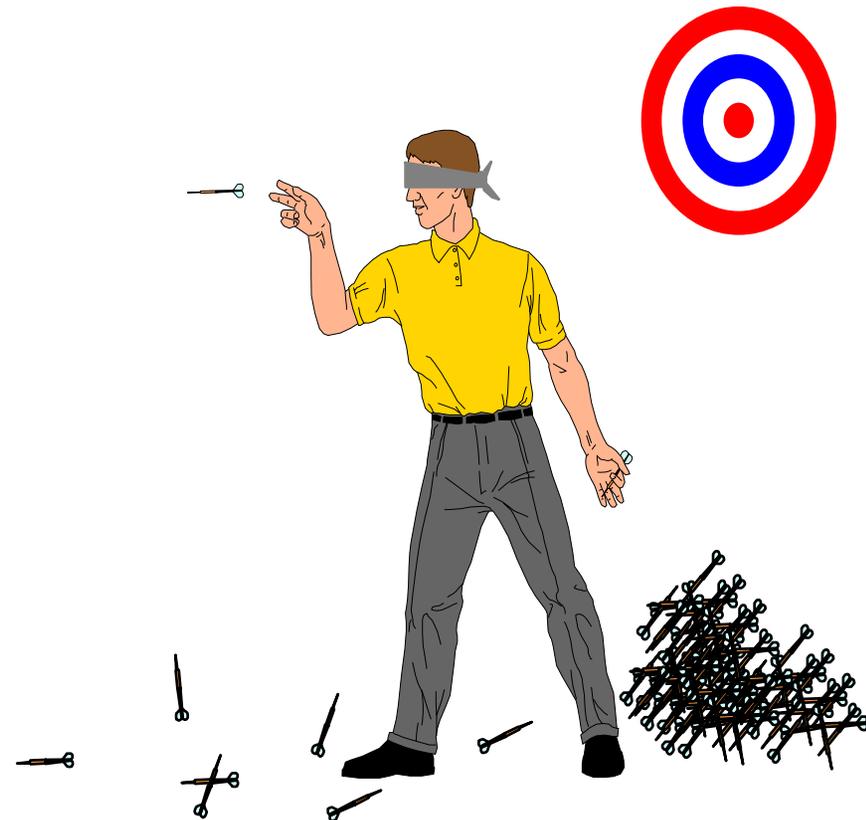


Photo by Dr. J.F. Burkhart

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

## Radon Induced Lung Cancer

- Risk increased equally by both duration and concentration of exposure



## Radon Induced Lung Cancer

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



# Radon Number Of Homes With High Radon Levels In Minnesota

The Minnesota Department of Health estimates that **1 in 3 homes in Minnesota** have radon concentrations above the EPA recommended action level of 4.0 pCi/L.

# **Radon and its Decay Products are Known Human Carcinogens**

- **Alpha particles from the radon decay products (RDPs) can damage living tissue including lung tissue.**
  - **Lung cancer is, scientifically, the best documented health effect of radon and its decay products.**

# Radon

## Lifetime Lung Cancer Death Risk Per Person (out of 1,000; 2003 Updated)

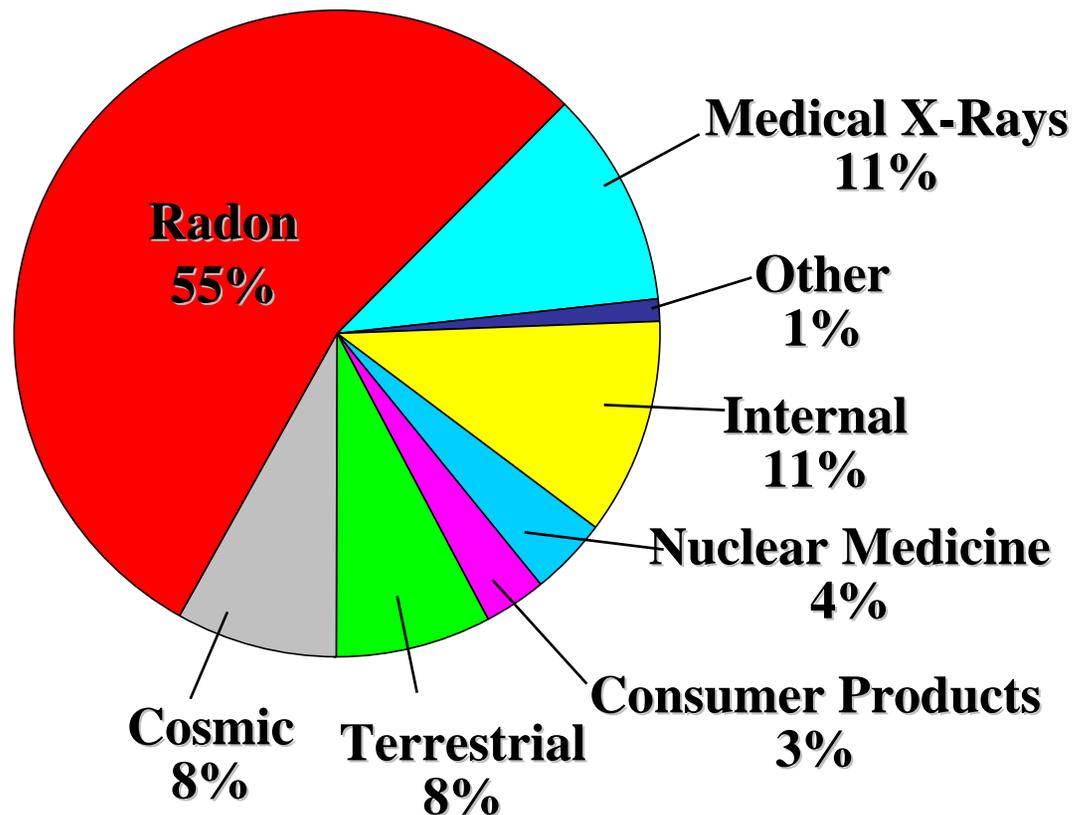
pCi/L	Never Smokers	Current Smokers	General Population
20	36	260	110
10	18	150	56
8	15	120	45
<b><u>4</u></b>	<b><u>7</u></b>	<b><u>62</u></b>	<b><u>23</u></b>
2	4	32	12
1.3	2	20	7

‘Remember, each of these numbers represent a real person with a loving family,’  
Dr. William Field, University of Iowa

# Radon

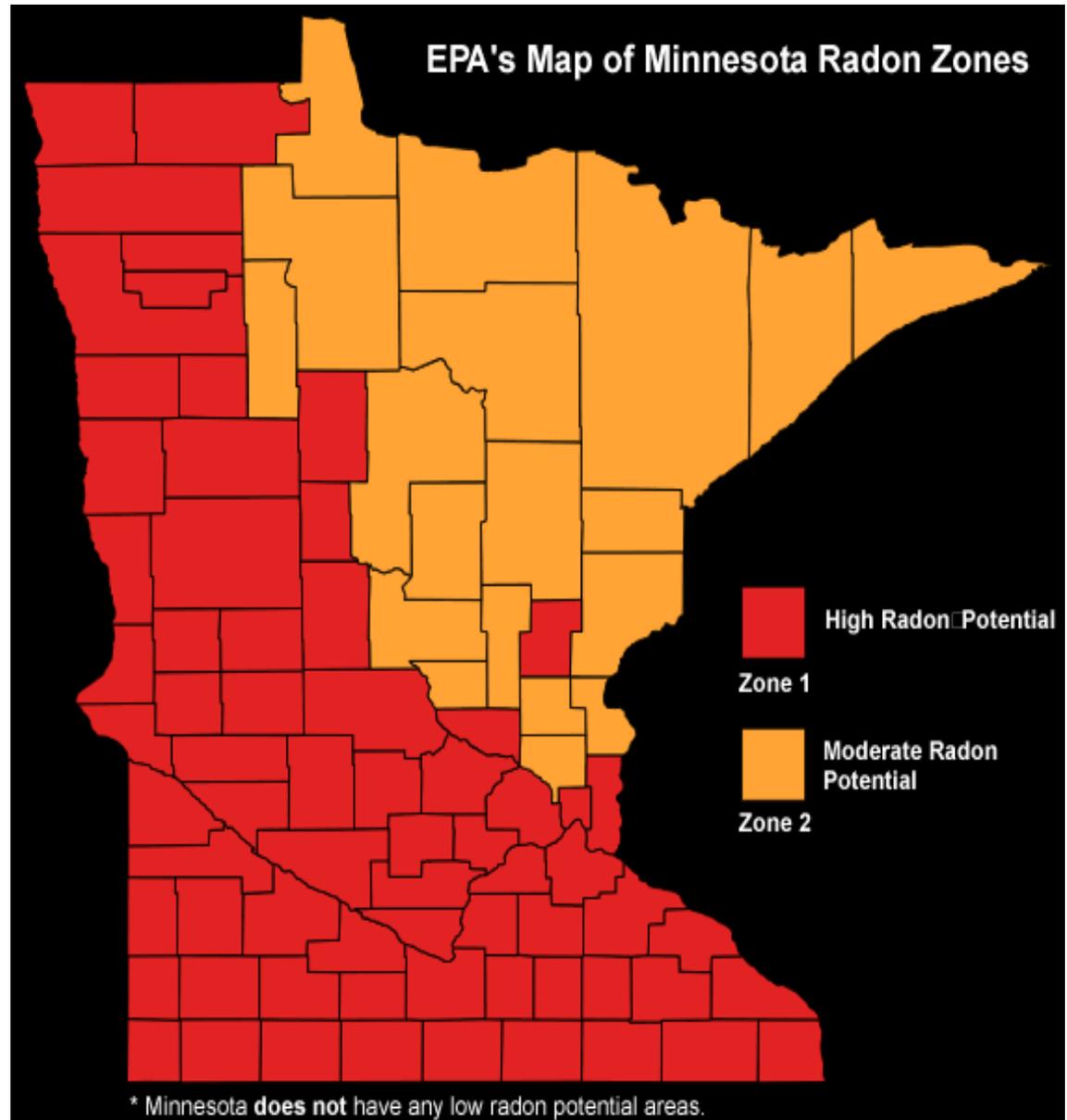
## Sources of Radiation Exposure to the U.S. Population

- Assumes average indoor radon concentration of 1.3 pCi/L.
- Radon is by far the greatest single source of radiation to the general public.

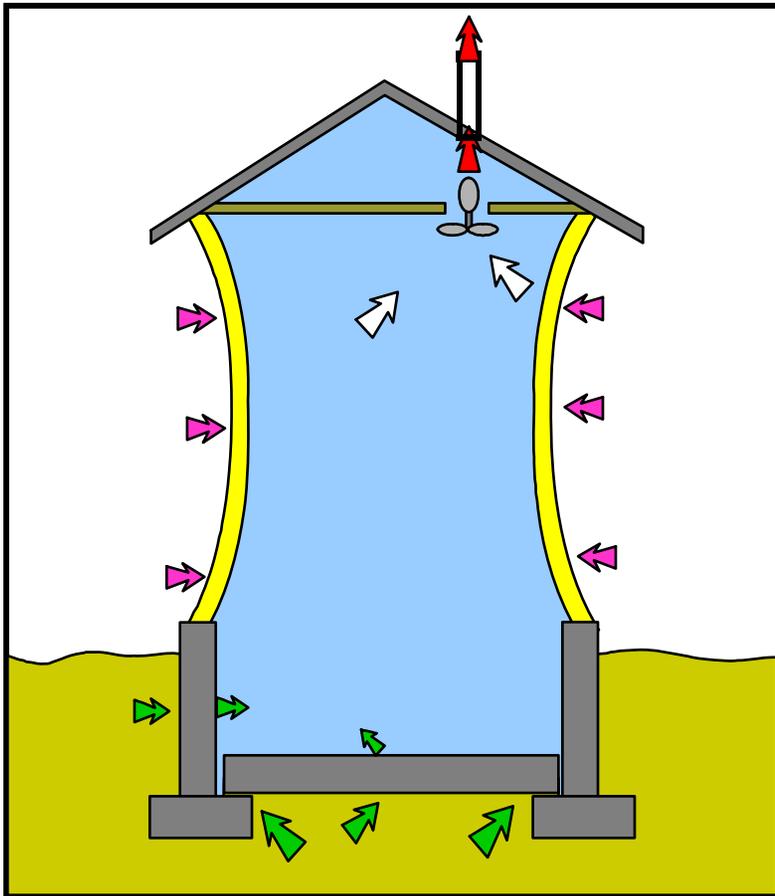


# Radon

**MN. Statutes require a Radon Control system be installed in Residential Structures in Minnesota.**



## How Is Radon Drawn Into A Building?



- **Vacuums created by:**
  - **Exhaust systems**
  - **Thermal stack effects**

## Why worry about new homes?

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## Why worry about new homes?

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  - It's cheaper than having to fix a radon problem after the house is built.
  - It helps protect everyone, not just those who can afford to fix an existing home.
  - **Most features of radon-resistant construction are common building practices since it only involves a few extra steps to prevent radon entry.**

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- **RRNC techniques are consistent with energy-efficient construction (e.g., sealing and weatherization).**

**Radon**

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- **Pursuant to Minnesota Statutes 2006 16B.61 section 1 subd. 3b**

## SUBSLAB DEPRESSURIZATION SYSTEM

- **Passive.** A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a vent pipe routed through the conditioned space of a building and connecting the sub-slab area with outdoor air, thereby relying on the convective flow of air upward in the vent to draw air from beneath the slab.

## SUBSLAB DEPRESSURIZATION SYSTEM

- **Active.** A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a fan-powered vent drawing air from beneath the slab.

## RADON GAS

- **A naturally-occurring, chemically inert, radioactive gas that is not detectable by human senses.** As a gas, it can move readily through particles of soil and rock and can accumulate under the slabs and foundations of homes where it can easily enter into the living space through construction cracks and openings.

## Subfloor preparation

- A layer of gas-permeable material shall be placed under all concrete slabs and other floor systems that directly contact the ground and are within the walls of the living spaces and conditioned crawl spaces, of the building, to facilitate the installation of a sub-slab depressurization system.

## Subfloor preparation

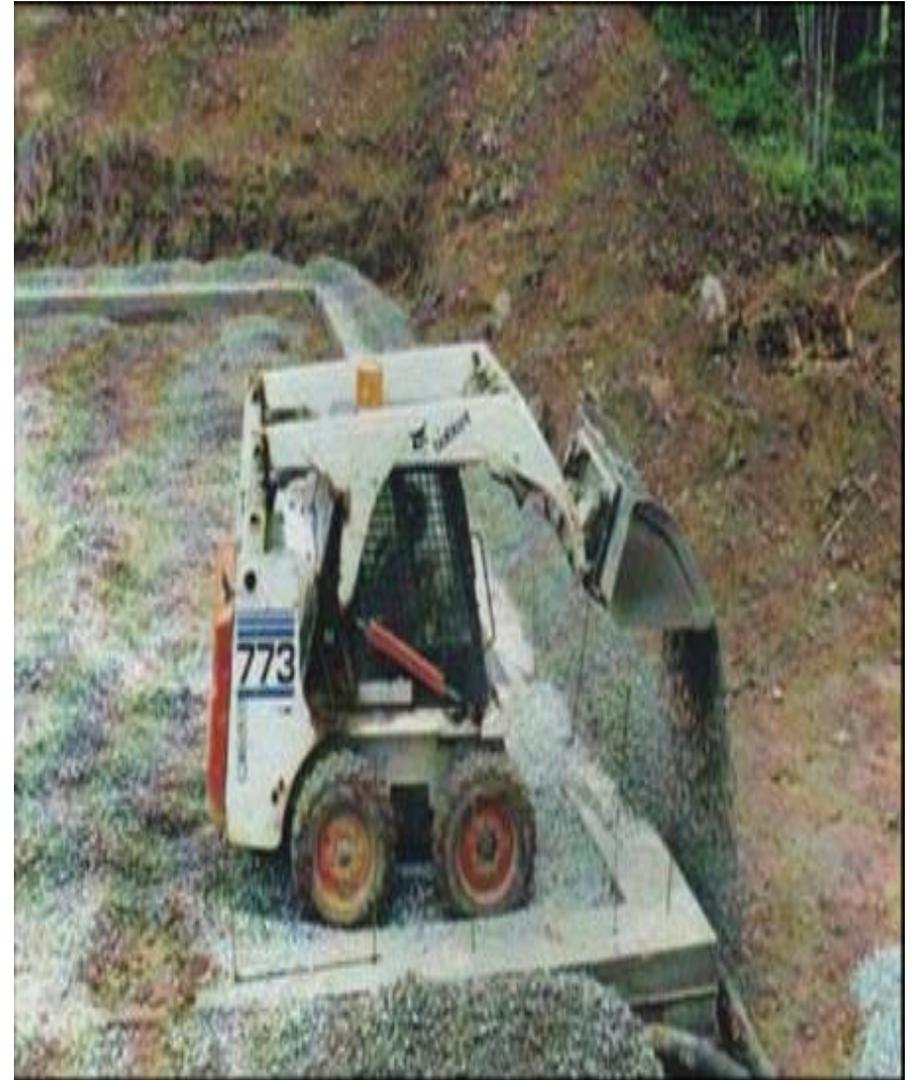
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**Radon**

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# Radon

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  - **3. Other materials, systems or floor designs with demonstrated capability to permit depressurization across the entire sub-floor area.**

# SOIL-GAS RETARDER

- A continuous membrane of 6-mil (0.15 mm) polyethylene, 3 mil (0.075 mm) cross-laminated polyethylene, or other equivalent material used to retard the flow of soil gases into a building.

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- Installed prior to casting the concrete slab
- Cover the entire floor area
- Seams lapped at least 12 inches
  - R506.2.3 requires 6 inch overlap
  - The most restrictive shall apply

# Radon



# SOIL-GAS RETARDER

- The sheathing shall fit closely around any pipe, wire or other penetration of the material.
- All punctures, tears or cuts shall be sealed or covered with additional sheathing.

# **Entry routes**

- Potential radon entry routes shall be closed or sealed.

## Entry routes

- **Floor openings**
  - Openings around **bathtubs, showers**, water closets, pipes, wires or other objects that penetrate concrete slabs or other floor assemblies shall be filled with a polyurethane caulk or equivalent sealant applied in accordance with the manufacturer's recommendations.

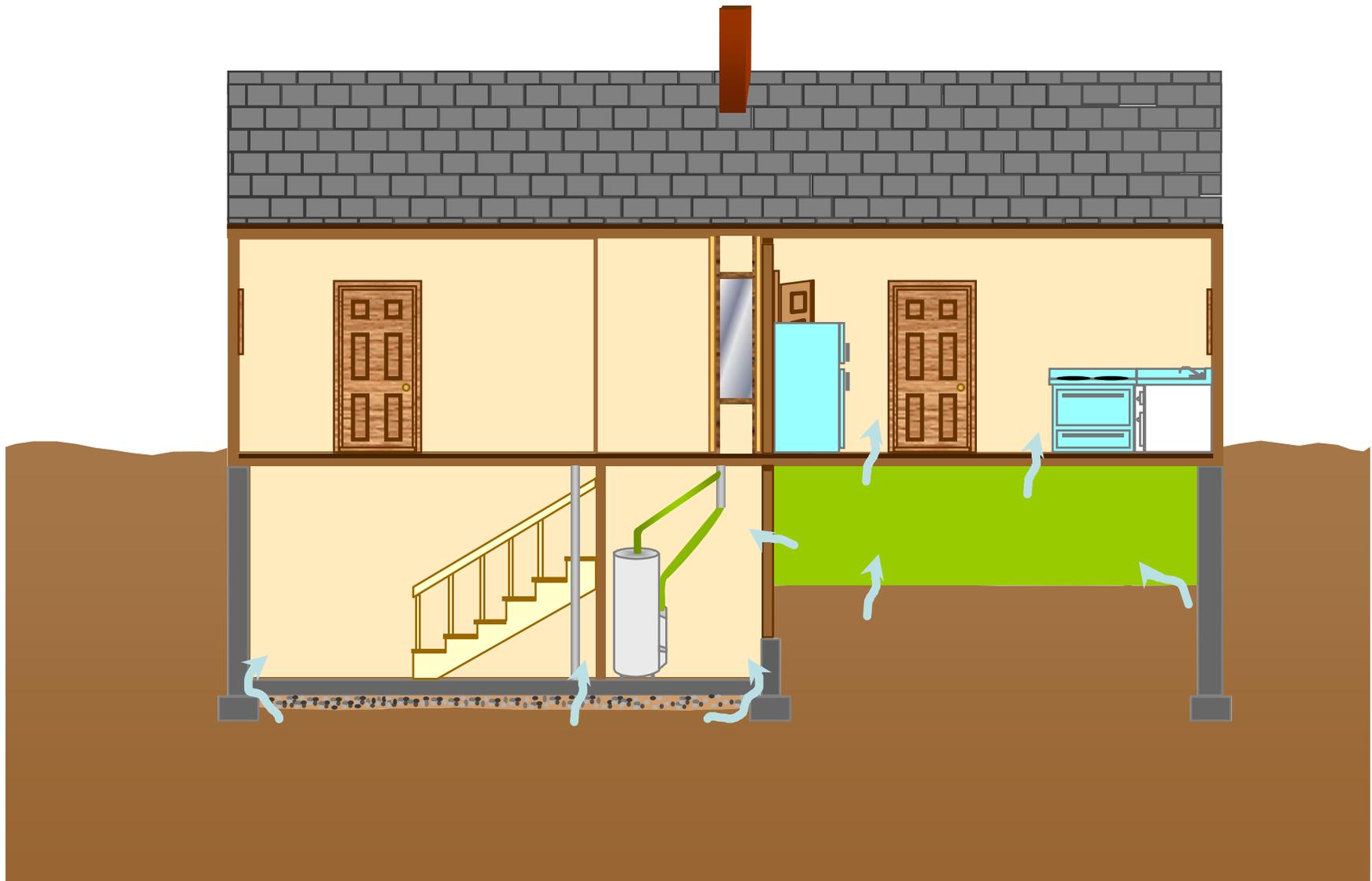


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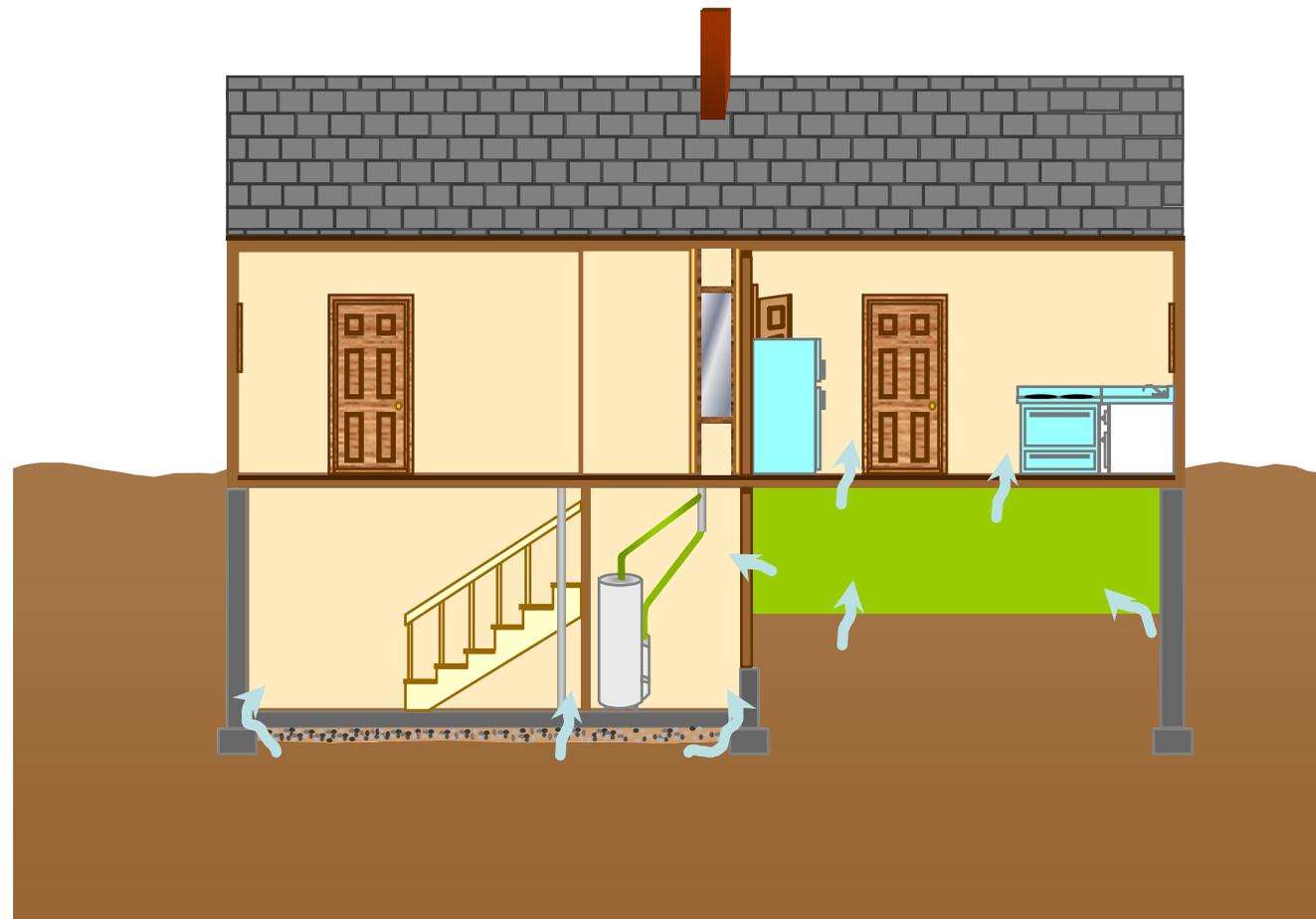
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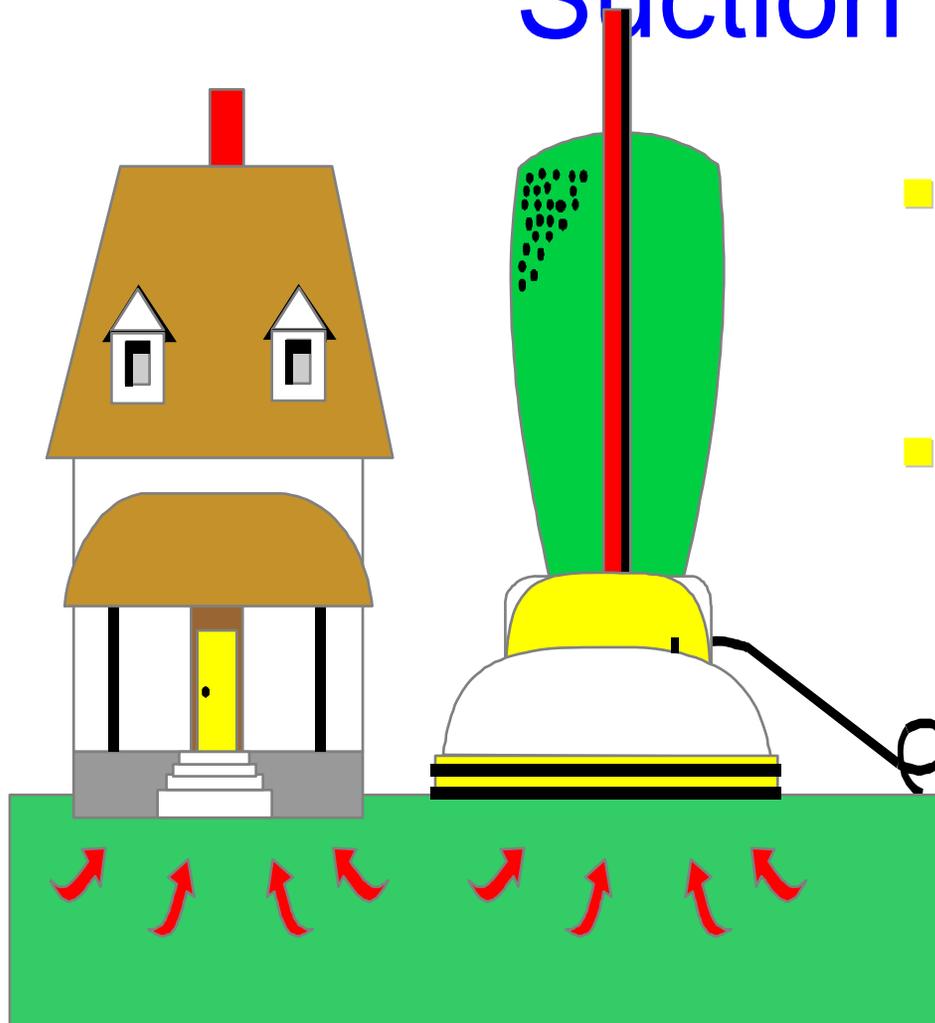


# Untreated Home Draws Radon In



# The Predominant Driving Force is Building Induced Soil Suction

Radon



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

# Entry routes



# Entry routes



# Radon



Radon

**Sumps must be sealed...**



# Foundation Walls

- **Hollow block masonry foundation walls shall be constructed with either**
  - a continuous course of solid masonry,
  - one course of masonry grouted solid, or
  - a solid concrete beam at or above finished grade.
- **Where a brick veneer or other masonry ledge is installed, the course immediately below that ledge shall be sealed.**

# **Unconditioned Crawl Space Floors**

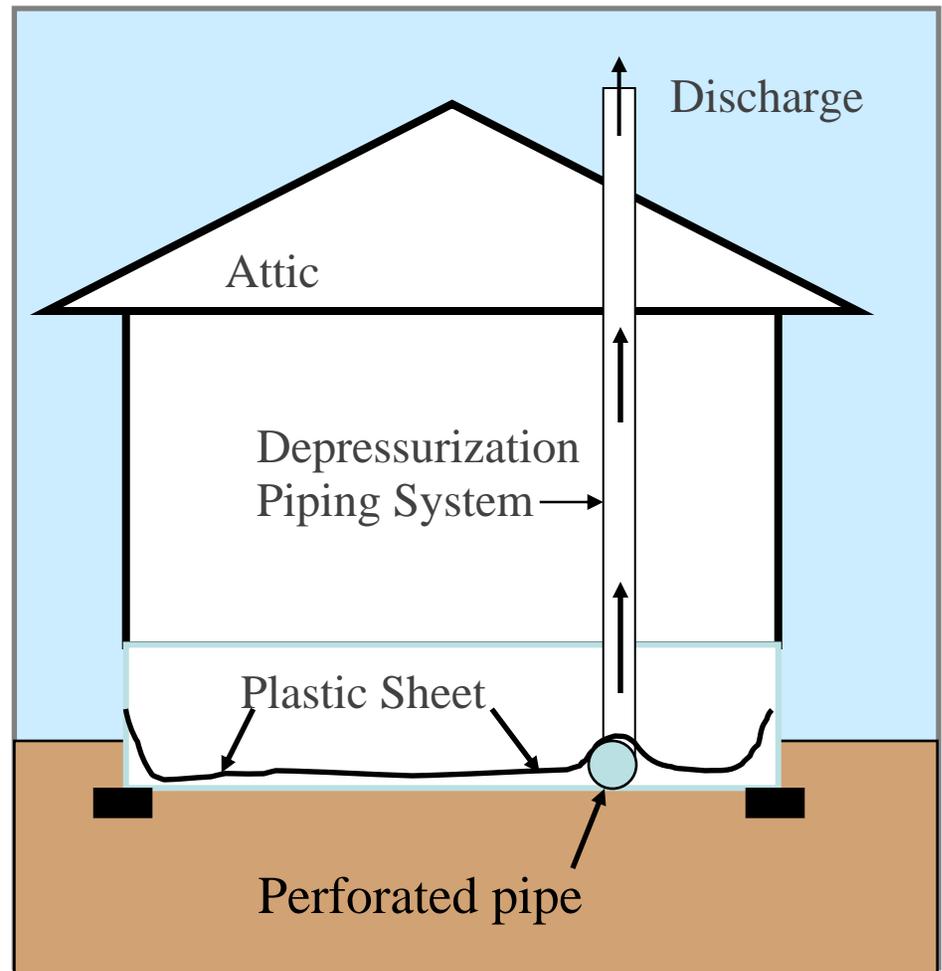
- **Openings around all penetrations through floors above **unconditioned** crawl spaces shall be caulked or otherwise filled to prevent air leakage.**

# **Unconditioned Crawl Space** <sup>Radon</sup> **Access**

- **Access doors and other openings or penetrations between basements and adjoining **unconditioned** crawl spaces shall be closed, gasketed or otherwise filled to prevent air leakage.**

# Passive System Concept for Crawl Spaces

- Suction point is under plastic sheet placed over exposed soil or rock
- Radon is collected and exhausted outdoors
- Seams and edges are sealed
  - Polyurethane caulk
  - Duct Tape



# Vent Pipe

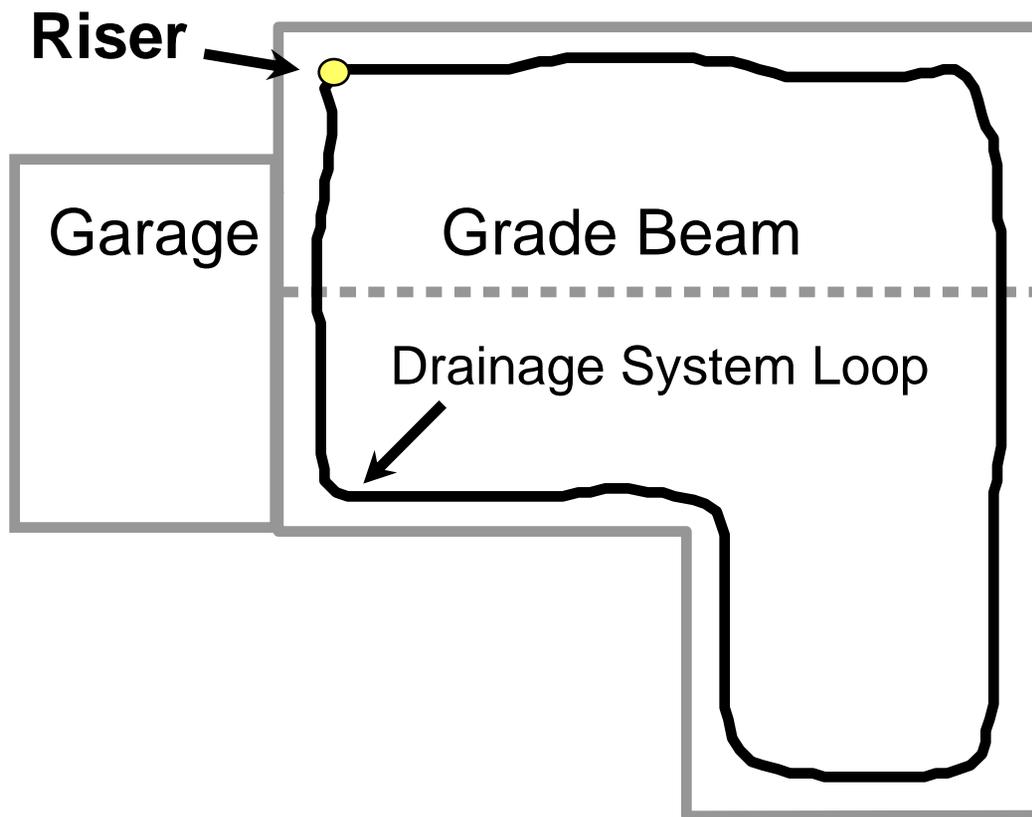
- **A plumbing tee or other approved connection with one ten foot section of a perforated pipe connected to each side shall be inserted horizontally beneath the sheeting and connected to a 3” or 4” vertical pipe extended up through the building floors and terminate at least 12” above the roof in a location at least 10 feet away from any window or other opening into the conditioned space...**

## AF103.6.1 Vent Pipe



- Connect vent pipe to aggregate layer.
- Tee beneath slab
- Add one ten foot section of perforated pipe in each direction

# Vent Pipe



- **Connect vent pipe to interior perimeter drain tile.**
- **Make provisions for pipe to penetrate obstructions.**

# **Multiple Vent Pipes**

- **In Buildings where interior footings or other barriers separate the sub slab aggregate or other gas permeable material, each area shall be fitted with an individual vent pipe**

## Vent Pipe



- **Sump basket option using the interior drainage system** (Few problems in the picture)

# Vent Pipe



**The pipe shall be extended up through the building floors and terminate 12” above the roof...**

# **Vent Pipe Drainage**

- **All components of the radon vent pipe system shall be installed to provide positive drainage to the ground beneath the slab or soil gas retarder.**

# **Vent Pipe Accessibility**

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  - This space shall be a minimum of 24 inches in diameter, centered on the axis of the vent stack
  - **Extending a minimum vertical distance of 3 feet**

# **Vent Pipe Identification**

- **All radon vent pipes shall be identified with at least one label on each floor and in accessible attics. The label shall read: “Radon Reduction System.”**

# Vent Pipe Identification

- **Clearly label the vent pipe as a “Radon Reduction System” to avoid it being misused for plumbing or drainage.**



## Warning System

- In case of failure in the active system, an audible or visible warning system should be installed in a frequently visited area.



## Warning System

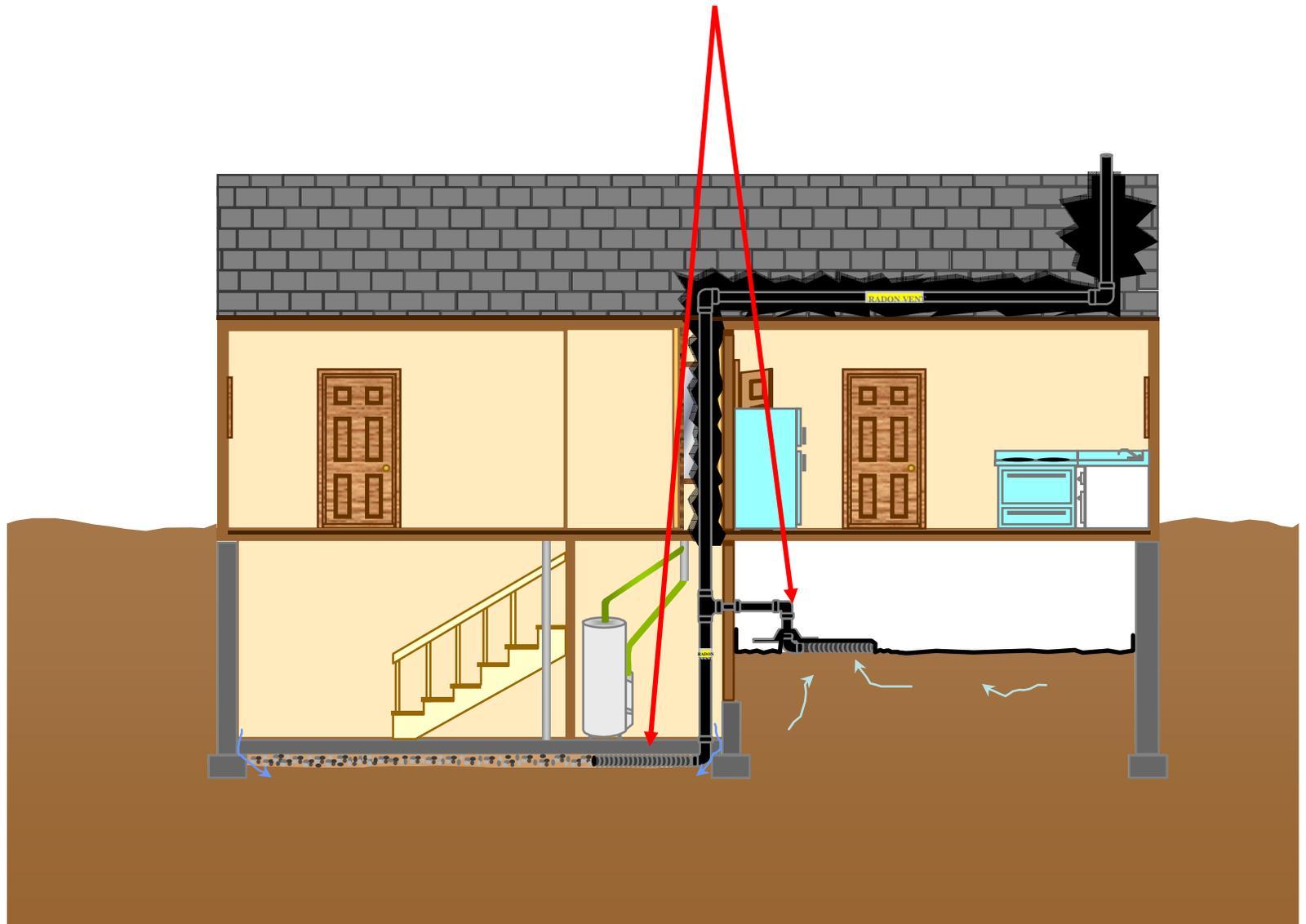
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# Combination Foundations

- **Combination basement/crawl space or slab-on-grade/crawl space foundations shall have separate radon vent pipes installed in each type of foundation area.**
- **Exception: A single vent pipe is allowed in a building with a combination foundation as long as soil gasses can flow freely between the areas of the combination foundations and it is connected to an approved vent pipe.**

# Combination Foundations



## Power Source

**To provide for future installation of an active sub-membrane or sub-slab depressurization system, an electrical circuit terminated in an approved box shall be installed during construction in the attic or other anticipated location of vent pipe fans.**



## Installing a Fan

- **When** a fan is added in the radon vent pipe.
- The fan shall be placed **outside the habitable spaces, such as in an attic.**



# 6 items to address for the foundation using the Energy Code, Radon Provisions and the IRC

Here is one version of what it may look like

# Radon

