Radon Control Methods

Uranium → Radon Particle → Radium Atom
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 Is An Equal Opportunity Hazard!

- Radon in homes can present an unhealthy environment.
- Radon concerns are not dependent upon the age of a home.
- Radon concerns affect expensive and affordable homes alike.
Radon – What is it Anyway?
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- Radon is a cancer-causing, radioactive gas that can be found in homes all across the U.S.
  - Minnesota especially high
    - Geology
    - Climate
    - Housing stock
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• Colorless, tasteless and odorless gas
• \textbf{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

- **Indoor-**
  - 1.3 Pico curies/liter
- **Outdoor-**
  - 0.4 Pico curies/liter
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• Indoor-
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• Outdoor-
  0.4 Pico curies/liter

• Minnesota-
  – About 4.0 pCi/L
  • Long-term average
Radon Entry

1,000s - 100,000s pCi/l

1.3 pCi/l * U.S. annual average indoors in home living areas

0.4 pCi/l * U.S. annual average outdoors

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 Is A Lung Cancer Causing Gas
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- Radon decay products inhaled.
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- Radon decay products inhaled.
- Particles irradiate lungs.
- Irradiation can cause lung cancer.
Alpha Particles Are Strong Enough To Pit Plastic

Photo by Dr. J.F. Burkhart
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• Plastic chip from passive radon test (alpha track).

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- 3 months at EPA Action Level of 4 pCi/L.

Photo by Dr. J.F. Burkhart
Radon Induced Lung Cancer

- Risk increased equally by both duration and concentration of exposure
Radon Induced Lung Cancer

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- **One dart at a time for a long time, or handfuls of darts over a short time**
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.
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<th>pCi/L</th>
<th>Never Smokers</th>
<th>Current Smokers</th>
<th>General Population</th>
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<tr>
<td>1.3</td>
<td>2</td>
<td>20</td>
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‘Remember, each of these numbers represent a real person with a loving family,’
Dr. William Field, University of Iowa
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 Sources Pie Chart]

- Radon: 55%
- Medical X-Rays: 11%
- Other: 1%
- Internal: 11%
- Nuclear Medicine: 4%
- Consumer Products: 3%
- Cosmic: 8%
- Terrestrial: 8%
MN. Statutes require a Radon Control system be installed in Residential Structures in Minnesota.

* Minnesota does not have any low radon potential areas.
How Is Radon Drawn Into A Building?

- Vacuums created by:
  - Exhaust systems
  - Thermal stack effects
Why worry about new homes?

- It makes sense to put RRNC features in while a home is being built -- before the structure is closed in because:
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  - *It helps protect everyone, not just those who can afford to fix an existing home.*
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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.**
Benefits of Passive RRNC System

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Radon

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

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• Pursuant to Minnesota Statues 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.

Radon
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

• The gas-permeable layer shall consist of one of the following:
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  1. A uniform layer of clean aggregate, a minimum of 4 inches (102 mm) thick. The aggregate shall consist of material that will pass through a 2-inch (51 mm) sieve and be retained by a 1/4 inch (6.4 mm) sieve.
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  - 2. A uniform layer of sand (native or fill), a minimum of 4 inches (102 mm) thick, overlain by a layer or strips of geotextile drainage matting designed to allow the lateral flow of soil gases.
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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.
SOIL-GAS RETARDER

- Installed prior to casting the concrete slab
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- Cover the entire floor area
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- Seams lapped at least 12 inches
  - R506.2.3 requires 6 inch overlap
  - The most restrictive shall apply
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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Untreated Home Draws Radon In
The Predominant Driving Force is Building Induced Soil Suction

- 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 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
• 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

- Radon vent pipes shall provide enough space around the pipe for future installation of a fan system.
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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.
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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

Radon
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
Foundation Drainage
Per IRC Section R405

Foundation Waterproofing Per Minn.Rule 1309.0406

(2)

Cap Block or Equivalent

Seal top of block (1)

Interior Drain tile System

R-10 Exterior foundation insulation

(4)

Sub-slab Vapor Retarder per IRC Section 506 extending up the wall 4” and sealed to foundation wall (3)

Provide mechanical ventilation in the basement (5)

Passive Sub – slab depressurization system (6)

Top of Basement Floor

Interior Drain tile System