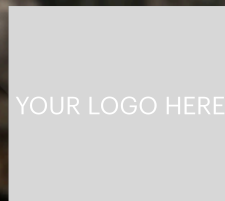


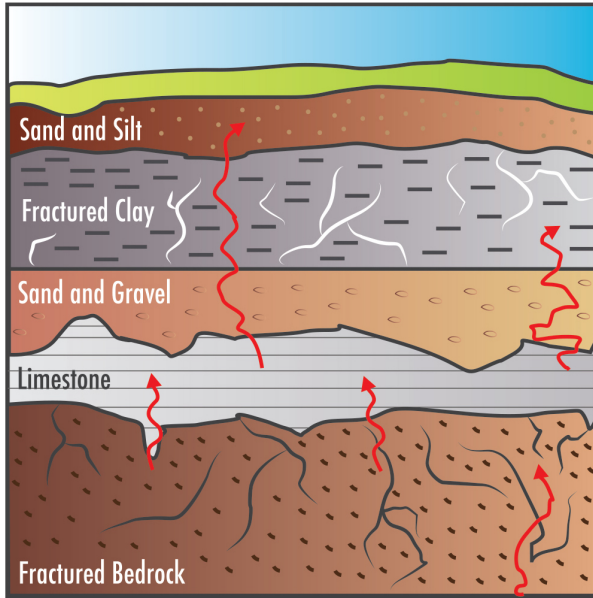
THE BLACK HILLS RADON GUIDE

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WHAT IS RADON?

Radon is a naturally occurring, radioactive gas that is invisible, odorless, and tasteless. It belongs to the noble gas family on the periodic table, meaning it does not react with other materials or leave a visible residue. Because your senses cannot detect it, radon can accumulate inside a home to elevated levels without any warning signs.

THE ORIGIN AND SCIENCE BEHIND THE GAS

Radon is not the result of poor building materials, bad ventilation, or poor housekeeping. It is a natural decay byproduct of **uranium-238**, a radioactive element embedded in the earth's crust since the formation of the planet.

- I. **Uranium to Radium:** Over billions of years, uranium in soil and rock slowly breaks down into **radium-226**.
- II. **Radium to Radon Gas:** As radium continues its natural decay, it transforms into **radon-222** gas.
- III. **Upward Migration:** Because radon is a gas, it frees itself from the surrounding dirt and granite, migrating upward through soil pores and rock fractures toward the surface.

In outdoor air, radon dilutes rapidly to safe, microscopic levels (averaging roughly 0.4 pCi/L nationwide). However, when radon gas encounters a house, the home acts as a trap. The air pressure differences between the warm interior of a building and the surrounding soil draw the gas inside through foundation cracks, sump pits, and slab gaps.

WHY GEOLOGY MATTERS IN THE BLACK HILLS

Here in the Black Hills region of South Dakota, our local geology features rich granite formations, shale, and uranium-bearing mineral pockets. Because our regional soil and rock

structures carry higher concentrations of natural radium, elevated radon levels are common across local homes, whether built slab-on-grade, with a crawl space, or full basement.

HOW RADON IMPACTS HEALTH

The Environmental Protection Agency (EPA) and the World Health Organization (WHO) classify radon as a **Class A known human carcinogen**. It is the leading cause of lung cancer among non-smokers in the United States, responsible for approximately 21,000 lung cancer deaths each year.

- **Radon Decay Products (Progeny):** Radon gas decays into tiny radioactive solid particles (Polonium-218 and Polonium-214).
- **Alpha Radiation in the Lungs:** When inhaled, these heavy particles attach to the delicate cellular lining of the lungs. As they decay further, they emit high-energy **alpha radiation**.
- **Cellular Exposure:** Over extended periods of exposure, alpha particles damage lung tissue DNA, increasing the risk of cellular mutation and lung cancer.

HOW IS RADON TESTED FOR?

Because radon levels fluctuate based on weather, barometric pressure, soil moisture, and HVAC usage, testing requires precise equipment and standardized protocols—especially during a real estate transaction. There are two primary testing methods: passive kits and active continuous monitors.

- **Passive Charcoal Test Kits (DIY / Screening):**
 - **How they work:** Charcoal canisters or liquid scintillation vials are placed in the home for 48 to 96 hours. The charcoal absorbs radon gas, and the kit is mailed to a laboratory for analysis.
 - **Best for:** Initial homeowner screenings or routine long-term tracking.
 - **Limitations:** Susceptible to delay in lab shipping, weather spikes, and lack tamper detection.
- **Continuous Radon Monitors (CRM) (Professional Standard):**
 - **How they work:** A calibrated electronic chamber samples the air every hour throughout a 48-hour period, recording real-time radon concentration, hourly temperature, relative humidity, and barometric pressure.

- **Best for:** Real estate inspection windows where immediate, verified data is required.
- **Advantages:** Provides an hourly graph showing fluctuations, includes motion/tamper sensors, and generates an official report on-site as soon as the test completes.

THE "CLOSED-BUILDING CONDITIONS" RULE

For a 48-hour radon test to be valid under EPA and InterNACHI guidelines, the home must be placed under **Closed-Building Conditions**. This creates a stabilized environment that reflects a home's typical wintertime conditions.

- I. **12-Hour Pre-Test Window:** All windows and exterior doors must remain closed for at least 12 hours prior to the start of the test (normal entry/exit is permitted, but doors cannot be left propped open).
- II. **Duration of the Test:** All windows and exterior doors must stay closed for the full 48-hour testing period.
- III. **HVAC Settings:** Heating and central air conditioning systems can run normally, but whole-house attic fans, window units in fresh-air mode, and wood-burning stoves/fireplaces should remain off.

PROPER MONITOR PLACEMENT

To ensure an accurate reading, inspectors place radon testing equipment under strict environmental parameters:

- **Lowest Livable Level:** The monitor is placed in the lowest level of the home that is lived in or could be adapted for living space (e.g., a finished basement or an unfinished basement intended for future living space).
- **Clearance Requirements:** The unit is placed at least 20 inches off the floor, away from exterior walls, out of direct sunlight, and at least 3 feet away from doors or windows.
- **Draft Avoidance:** Monitors are kept clear of supply vents, ceiling fans, kitchens, and high-humidity areas like bathrooms or laundry rooms.

INTERPRETING THE RESULTS

Once the 48-hour test concludes, the monitor calculates the **overall average concentration**.

- **Under 2.0 pCi/L:** Considered low indoor radon concentration. No action required.
- **2.0 pCi/L to 3.9 pCi/L:** Moderate level. The EPA suggests considering mitigation, especially if long-term plans involve spending significant time in lower levels.
- **4.0 pCi/L and Above:** Elevated level. The EPA recommends professional mitigation to reduce indoor concentrations.

 **Inspector's Quick Tip for Real Estate Testing:** If you are selling a home, do not open windows right before or during a radon test. Opening windows can create a draft effect that actually pulls *more* soil gas into the basement, inadvertently spiking your test average higher than normal.

WHAT ARE MY OPTIONS IF RADON IS FOUND?

Discovering elevated radon levels during an inspection can feel worrying, but in the context of residential construction, radon is one of the most manageable discoveries on a home report.

Option 1: Active Soil Depressurization (ASD)

The industry standard and most effective method for reducing indoor radon is **Active Soil Depressurization (ASD)**.

- Instead of trying to seal every hairline crack in a concrete floor, an ASD system alters the pressure dynamic beneath the building.
- A specialized inline radon fan creates a continuous vacuum underneath the foundation slab or vapor barrier.
- The system pulls radon gas out from beneath the house before it ever enters the living space and vents it safely above the roofline.
- Properly installed ASD systems routinely reduce elevated radon levels (20–50+ pCi/L) down to well below 2.0 pCi/L.

Option 2: Crawl Space Sub-Membrane Depressurization

If your home is built over a dirt or gravel crawl space rather than a concrete slab:

- A heavy-duty, reinforced poly plastic vapor barrier (typically 6-mil to 20-mil thickness) is laid over the entire dirt floor and sealed tightly to the foundation walls and piers.
- A suction pipe is installed underneath this membrane, connected to an inline fan.
- This encapsulates the soil gas and pulls it outside before it can pass through the floorboards into the home.

Option 3: Passive Systems & HVAC Options

- **Passive Radon Systems:** Often installed in newer home construction. A PVC pipe runs from beneath the slab up through the roof without a fan, relying on natural heat stack effects. If test levels remain above 4.0 pCi/L, a certified mitigator simply adds an inline fan to convert it into an active system.
- **Energy Recovery Ventilators (ERV):** In rare cases where sub-slab vacuuming is mechanically unfeasible, an ERV system exchanges indoor air with fresh outdoor air while preserving interior heating and cooling.

NAVIGATING RADON IN REAL ESTATE ESCROW

When elevated radon (4.0 pCi/L or higher) turns up during a buyer's inspection, it is handled routinely through standard real estate repair negotiations.

1. **Seller Credit or Concession:** The seller offers a financial credit at closing to cover the cost of professional mitigation (typically ranging between \$1,500 and \$2,500 depending on foundation design).
2. **Seller-Installed Mitigation:** The seller contracts a state-licensed/NRPP-certified radon mitigation specialist to install a system prior to closing.
3. **Post-Mitigation Re-Test:** A follow-up 48-hour continuous radon test is performed after system installation to verify that levels have dropped below 4.0 pCi/L before closing escrow.

 **Inspector's Perspective:** Never let a high radon number break a contract. A home with an active, professionally installed radon mitigation system often enjoys cleaner, safer indoor air quality than a home that was never tested at all.

HOW ARE RADON SYSTEMS INSTALLED?

Understanding how a radon mitigation system is physically constructed helps sellers and buyers evaluate system quality, aesthetic placement, and ongoing maintenance needs.

Step 1: Selecting the Suction Point & Route

A certified radon mitigation contractor evaluates the home's footprint to find the optimal location for the suction pit and exhaust routing.

- **Slab Diagnostic:** The installer identifies an unobtrusive location on the lowest floor—frequently inside a mechanical room, utility closet, or corner of the basement.
- **Exhaust Pathing:** The PVC pipe path is planned either *internally* (running up through closets and out the roof) or *externally* (exiting the basement wall and running up the exterior siding).

Step 2: Excavating the Suction Pit

1. **Slab Core:** The installer cuts a neat 4-inch or 5-inch hole through the concrete slab foundation using a diamond core bit.
2. **Soil Removal:** They excavate roughly 5 to 10 gallons of dirt, rock, or gravel from directly beneath the slab hole.
3. **Creating a Suction Pit:** Removing this material creates a small open cavity under the concrete, allowing the fan's vacuum draw to spread across the entire underside of the house.

Step 3: Running the PVC Vent Pipe

- A 3-inch or 4-inch schedule 40 PVC pipe is inserted into the suction hole and sealed airtight with polyurethane caulk.
- The pipe runs upward toward its termination point. All horizontal runs must slope slightly back toward the suction pit so that condensation inside the pipe drains naturally down into the soil rather than pooling in the pipe or freezing the fan.

Step 4: Fan Placement & Electrical Wiring

Per national standards (AARST/NRPP), **the radon fan must never be installed inside the living space or in a basement.** If a pressurized pipe leak were to occur, it would pump concentrated radon gas right back into the living area.

- **Approved Locations:** Exterior side wall, unheated attached garage, or attic space.
- **Exhaust Clearance:** The top of the exhaust pipe must extend at least 10 feet above ground level, at least 12 inches above the roofline, and at least 10 feet away from any openable windows, doors, or fresh air intakes.

Step 5: Sealing Key Air Leaks

To maximize system efficiency, the technician seals visible floor cracks, open sump pump pits (installing airtight sump covers), and perimeter slab expansion joints with specialized polyurethane sealant. This prevents the system from pulling conditioned interior air out of the home.

Step 6: System Monitoring with a U-Tube Manometer

Every installed system includes a simple diagnostic gauge called a **U-Tube Manometer**, mounted directly to the indoor PVC pipe.

- **How to Read It:** The clear tube contains a bright red or blue liquid. One side of the tube is open to room air; the other side connects into the PVC pipe.
- **Normal Operation:** When the fan is drawing a vacuum, the liquid levels on the two sides of the "U" will be offset (uneven).
- **System Failure:** If the liquid levels are equal (zeroed out), it indicates that the fan has lost power, the circuit breaker tripped, or the fan unit has failed.

Step 7: Post-Mitigation Verification

After installation, a 48-hour continuous radon test should be conducted to verify that indoor levels are well below 4.0 pCi/L. Once confirmed, the system operates continuously 24/7 with minimal energy draw (typically equivalent to a standard 60-watt lightbulb).

 Inspector's Final Checklist for System Approval:

- Is the fan mounted outside the living space (attic, garage, or exterior wall)?
- Does the exhaust stack terminate safely above the roofline?
- Is the U-Tube manometer clearly visible on the PVC pipe?
- Did the contractor provide a written post-mitigation test verifying levels below 4.0 pCi/L?



Radon is a silent variable, but it doesn't have to be an intimidating one. Whether you are buying a home nestled against the granite of the Black Hills or preparing to sell a property you've cherished for years, understanding radon is simply part of taking care of the home. Testing is straightforward, mitigation is dependable, and a certified professional can turn an unexpected test result into a solved problem in a matter of hours. Approach the data methodically, trust the process, and remember that a well-maintained home is a safe and healthy home.



This guide was prepared for you by Ridgeline Home Inspections, LLC.

Ridgeline Home Inspections is a veteran-owned, family-run home inspection firm proudly serving Western South Dakota and Eastern Wyoming.

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Our Services

- **Pre-Listing Home Inspections:** Comprehensive evaluations for sellers who want to uncover potential deal-breakers, perform repairs early, and list with total peace of mind.
- **Buyer's Home Inspections:** In-depth property inspections designed to help buyers understand the condition of their future home before closing.
- **Aerial Drone Roof Inspections:** To safely evaluate roof lines, chimneys, and multi-story structures that are otherwise inaccessible.
- **Maintenance & System Audits:** Periodic property evaluations for homeowners looking to proactively protect their investment and catch small issues before they become major repairs.
- **Radon Testing:** Continuous digital monitoring to accurately measure levels of odorless, invisible radon gas in the home, delivering fast, precise reports needed for real estate transactions and family health peace of mind.
- **Water Quality Testing:** Certified laboratory water sampling for both private wells and municipal drinking supplies. Well water testing packages are customized to meet strict FHA, VA, USDA, and conventional loan compliance requirements.

Disclaimers & Legal Limitations

Safety First: Know Your Limits

While understanding and managing radon is an essential part of homeownership, safety and regulatory compliance always come first. Certain aspects of radon testing and mitigation—such as core-drilling foundation slabs, running electrical wiring for active systems, or modifying structural elements—require specialized training and equipment. Never attempt modifications beyond your comfort level or local licensing capabilities. If a radon mitigation system requires electrical wiring, core drilling, or structural penetration, utilize a state-certified, licensed, and insured radon professional. Improper installation can compromise the effectiveness of the system, cause property damage, or result in personal injury.

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This checklist is provided solely as a general educational resource to assist homeowners and real estate professionals in preparing a property for market. It is not a substitute for a comprehensive, professional home inspection conducted in accordance with SDREC standards of practice. Completing the items on this list does not constitute a formal warranty, guarantee, or structural certification of the property, nor does it guarantee a flawless buyer inspection report.

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