



# radon

Keeping your home safe from radon

**m** DEPARTMENT  
OF HEALTH

# What is radon?

Radon is a colorless and odorless gas that comes from the soil. The gas can accumulate in the air we breathe. Radon gas decays into fine particles that are radioactive. When inhaled these fine particles can damage the lung. Exposure to radon over a long period of time can lead to lung cancer.

It is estimated that **21,000 people die each year in the United States from lung cancer due to radon exposure**. A radon test is the only way to know how much radon is in your home. Radon can be reduced with a mitigation system.

The Minnesota Department of Health has created this guide to explain:

- how radon accumulates in homes
- what are the health risks of radon exposure
- how to test your home for radon
- what to do if your home has high radon, and
- radon policies and professional licensing.



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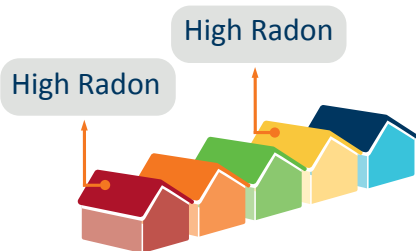
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# Where does radon come from?

Radon is produced from the natural decay of uranium and radium, found in rocks and soil. Uranium breaks down to radium and radium eventually decays into the gas radon. Radon gas is in the soil and common throughout Minnesota. Because soil is porous, radon moves up from the soil and into the home. It can then accumulate in the air and become a health concern.

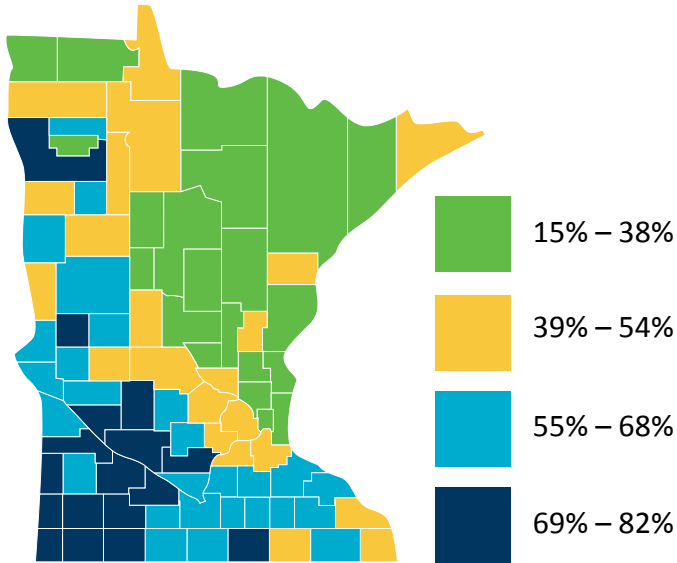
## Radon in Minnesota

Radon is a serious public health concern in Minnesota. The average radon level in Minnesota is more than three times higher than the U.S. radon level. This is due to our geology and how our homes are operated. Minnesota homes are closed up or heated most of the year, which can result in higher levels of radon. **In Minnesota, more than two in five homes have radon levels that pose a significant health risk.**



*Any home can have high radon, whether old or new, well-sealed or drafty and with or without a basement.*

## Percent of MN Properties Tested for Radon that are $\geq 4$ pCi/L (2010 – 2016)



## Is there a safe level of radon?

Any radon level poses some health risk. While it is not possible to reduce radon to zero, the best approach is to lower the radon level as much as possible. The Environmental Protection Agency (EPA) has set the action level at 4 pCi/L (picocuries of radon per liter of air). It is highly recommended at 4 pCi/L or higher a radon mitigation system is installed to reduce the radon level.

# Radon health risks

It is the number one cause of lung cancer for non-smokers and the second leading cause of lung cancer in smokers. Your risk for lung cancer increases with higher levels of radon and longer periods of exposure. If you smoke, the combined risk of smoking and radon exposure is much higher. Reducing smoking and radon exposure greatly reduces your lung cancer risk.

## Lifetime Risk of Lung Cancer Death from Radon Exposure (per 1,000 people)

Average Radon Level (pCi/L)	People who never smoked	People who currently smoke	U.S. general population
20	36	260	110
10	18	150	56
4*	7	62	23
2	4	32	12

2003, "US Environmental Protection Agency Assessment of Risks from Radon in Homes".

\* **EPA Action Level.** For the U.S. general population who are exposed to 4 pCi/L of radon over a lifetime, it is estimated that 23 out of 1,000 people will die from lung cancer due to radon exposure.

# How radon enters the home

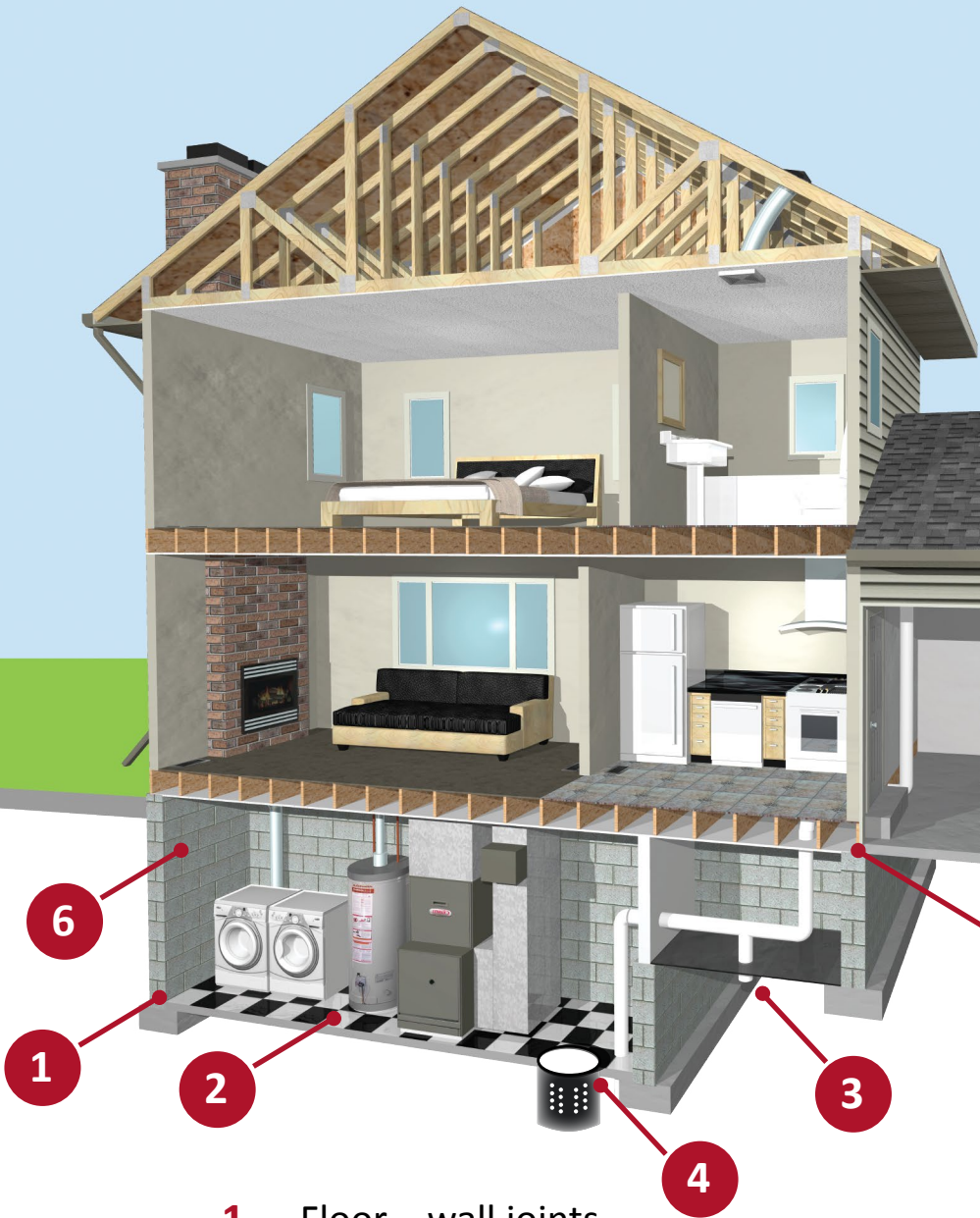
Radon levels are very low outdoors, but can accumulate to high concentrations in the home. This depends on radon levels in the soil, pathways for radon to enter the home, and the driving force. Air pressure differences between the outside air and the inside air act to drive radon into the home. Some homes pull more radon into the home than others due to greater pressure differences and available pathways.



**Source** – High levels of radon are naturally found in Minnesota soils.

**Pathways** – Are routes the gas takes to enter the home, usually through openings between the soil and the home. These may include cracks in the concrete slab, floor-wall joints, an open sump pit, or untreated crawl space.

**Air Pressure** – Differences in air pressure between the home's interior and the soil can pull radon gas into the home through the pathways.

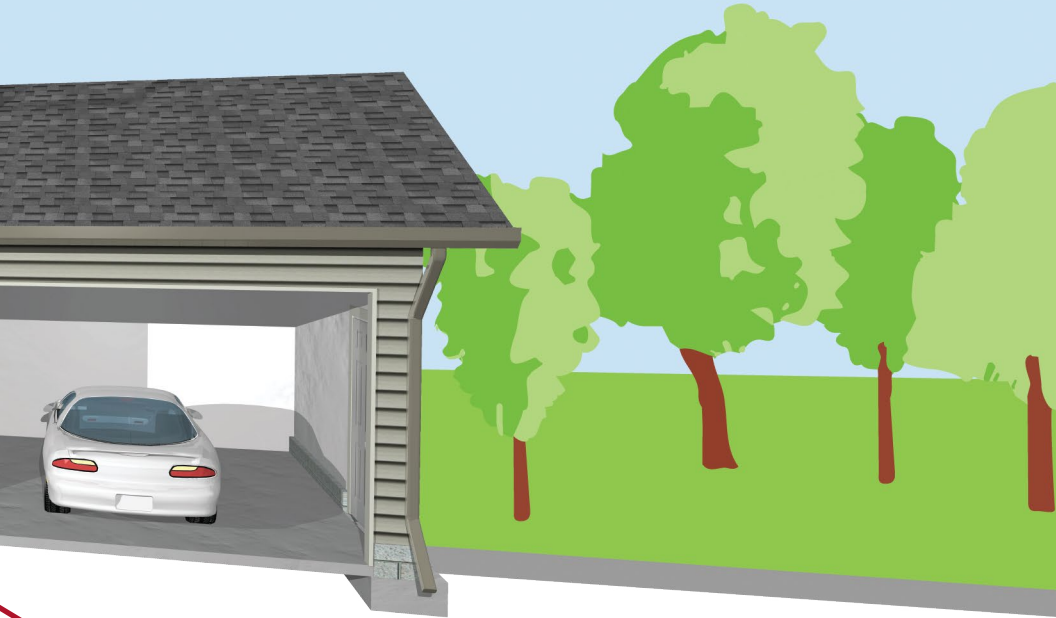


- 1** Floor – wall joints
- 2** Pores and cracks in concrete blocks or slabs
- 3** Exposed soil, such as in a crawl space





# Radon Pathways



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The examples provided here are the most common pathways.

- 4 Sump basket
- 5 Open tops of block walls
- 6 Mortar joints

## Air pressure

Homes commonly operate at a lower ('negative') pressure compared to the outside air. This pressure difference creates a vacuum and outside air can be pulled into the home through openings like doors and windows. Some of the replacement air comes from the soil. There are three main components contributing to air pressure changes in the home that can bring in radon gas.



**Stack Effect** – Warm air rises to the upper portion of the home and is lost to the outside air. Make up air enters the lower part of the home, some make-up air comes from the soil.



**Down Wind Draft Effect** – Strong winds can blow over the top of the home, pushing and pulling air into and out of the house.



**Vacuum Effect** – Appliances (water heaters, fireplaces, clothes dryers, older furnaces, etc.) and exhaust fans remove air from the home. This can drive soil gas into the home as make-up air enters the lower part of the house.

# Foundations

Any home can have a radon problem, no matter the type of foundation.



A **basement** provides a large surface area in contact with the soil and radon can enter through different pathways. Taller homes also add potential for a greater stack effect.

Homes built **slab-on-grade** have many openings that allow radon to enter, similar to a basement.



Homes built with **crawl spaces** are directly connected to the soil and create a pathway for radon to enter the home.

**Manufactured homes with solid skirting** act like crawl spaces and provide a direct connection to the soil.



# Radon testing

MDH recommends all Minnesotans test their home for radon. A radon test is the only way to find out how much radon is in your home. You can test your home yourself or hire a professional. Most radon tests can be performed on your own, once you familiarize yourself with the instructions. Hiring a radon measurement professional is recommended when an unbiased, third party is needed, such as in a real estate transaction. The result from a properly performed test will help you decide if you need to reduce your home's radon levels.

## Types of radon test kits



### Short-term

A short-term test measures radon levels for 2 – 7 days and is a quick way to screen a home for radon. When you test for radon you should start with a short-term test.

## Long-term

A long-term test measures radon levels for a period greater than 90 days. They are the best way to estimate the annual average radon level in the home. Long-term testing should include part of the heating and non-heating seasons.

## How often should I test for radon?

- All Minnesota homes should be tested for radon and then retested every 2 – 5 years.
- Retest after adding a radon mitigation system to make sure it is working properly.
- Test before and after you make changes to the home, like finishing a basement, adding an addition, or installing a vent hood in the kitchen. This also includes if you add or modify your home's central air conditioning or heating system.

## Where can I get a radon test kit?

Radon test kits are available for a discount at the MDH radon website. A radon test kit costs between \$5 and \$30, depending on the type of kit. Some test kits may also require an analysis fee paid after mailing the kit to the lab. Your local health department or government agency may also offer test kits at reduced prices. A list of those offering test kits can be found at the MDH website.

# RADON TESTING GUIDELINES

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**Instructions** – Read the instructions that come with the radon test kit and fill out the information. Check the expiration date on the kit.

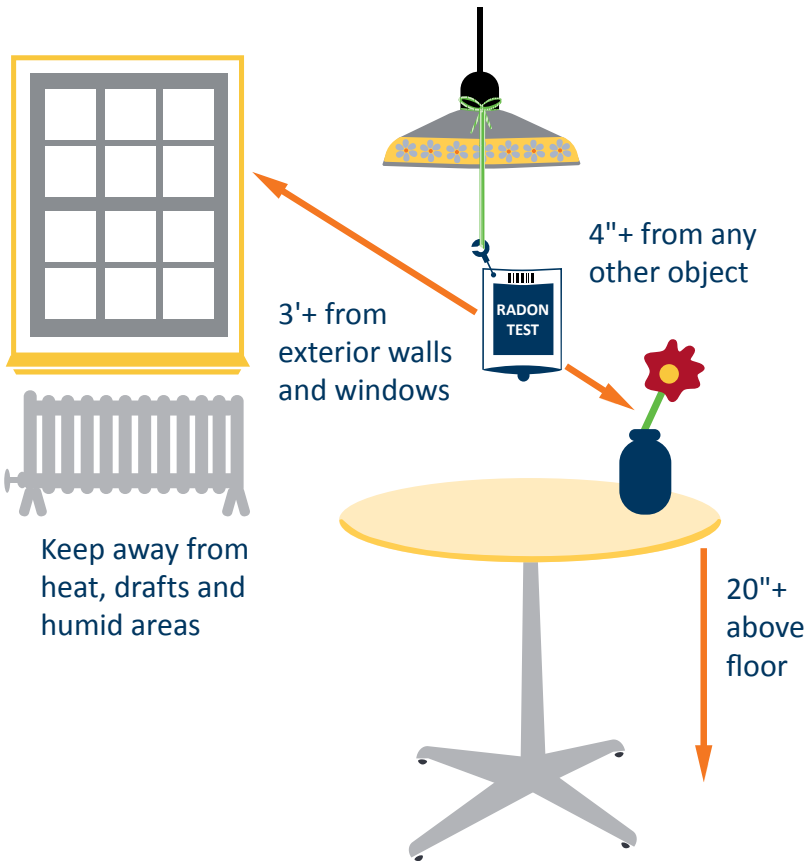
**Time of Year** – Short-term tests can be completed any time of year, but the heating season is the best time to test. Long-term tests should include some of the heating and non-heating seasons.

**Weather** – Weather can affect the radon levels in the home. If there is severe or unusually windy weather, wait to perform a short-term test.

**Test Location** – Test the lowest level of the home that is regularly used. For example, if you spend more than 10 hours a week in the basement, we recommend testing the basement. For real estate transactions, test the lowest level that can be occupied ("livable"). Place the test kit at least 20 inches off the floor where it will not be disturbed. Keep the kit three feet from exterior walls and windows and away from drafts. Keep away from high humidity areas like kitchens, baths, and laundry rooms. Keep away from heat, like fireplaces and furnaces.

**Home Conditions** – Any test lasting less than 3 months requires closed-house conditions. This means keeping all windows and exterior doors closed, except for normal entry and exit.

# Test Device Placement



Once the test is finished seal the package and send to the lab immediately. Make sure all information is completed and note the test kit ID number for future reference.

# Radon test results

You should **complete two tests** before deciding to install a radon mitigation system, except when a professional uses a continuous radon monitor. **Start with a short-term test.**

## Initial short-term test

Result (pCi/L)	Action
0 – 1.9	Retest every 2 to 5 years with a short-term test
2 – 8	Perform a follow-up long-term test
Greater than 8	Perform a follow-up short-term test







## Second test (either short or long-term test)

Result (pCi/L)

Action

0 – 1.9



Retest every 2 to 5 years\*

2 – 3.9



Consider a radon mitigation system

4 or  
greater



Highly recommend  
a radon mitigation  
system

\* If the initial test was 8 pCi/L or above,  
consider performing a long-term test.

# Radon mitigation systems

Radon mitigation is any process or system used to reduce radon concentrations in buildings. The goal of the radon mitigation system is to reduce the indoor radon level as low as reasonably achievable. All systems should reduce radon below the EPA action level of 4 pCi/L. A quality radon mitigation system may reduce year-round levels to below 2 pCi/L.

A home's foundation type helps determine the radon mitigation system that will work best. A radon professional should determine the type of mitigation system to install and may conduct some diagnostic testing. Radon mitigation systems use a fan to continuously pull air from the soil and exhaust it outdoors through a pipe. The pipe can either run inside or outside the home and discharges outside, away from windows and openings. In addition, cracks and openings in the foundation are sealed. Sealing limits the flow of radon and makes the radon mitigation system more efficient.



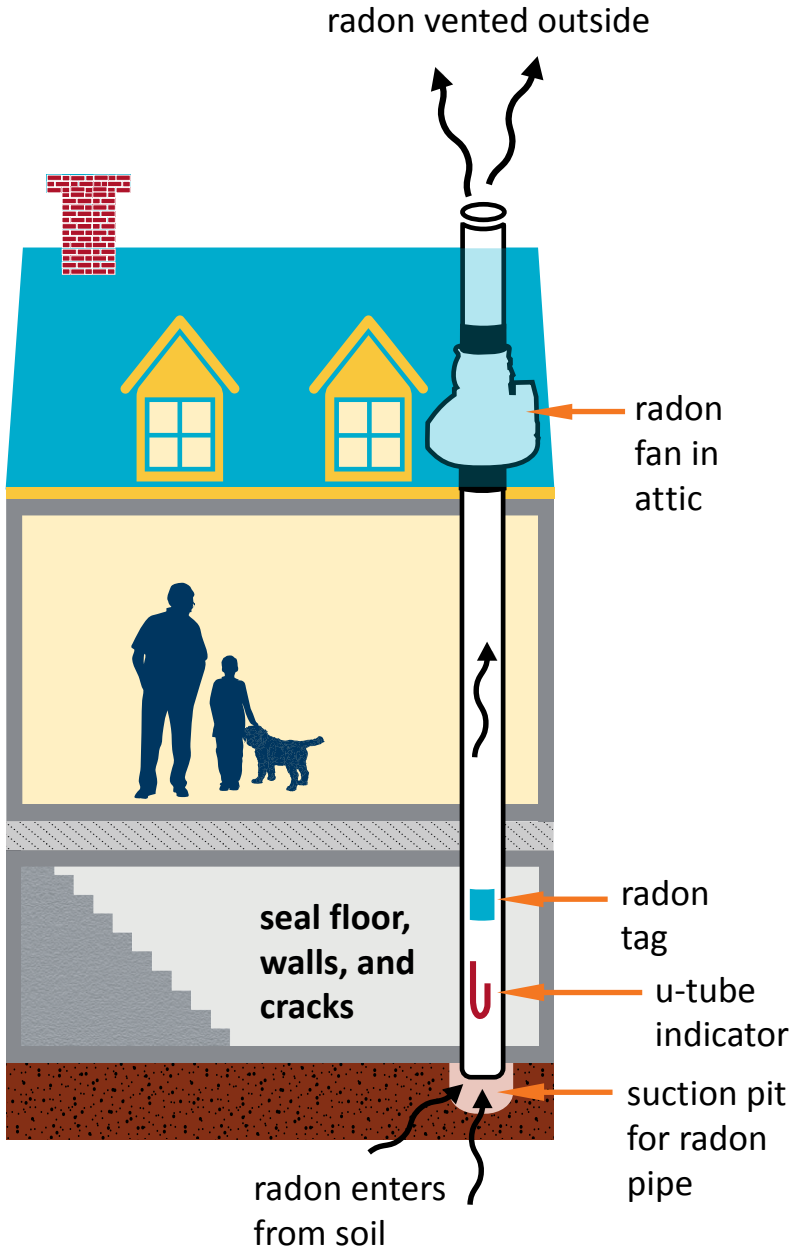
## Three of the most common types of radon mitigation systems

1. **Sub-slab suction** – This radon mitigation system pulls radon directly beneath the home's foundation and vents it outside.

2. **Drain tile suction** – This radon mitigation system's pipe penetrates into the drain tile and vents the soil gases outside. Covers are placed on the sump baskets.

3. **Sub-membrane** – Used in crawl spaces, a plastic sheet covers exposed dirt on the floor, extends up onto the wall and is sealed. A radon pipe penetrates the plastic sheeting, pulls the soil gas from the crawl space, and vents it outside.

# Radon mitigation system diagram



# Understanding basic radon mitigation system components



The **radon fan** is located in an unconditioned space, like an attic or outside, to prevent radon leaking back into the home. The fan is plugged into an electrical junction box or hard wired.

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The **U-tube manometer** is a monitoring device that is installed with every system. The u-tube visually indicates if the fan is working.

"J" shape shows fan is **working**



"U" shape shows fan is **not working**



The **radon pipe vent discharge** should be:

- 10+ feet above ground
- 10+ feet away from windows, openings, doors, and openings to adjacent buildings
- Above the edge of the roof

## Finding a professional to install a radon mitigation system

Starting in January 2019, professionals that install radon mitigation systems or measure for radon must be licensed in Minnesota. A licensed professional has completed training, passed an examination, and completes continuing education. Professionals who install a radon mitigation system must place a MDH issued tag on the pipe next to the u-tube. Information on the radon mitigation system tag will include:

- Company name and phone number
- License number
- Install date and installer's name
- MDH system tag ID number

A list of licensed radon professionals is available on MDH's website.

## Cost of a radon mitigation system

The cost can depend on many factors including the type of radon system to be installed and how your home was built. In general, costs can range from \$1,500 to \$2,500. Financial assistance may be available to help pay for a radon mitigation system and depends on household income, geographic location, and funding availability. Financial assistance information is available on MDH's website.

# KEY QUESTIONS

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to ask a radon professional before they install a radon mitigation system

- Will a licensed Minnesota radon mitigation professional install the system? If not, will they affix the tag and inspect the system?
- Will diagnostics be performed to determine the best location for the radon pipe and fan size?
- Will permits be required and who is responsible for obtaining them?
- If needed, who will do the licensed electrical work?
- Will a contract be provided?
- Is there a warranty on materials or workmanship? If so, for how long?
- Will an explanation of how the radon mitigation system works be given?
- Will they guarantee levels below the EPA action level? And if the level is not reduced how will it be fixed?
- Will a list of references be provided?
- Is the quoted price guaranteed?



# 10 STEP GUIDE

to the radon mitigation process

## Before mitigation

1



Radon test reveals the home has a radon problem.

2



Contact licensed radon mitigation professionals to request bids.

3



Professional does a walk-through of the home to identify the mitigation system to install.

4



Review key questions with professional, and request a proposal.

5



Review bids and select a professional.



## Before mitigation • During mitigation

### After mitigation

#### During mitigation

6



Professional may perform diagnostic testing to ensure proper fan size and correct installation.

7



Professional seals cracks and openings in the basement.

8



Professional installs the radon mitigation system.

#### After mitigation

9



Professional provides a full explanation of how the system operates to the homeowner.

10



Retest the home to ensure the system has reduced radon levels.

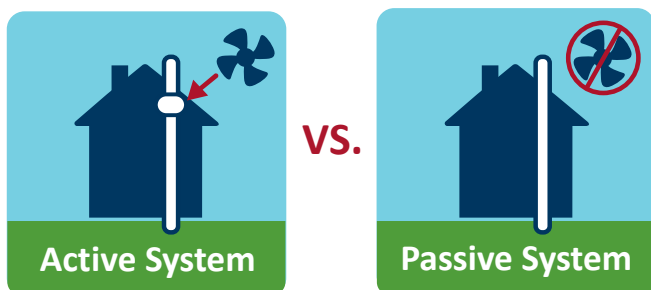
# Radon resistant new construction

Since 2009, all new homes are required to be built radon-resistant. Home builders must use materials and techniques to help prevent radon from entering the home. This includes sealing radon entry points and installing a pipe, but does not include a fan. Instead this passive radon system relies on the natural upward flow of air to exhaust radon through the pipe.

Builders in MN may have MDH's **Gold Standard Radon** designation, which means they will offer an option to install a radon fan at the time of the building process. Installing a fan will make the radon system active rather than passive. An active system is better at removing radon than a passive system. An active system may have the added benefit of decreasing moisture and soil vapors that may be present. Ask your builder about the cost of adding a fan to your radon system.

To check if a builder has met the **Gold Standard Radon** designation go to MDH's website.





## Homes built with an active system will be required to have:

1. All passive radon system features. This includes a vent pipe that travels from below the foundation through the roof. It also includes sealing of openings, joints and penetrations in the foundation.
2. A fan installed in an unconditioned space like an attic.
3. A device to monitor whether the fan is working.
4. An outlet label installed next to the radon pipe.
5. A checklist affixed to the radon pipe explaining the radon system.
6. A label on the radon pipe providing a description of the fan size and its estimated energy usage.
7. A radon test to confirm the radon levels are low.

# Radon in real estate

The Minnesota Radon Awareness Act requires specific disclosure and education be provided to potential home buyers during residential real estate transactions. Before signing a purchase agreement to sell or transfer residential real property, the seller shall provide the Minnesota Department of Health's publication, "Radon in Real Estate Transactions" and shall disclose in writing to the buyer:

- whether a radon test or tests have occurred on the property;
- the most current records and reports pertaining to radon concentrations within the dwelling;
- a description of any radon concentrations, and any mitigation or remediation that has occurred;
- information on the radon mitigation system, if a system was installed in the dwelling; and
- a radon warning statement.

In Minnesota, buyers and sellers in a real estate transaction can negotiate radon testing, radon mitigation system installation and who is responsible for the costs. Ultimately, it is up to the buyer to decide what is an acceptable level of radon.

# Radon testing and mitigation in real estate

Radon testing and mitigation are not required during real estate transactions, but testing is highly recommended. There are special procedures for testing as part of a real estate transaction. MDH recommends a licensed radon professional conduct testing during real estate transactions when an unbiased third-party is desired. A buyer can request a test, for example, as part of a home inspection.

## Radon testing procedures

Any real estate testing requires closed-house conditions. This means keeping all windows and doors closed, except for normal entry and exit. Operate home heating or cooling systems normally during the test. Radon tests conducted for a real estate transaction need to be done in all occupiable foundations of the home including the lowest livable area. That lowest area is typically the basement, whether finished or unfinished.



## Conducting the radon test in real estate transactions

There are special procedures for radon testing in real estate transactions. A radon professional should conduct the test and produce a report. Tests are done for a minimum of 48 hours. The average over the time period is used to make a decision to mitigate. Here are the two most common radon tests performed.



### Continuous radon monitor (CRM)

This calibrated electronic monitor measures hourly levels. Other data may also be collected to ensure a valid test.



### Simultaneous short-term testing

Two short-term test kits are used at the same time, placed 4 inches apart. Tests are sent to the lab for analysis. The two test results are averaged to give an overall radon level.



## Recommendations for buyers

### If the home has been tested

The buyer must decide if the results of past tests are acceptable. Items to consider include:

- What was the level of radon found?
- What was the duration of the test?
- When was the test performed?
- What area of the home was tested?
- Who performed the test?

### If the home has not been tested

The buyer should decide if they wish to request testing. If yes, some items to consider include:

- Who will perform the test?
- What type of test will be performed?
- What area of the home will be tested?
- How will the results be shared?
- At what level will a radon mitigation system be installed?
- Who will pay for it?



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