



radon

Keeping you safe from radon



Bonnie's Story



I went to the doctor thinking I had pneumonia and I was going to get antibiotics to knock it out. Instead the doctor said I had a large mass in my left lung.

Smoking and lung cancer seem to go hand and hand, but I never smoked. This left me with the question of why. One of my doctor's asked if I was ever exposed to radon? I had never heard of radon before, but after some research I ordered a simple test and found out our home in Garrison was off the charts. It tested at 30 picocuries per liter.

"Prevention is so much easier and far less painful than the road I have had to travel."

We hired a licensed radon mitigation company that fixed the problem in a day. It ended up being very easy. Prevention is so much easier and far less painful than the road I have had to travel. Please, get your home tested and please get a radon system if you need to.

Table of Contents

What is radon?	4
Where does it come from?	5
Minnesota levels	5
Is there a safe level?	6
Health risks.	7
How it enters the home	7
Common pathways radon enters the home	8
Testing	12
Testing guidelines	14
Test kit placement	15
Test results	16
Real estate	18
Mitigation systems.	22
Radon resistant new construction	30

What is radon?

Radon is a colorless and odorless gas that comes from the soil. The gas can accumulate in the home. 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 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
- radon policies and professional licensing

Where does it 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.

Minnesota levels

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.

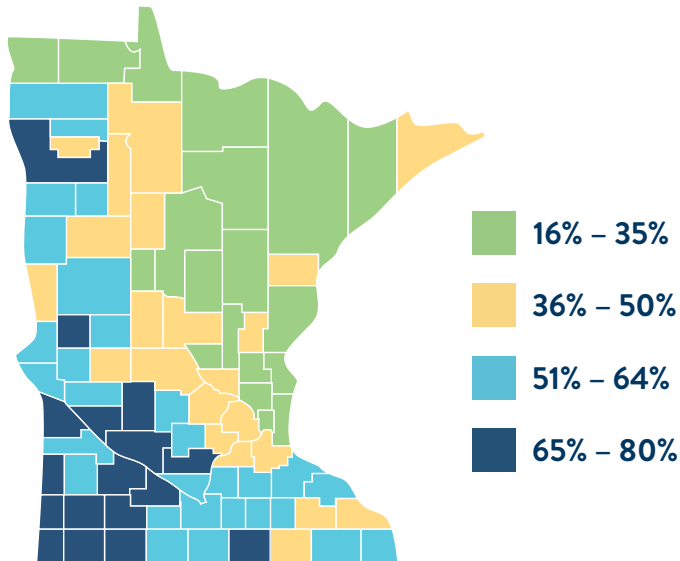


In Minnesota **2 in 5**
homes have high radon

Is there a safe level?

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).** MDH recommends installing a radon mitigation system when the radon level is at 4 pCi/L or higher. Between 2 and 4 pCi/L, a radon mitigation system can be considered to lower the level as much as possible.

Percent of MN Properties Tested for Radon that are ≥ 4 pCi/L (2010 – 2020)



Health risks

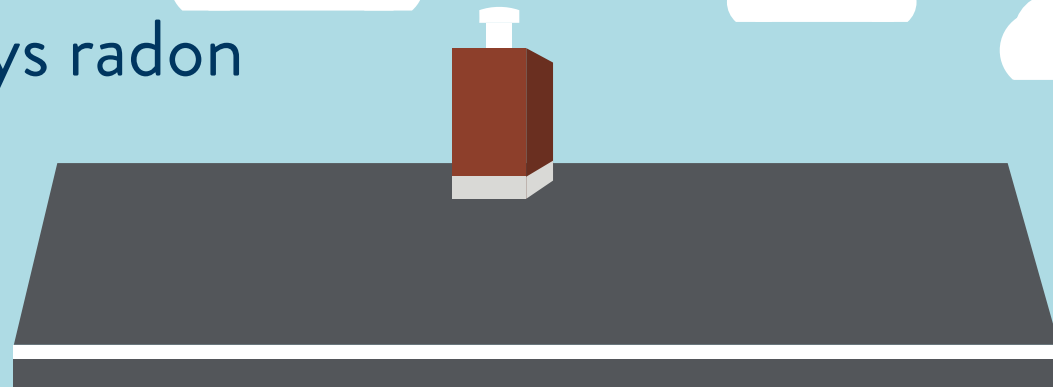
It is the number one cause of lung cancer for non-smokers and the second leading cause of lung cancer in smokers. Your risk for lung cancer increases with higher levels of radon and longer periods of exposure. If you smoke, the combined risk of smoking and radon exposure is much higher.

How it enters the home

Radon can accumulate to high concentrations in the home. This depends on radon concentrations in the soil (source), how radon enters the home (pathways), and pressure differences between the outside air and the inside air (air pressure) that drive radon into the home.

- Source** In Minnesota, soil is the main source of radon, where it occurs naturally.
- Pathways** Radon gas enters the home, usually through openings between the soil and the home. These pathways may include cracks in the concrete slab, floor-wall joints, an open sump pit, or a 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.

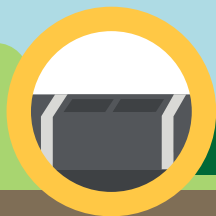
Common pathways radon enters the home



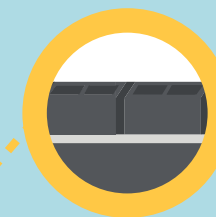
Open tops of block walls



Mortar joints



Floor – wall joints



Exposed soil, such as a crawl space



Sump basket



Pores and cracks in concrete blocks or slabs



Radon

Air pressure

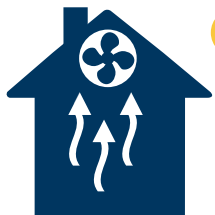
Homes commonly operate at a lower ("negative") pressure compared to the outside air. Air pressure differences between the home and outside air create a vacuum and pull air into the home. Air can be pulled into the home through walls, windows, doors or from the soil. And soil can contain radon gas. There are three main factors that contribute to these air pressure changes.



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



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



3. **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 from 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, where radon can enter through different pathways. Taller homes have the 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.



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 licensed professional. Most radon tests can be performed on your own, after reading 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(s) from a properly performed test will help you decide if you need to reduce your home's radon levels.

Types of radon tests



Short-term radon tests

A short-term test typically measures radon levels for 2 – 7 days and is a quick way to screen a home for radon.

Long-term radon tests

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, including finishing a basement, adding an addition, making energy efficiency improvements (replacing windows or adding insulation), 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 inexpensive and available at local health departments, hardware stores, and for a discount at the MDH radon website (mn.gov/radon). Local health departments or government agencies may offer test kits at reduced prices. A list of those offering test kits can be found at the MDH website. Some test kits may require an additional analysis fee paid after mailing the kit to the lab.



Testing guidelines

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

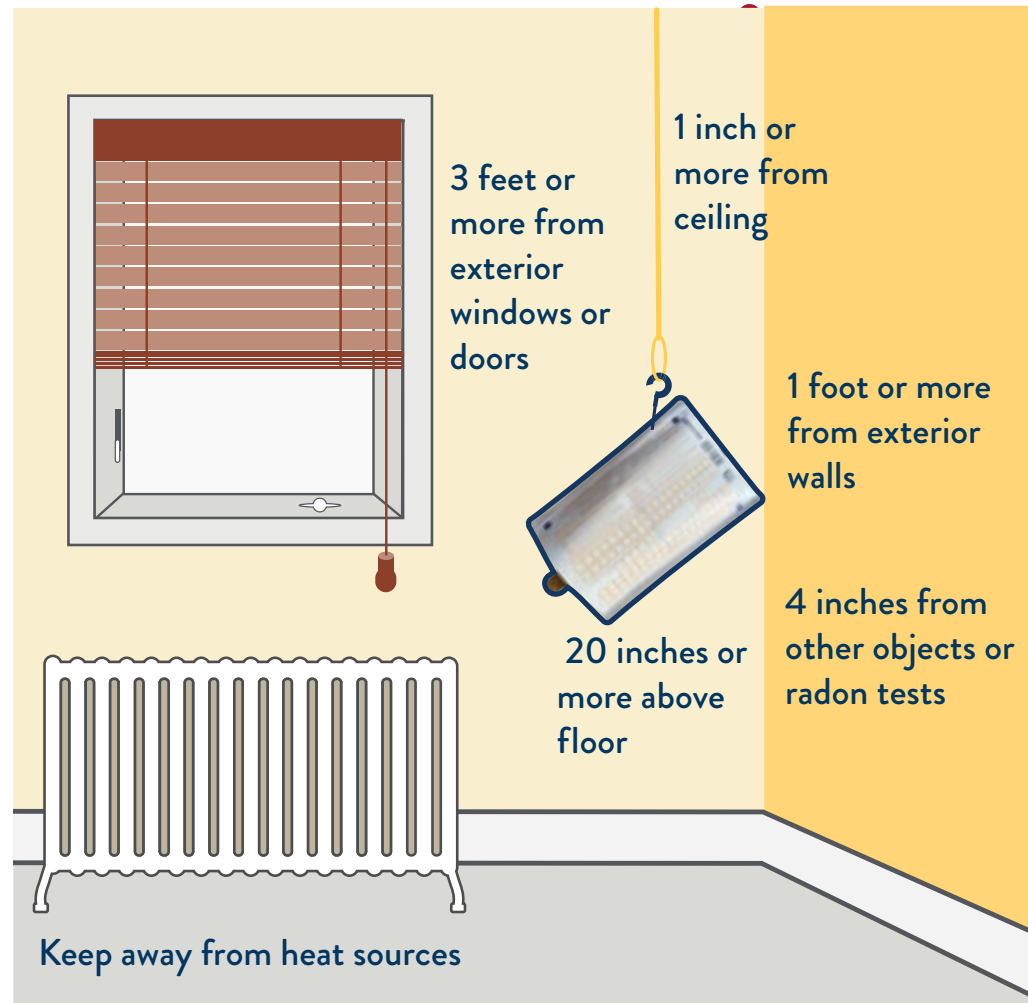
Time of Year – Short-term tests can be completed any time of year, but the heating season is the best time to test. Long-term tests should include some of the heating and non-heating seasons.

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. Place the test kit at least 20 inches off the floor, preferably at your "breathing level". Keep the kit one foot from exterior walls, three feet from exterior windows, and away from drafts. Keep away from high humidity areas like kitchens, baths, and laundry rooms. And keep away from heat, like furnaces and radiators.

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. Run the heating and air conditioning system as you normally would.

Test kit placement



- Once the test is complete, seal the package and mail it to the lab immediately.
- Make sure all information is written on the test and note the test kit ID number.
- You can add your e-mail address to the test kit for faster notification of results.



Test results

You should **complete two tests** before deciding to install a radon mitigation system, except when a professional uses a continuous radon monitor as part of a real estate transaction.




First Test

(Start with a short-term test)

Result (pCi/L)	Action
0 – 1.9	Retest every 2 to 5 years with a short-term test
2 – 7.9	Perform a follow-up long-term test
8 or greater	Perform a follow-up short-term test

Second test

(Choose a short or long-term test. The type of test depends on your first test result.)

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 first test was 8 pCi/L or greater, consider performing a long-term test.

The decision to mitigate should be based on the long-term test result or the average of the first and second short-term test result.

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 of 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.



You can go to mn.gov/radonpro to find a current list of licensed radon measurement and mitigation professionals.

Testing and mitigation in real estate

Radon testing and mitigation are not required during real estate transactions, but testing is highly recommended. 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.

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. In real estate transactions the lowest livable area of each foundation of the home needs to be tested. The lowest level is typically the basement, whether finished or unfinished. An example of testing another foundation in the home includes a livable area above a crawl space.



How to test in a real estate transaction

There are special procedures for radon testing in real estate transactions. A licensed radon measurement professional should conduct the test and produce a report. Tests are done for a minimum of 48 hours. When time is limited there are two testing options.



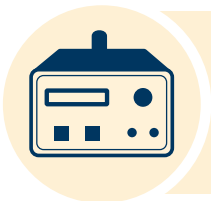
Continuous radon monitor (CRM)

This calibrated electronic monitor measures hourly levels. Other data may also be collected to ensure a valid test. Licensed professionals can conduct this test.



Simultaneous short-term testing

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



You can ask to see a measurement professional's current license and proof of device's annual calibration.

Home buyer recommendations

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 radon level and is it near the 4.0 pCi/L action level?
- Was the test up for the minimum time required?
- Was the test done in the last 2 to 5 years?
- Was the basement tested if it is livable?
- Did the homeowner perform the test or a licensed professional?

If the home has not been tested

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

- Will a licensed professional conduct the test?
- Will a calibrated continuous radon monitor be used?
- Will the lowest livable area of each foundation be tested?
- At what level will a radon mitigation system be installed?
- Who will pay for the installation of the radon mitigation system?



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 licensed radon professional should determine the type of mitigation system to install and may conduct some diagnostic testing to help guide where to place the mitigation system.

Radon mitigation systems use a fan to continuously pull air from the soil and vent it outdoors through a pipe that ends above the edge of the roof. The pipe can either run inside or outside the home and vents outside, away from windows and openings. In addition, cracks and openings in the foundation are sealed. Sealing limits the flow of radon into the home and makes the radon mitigation system more efficient.



Three of the most common mitigation systems

Sub-slab suction

This radon mitigation system pulls radon directly beneath the home's foundation and vents it outside.

Drain tile suction

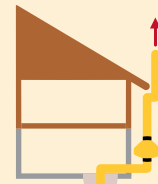
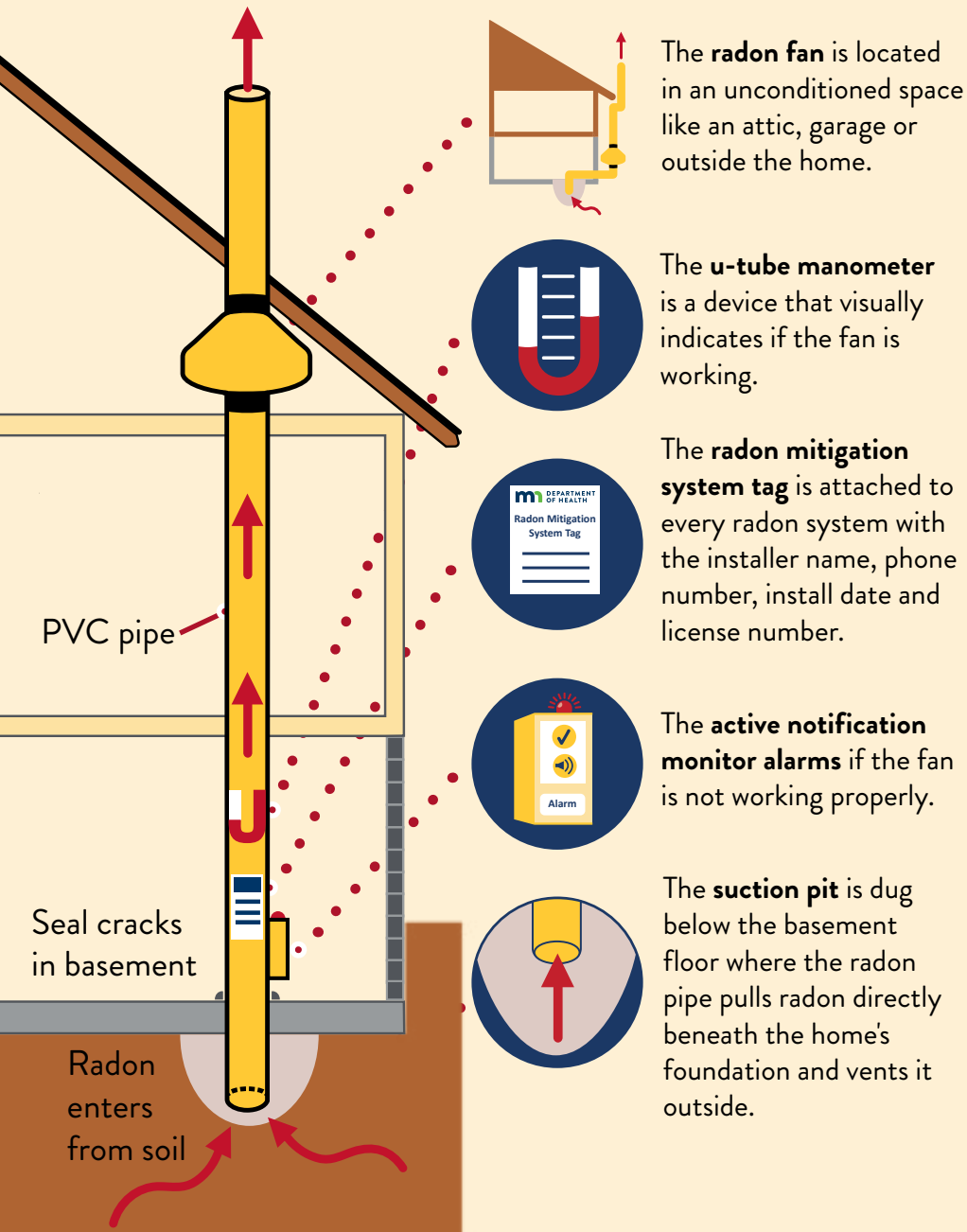
This radon mitigation system's pipe penetrates into the drain tile and vents radon outside. Covers are placed on the sump baskets.

Sub-membrane suction

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.

A Radon mitigation system

Radon vented outside



The **radon fan** is located in an unconditioned space like an attic, garage or outside the home.



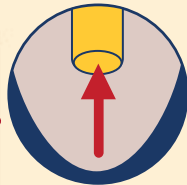
The **u-tube manometer** is a device that visually indicates if the fan is working.



The **radon mitigation system tag** is attached to every radon system with the installer name, phone number, install date and license number.



The **active notification monitor alarms** if the fan is not working properly.



The **suction pit** is dug below the basement floor where the radon pipe pulls radon directly beneath the home's foundation and vents it outside.

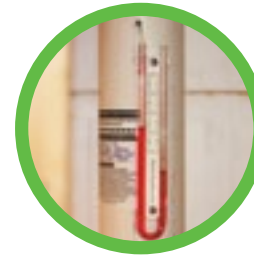
Understanding basic radon mitigation system components



The **radon fan** is located in an unconditioned space, so radon does not enter the home if the fan or pipe above it leaked. The fan is plugged into an electrical junction box or hard wired with a switch.

The **U-tube manometer** is a monitoring device 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
- Above the edge of the roof
- 10+ feet away from windows, openings, doors, and openings to adjacent buildings

Finding a professional to install a radon mitigation system

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 (mn.gov/radonpro).

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 \$3,000. Financial assistance may be available. Financial assistance information is available on MDH's website (mn.gov/radon).



Contact MDH to request a free inspection of your radon mitigation system, if installed after June 2020.
Email: health.indoorair@state.mn.us

KEY QUESTIONS

to ask a professional before they install a radon mitigation system

- Will a licensed Minnesota radon mitigation professional install the system or at least review the mitigation work at the property?
- Will a licensed professional place the MDH radon mitigation system tag to the mitigation system?
- Will you perform diagnostics to determine the best location for the radon pipe and fan size?
- Will permits be required for the work and who is in charge of getting them?
- Is electrical work needed, is it included in the price, and will a licensed electrician do the work?
- Is there a warranty on materials or workmanship? If so, for how long?
- Will you offer the homeowner training on the operation of the radon mitigation system?
- Will you guarantee radon levels below the EPA recommended action level of 4.0 pCi/L?
- What will you do if radon levels are not below the EPA action level after mitigation?
- Will the final payment be made after the work is complete and the radon test shows reduced levels?






10 STEP GUIDE

to the mitigation process




Before mitigation • During mitigation

After mitigation



Before mitigation

-  **1** Radon test reveals the home has a radon problem.
-  **2** Contact licensed radon mitigation professionals and request bids.
-  **3** Professional does a walk-through of the home to layout how to build the mitigation system.
-  **4** Review key questions with a professional, and request a proposal.
-  **5** Review bids and select a professional.

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.

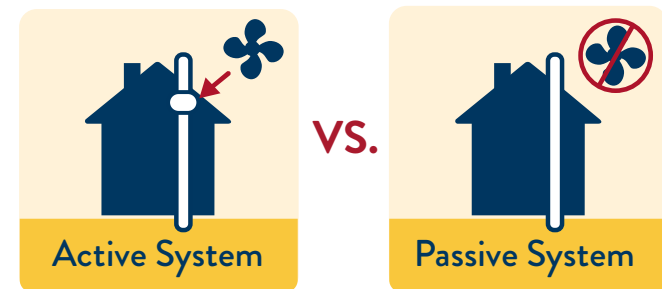
After mitigation

-  **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 draw radon through the pipe.

Some builders in MN may offer an option to install a fan during construction. 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.



Homes built with an active system are required to have:

- 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.
- A fan installed in an unconditioned space like an attic.
- A device to monitor whether the fan is working.
- An electrical outlet installed next to the radon fan.

In addition, an active systems is recommended to have:

- A checklist affixed to the radon pipe explaining the radon system, a description of the fan size, and it's estimated energy usage.
- An active notification monitor to alert home occupants if the fan stops working.
- A radon test to confirm the radon levels are low.



Indoor Air Unit
PO Box 64975
St Paul, MN 55164-0975
651-201-4601

health.indoorair@state.mn.us
mn.gov/radon

Updated 01/2022