



Keeping Your Home Safe From

RADON



MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

800-662-9278 | Michigan.gov/radon

What is Radon?

Radon is a colorless and odorless gas that comes from the soil. The gas can accumulate in our home and 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 Michigan Department of Environment, Great Lakes, and Energy (EGLE) has created this guide to explain:

- How radon accumulates in homes
- The health risks of radon exposure
- How to test your home for radon
- What to do if your home has high radon
- Radon policies



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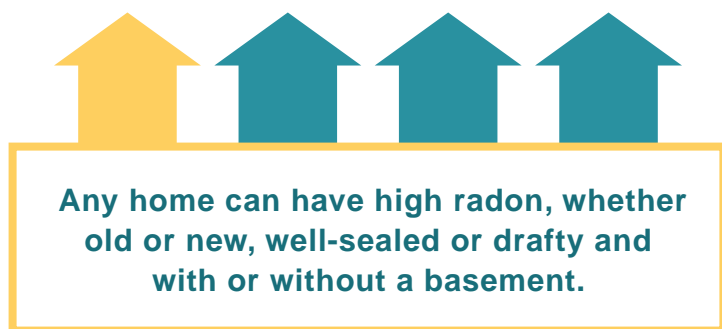
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Where Does Radon Come From?

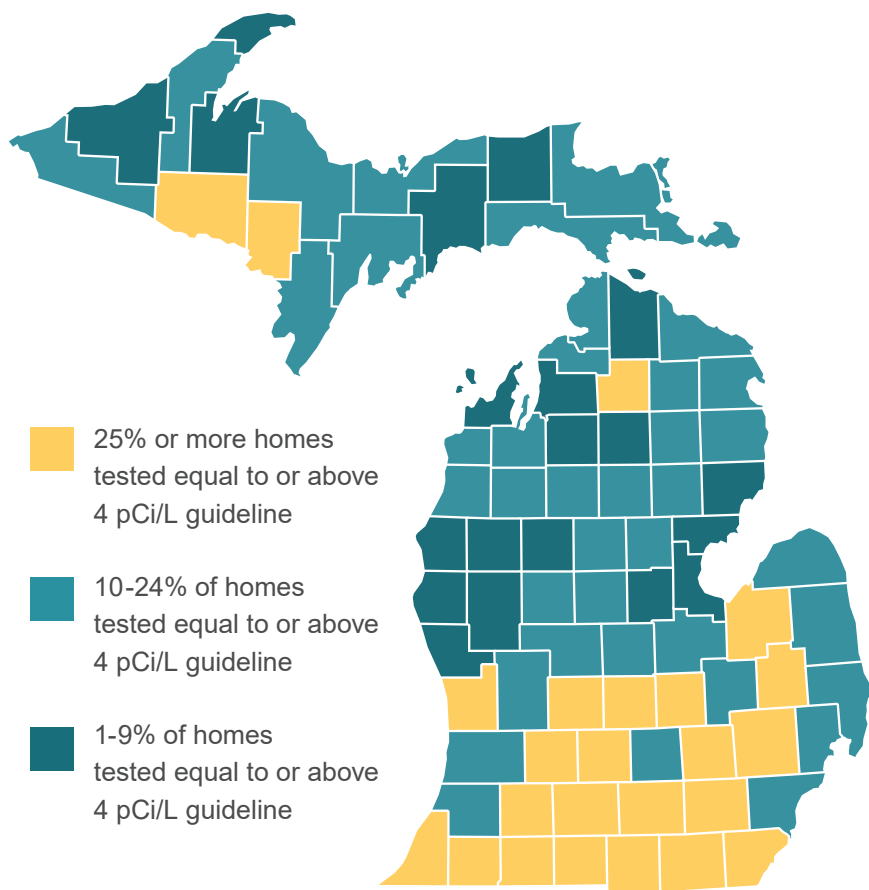
Radon is produced from the natural decay of uranium and radium, found in rocks and soil. Uranium breaks down to radium and radium eventually decays into the gas radon. Radon gas is in the soil and common throughout Michigan. Because soil is porous, radon moves through the soil and into the home. It can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

Radon in Michigan

Radon is a serious public health concern in Michigan. The average radon level in Michigan is almost twice the average radon level in the United States. This is due to our geology and how our homes are operated. Michigan homes are closed up or heated most of the year, which can result in higher levels of radon. In Michigan, one in four homes has a radon level that poses a significant health risk.



Percentage of Elevated Radon Test Results by County



*Note: Test result data collected from Air Chek (Radon.com).
This map is not intended to determine if a home should be tested for radon. All homes should be tested.*

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 U.S. Environmental Protection Agency (EPA) has set the action level at 4 pCi/L (picocuries of radon per liter of air). It is highly recommended that at 4 pCi/L or higher a radon mitigation system is installed to reduce the radon level.

**As
Low
As
Reasonably
Achievable**

Radon Health Risks

Many national and international organizations believe radon is a serious environmental health concern, and they support testing for radon and reducing exposure to elevated radon levels. Just a few of those organizations are listed below.

- American Lung Association
- American Medical Association
- Centers for Disease Control
- Environmental Protection Agency
- International Commission on Radiological Protection
- National Academy of Sciences
- National Council on Radiation Protection and Measurements
- U.S. Surgeon General
- World Health Organization

Radon 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, "U.S. 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

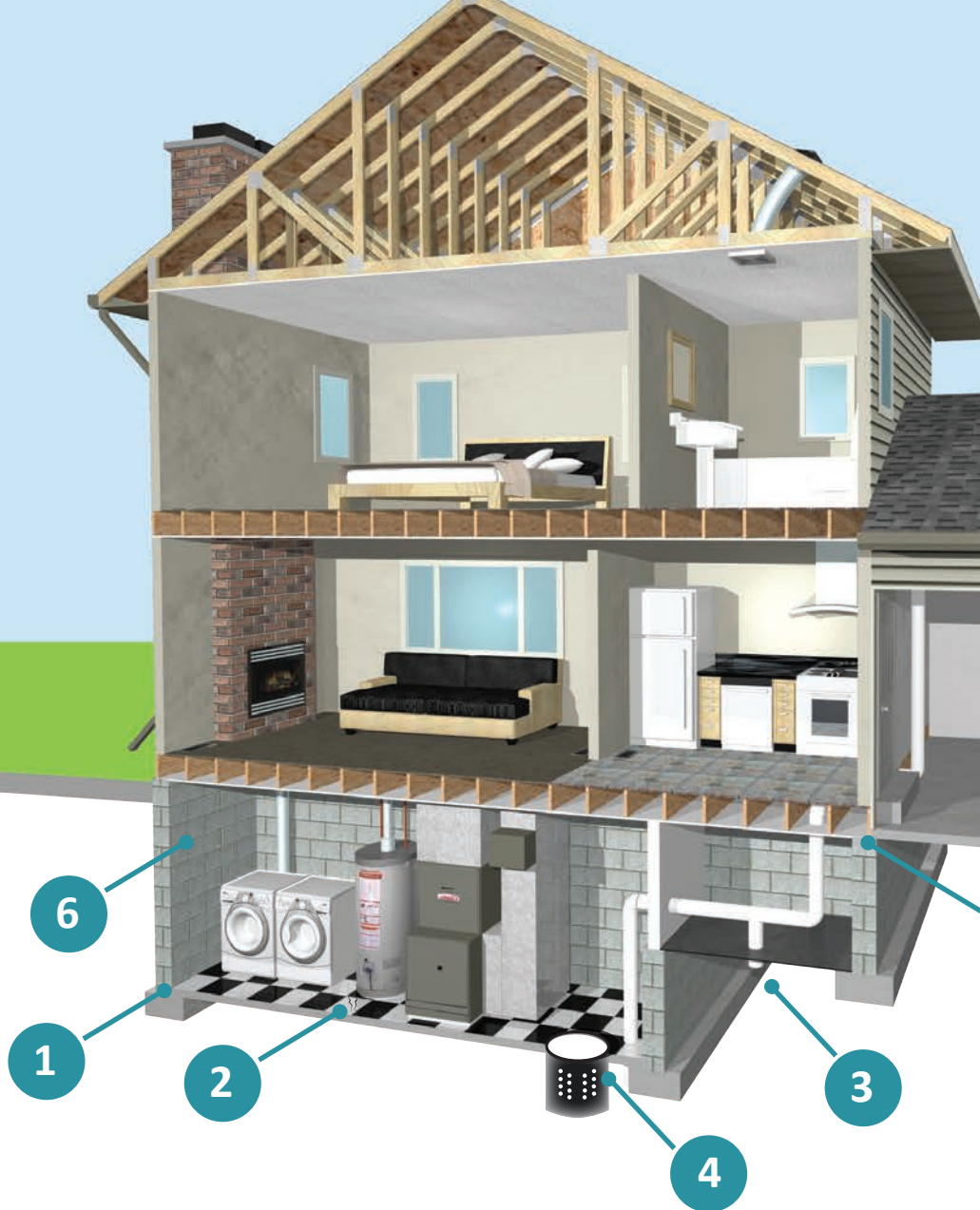
Radon levels are very low outdoors, but can accumulate to high concentrations in the home. This depends on radon levels in the soil, pathways for radon to enter the home, and the driving force. Air pressure differences between the outside air and the inside air act to drive radon into the home. Some 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 Michigan soils.

Pathways: The routes that radon gas takes to enter the home. These are usually through openings between the soil and the home and 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



5

The examples provided here are the most common pathways.

4. Sump basin
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 draw 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

EGLE recommends all homes be tested for radon regardless of foundation type, age, or location. 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.



Short-term test kits: 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 test kits: 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 homes should be tested for radon and tested again 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 modifications to 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 your local health department. 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. Contact information for your local health department can be obtained by calling the Radon Hotline at **1-800-RADONGAS (800-723-6642)** or visit Michigan.gov/radon for more information.

Radon 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.

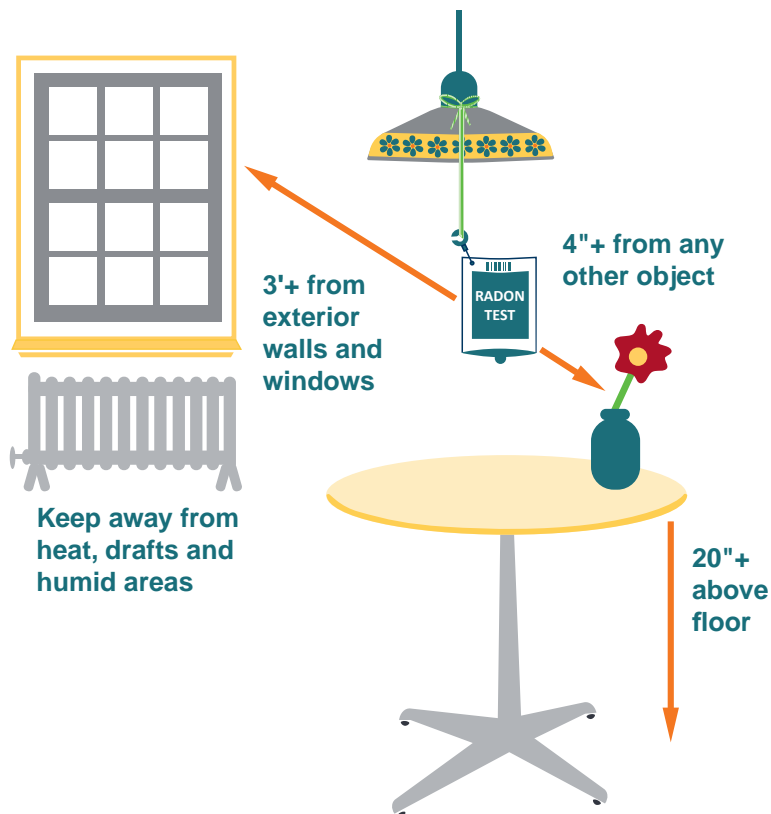
Time of Year: Short-term tests can be completed any time of year, but the heating season is the best time to test. Long-term tests should include some of the heating and non-heating seasons.

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. 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 such as fireplaces and furnaces.

Home Conditions: Any test lasting less than three months requires closed-house conditions. This means keeping all windows and exterior doors closed, except for normal entry and exit. Keep all exhaust fans off throughout the home 12 hours prior to testing and during the testing period.

Test Device Placement



Once the test is finished, seal the package and send it 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 – 7.9 | Perform a follow-up long-term test |
| 8 or above | 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 above | 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.

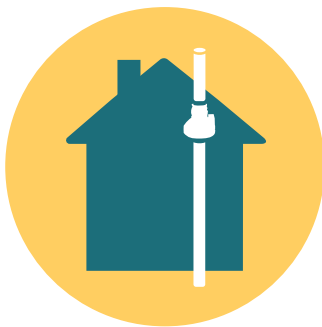
A home's foundation type helps determine the radon mitigation system that will work best. A radon professional should determine the type of mitigation system to install and may conduct some diagnostic testing. Radon mitigation systems use a fan to continuously pull air from the soil and exhaust it outdoors 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 radon entering the home and makes the radon mitigation system more efficient.

Three of the Most Common Types of Radon Mitigation Systems

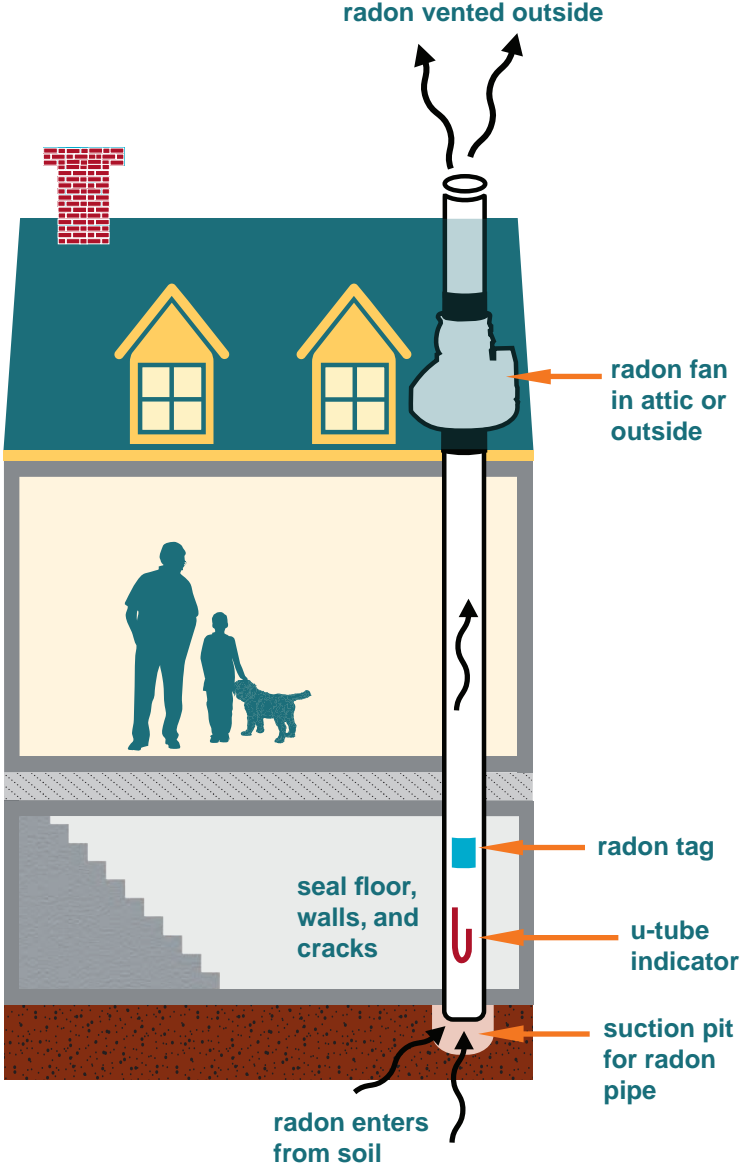
Sub-slab suction: This radon mitigation system pulls radon directly beneath the home's foundation and vents it outside.

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

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 below the plastic sheet in 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.

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

The state of Michigan encourages the use of a certified contractor but does not license, register, or certify mitigation professionals.

Call the Radon Hotline **1-800-RADONGAS (800-723-6642)** to get a list of certified contractors or visit the certification program websites at **NRSB.org** or **AARST-NRPP.com**.

A certified professional has completed training, passed an examination, and completes continuing education.

Cost of a Radon Mitigation System

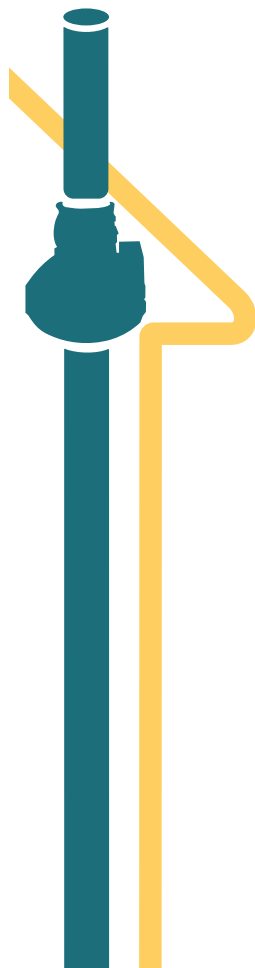
The cost can depend on many factors including the type of radon system to be installed and how your home was built. In general, costs can range from \$800 to \$1,500. Financial assistance may be available to help pay for a radon mitigation system and depends on household income, geographic location, and funding availability.

Low income financial assistance:

- **Community Development Block Grant – U.S. Housing and Urban Development (HUD):** 202-708-3587
- **203K Program – HUD:** 202-708-2121
- **Environmental Justice Grants – EPA Office of Environmental Justice:** 800-962-6215
- **Single Family Housing Repair Loans & Grants – USDA:** RD.USDA.gov | 517-324-5210

Key Questions to Ask a Radon Professional Before They Install a Radon Mitigation System

- Will a certified radon mitigation professional install 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 certified radon mitigation professionals to request bids.

3



Professional does a walkthrough 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.

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

As of July 2001, all new homes built in Branch, Calhoun, Cass, Hillsdale, Jackson, Kalamazoo, Lenawee, St. Joseph, and Washtenaw counties 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. You can reference the radon resistant requirements in Appendix F of the Michigan Residential Building Code.

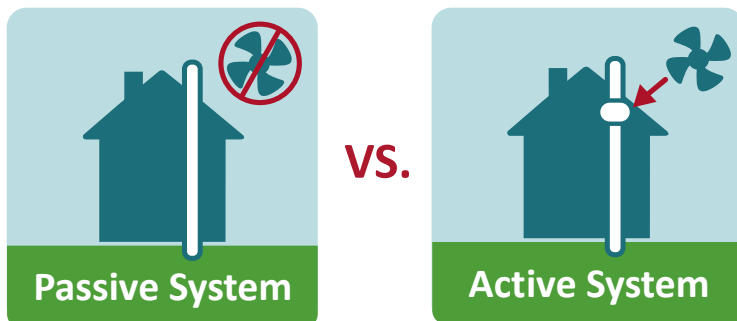
There are simple techniques specific to radon-resistant construction, and when combined with other good building practices, the process of building a radon-resistant home is relatively easy and inexpensive. The average cost of installing a passive radon control system will be \$350-\$500.

If you're building a home, make sure your builder uses these techniques to make your new home radon-resistant! Then test it to determine the radon levels, and if there's still a problem, simply have the system activated by installing a radon fan. Though builders are not required to use radon-resistant techniques in homes built in some counties, you may want to request that the builder do it anyway.

For more detailed information about radon-resistant new construction, check out the following:

- **Michigan Residential Building Code Appendix F**
- **EGLE website: *Michigan.gov/radon***
- **ANSI/AARST Standard CCAH-2013 RRNC 2.0**
- **EPA Building Radon Out: A Step-by-Step Guide on How to build Radon-Resistant Homes**

Activating a Passive System



A passive system can be upgraded to an active system if radon levels are still high. Activating a passive system will involve the following steps:

1. A fan is installed in an unconditioned space like an attic.
2. A device is added to monitor whether the fan is working.
3. A checklist is affixed to the radon pipe explaining the radon system.
4. A label is placed on the radon pipe providing a description of the fan size and its estimated energy usage.
5. A radon test is conducted to confirm the radon levels are low.

Radon in Real Estate

The Seller's Disclosure Act requires the seller to provide radon test results to potential home buyers. 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.

Seller's Disclosure Act, Public Act 92 of 1993, as amended, requires that radon be included in the list of known hazards under property conditions, improvements, and additional information:

10. **Environmental Problems:** Are you aware of any substances, materials, or products that may be an environmental hazard such as, but not limited to, asbestos, radon gas, formaldehyde, lead-based paint, fuel or chemical storage tanks and contaminated soil on the property.

unknown___ yes___ no___

If yes, please explain: _____

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. EGLE recommends a certified 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 spaces in 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 radon level 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?



Daycare Licensing and Radon

In order to be a licensed daycare in the state of Michigan you must:

- Test the lowest level of the child care home.
- Show that the level of radon gas does not to exceed 4 pCi/L of air.
- Document the results and keep the records on file in the home.

Daycare Technical Manual, Section R 400.1934



MICHIGAN INDOOR RADON PROGRAM

Radon Hotline
800-RADONGAS (800-723-6642)

[Michigan.gov/radon](https://michigan.gov/radon)

Radon@michigan.gov

EGLE Environmental Assistance Center: 800-662-9278

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