

## Nevada Bureau of Mines and Geology Educational Series No. 21



# REDUCING RADON IN NEVADA HOMES

The purpose of this brochure is to inform homeowners of methods to reduce radon in existing homes. Although there is no “safe” concentration of radon, the U.S. Environmental Protection Agency (EPA) recommends that the radon concentration in homes should be less than 4 picocuries per liter (pCi/L); if the radon concentration in your home is 4 pCi/L or more, you should take corrective action to lower it below that level, for your family’s health.

### What is radon and how can it affect me?

Radon is an odorless, colorless gas produced from the breakdown of radioactive minerals that occur naturally in rock and soil. Radon breaks down into radioactive products that attach to dust or smoke in the air. When inhaled, the radioactive particles cause increased risk of lung cancer. Your degree of risk depends on the radon concentration in your home and on the length of time you spend there. The American Cancer Society estimates that approximately 15% of lung cancer deaths in the United States may be due to radon exposure,

making it the leading cause of lung cancer among nonsmokers. According to EPA, your risk of dying from lung cancer due to exposure to 15 to 20 pCi/L of radon over your lifetime is about equal to that of a one-pack-a-day cigarette smoker; risk from exposure to 30 to 40 pCi/L of radon concentration is about the same as that of a two-pack-a-day cigarette smoker. Additional risk data are available in the EPA brochure *A Citizen’s Guide to Radon; What It Is And What To Do About It*.

### Is radon a problem in Nevada homes?

In 1990 and 1991, the Nevada Bureau of Mines and Geology (NBMG), in cooperation with the Nevada Division of Health and EPA, tested more than 2,000 homes in Nevada for radon. Over 19% of the homes tested in Nevada exceeded 4 pCi/L, the level above which EPA recommends that measures be taken to reduce radon concentrations. The highest concentration measured in a Nevada home was 47 pCi/L, and the average concentration for Nevada homes was 2.9 pCi/L. Highest readings were obtained during the winter months, when homes are generally more tightly sealed against the weather, and higher concentrations were measured on the lowest floors of multilevel dwellings. A significantly greater percentage of homes with basements had higher ground-floor radon concentrations than homes built over crawlspaces or on concrete slabs. Several Nevada communities were

found to have a large percentage of homes with high radon concentrations: radon concentrations exceeded 4 pCi/L in 21% of the homes tested in the Reno area, 37% in Hawthorne, 39% in Pioche, 56% in Lovelock, and 69% of the homes tested in Zephyr Cove. By contrast, radon concentrations exceeded 4 pCi/L in only 3% of the homes tested in Las Vegas. Nonetheless, even in the Las Vegas area, thousands of homes are likely to contain unsafe concentrations of radon. Complete results of the testing done in Nevada are available in the NBMG Educational Series No. 18 brochure *Radon in Nevada—A Natural Hazard*. Your home may be among the majority of Nevada homes that do not have a radon problem. If, however, your home is one of the 10% to 20% of Nevada homes that have high radon concentrations, then you should take steps to reduce the radon threat to your family.

## How do I know if my home has a radon problem?

The only way to know for sure is to test your home for radon with a reliable radon detector. There are several different types of radon detectors available for use by homeowners or professional radon testing services. A charcoal canister detector can give you an initial indication of the radon concentration in your home in a short period of time, usually 2 to 7 days. Alpha-track detectors measure radon concentrations over a longer period of time (3 to 12 months) and should be used to confirm an initially high radon measurement. Both of these types of detectors are inexpensive and easy to use, and can be purchased at some hardware and home improvement stores. More information on these and other types of detectors and a list of radon testing companies who have qualified with the EPA Radon Measurement Proficiency (RMP) Program can be obtained from the Radiological Health Section of the Nevada Division of Health. Alpha-track detectors are available from the American Lung Association of Nevada (addresses and phone numbers of all agencies referred to are listed at the end of this brochure).

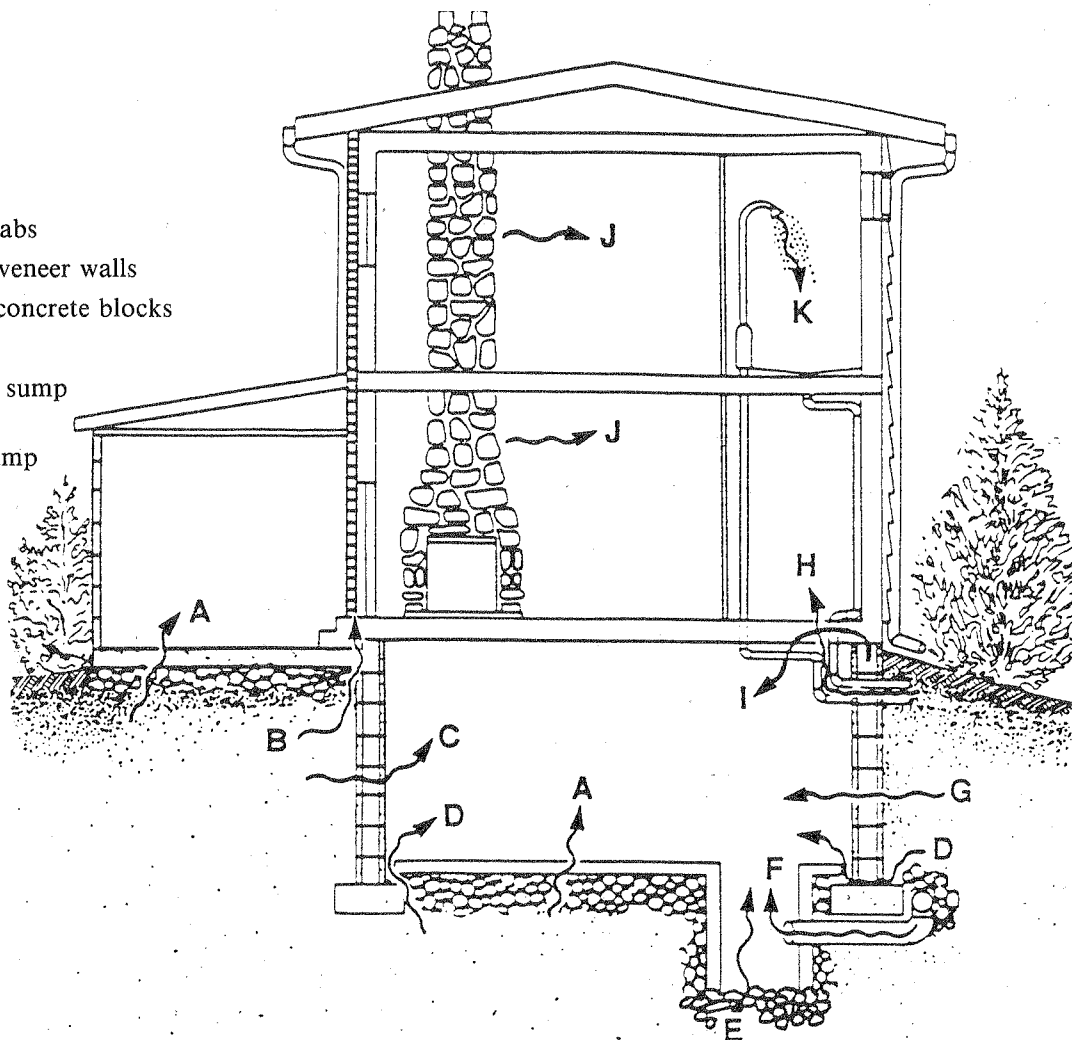
A low radon concentration in one house does not mean that the house next door will also have a low radon concentration. Many factors such as local geology, soil permeability, type of foundation and construction, and presence of cigarette smoke in a home can cause great variations in radon concentrations from house to house, so each home should be tested to determine if it has a radon problem.

If you have determined that your home does have a high radon concentration and your initial radon measurement was not made over a long period of time (3 to 12 months), retest to make sure that the high radon measurement first obtained was reliable. This follow-up testing should be done over a period of at least 3 months with an alpha-track or electret type of radon detector. If your follow-up testing still indicates that the radon concentration in your home is 4 pCi/L or higher, you need to take steps to reduce it.

Figure 1.

### Major radon entry routes

- A. Cracks in concrete slabs
- B. Spaces behind brick veneer walls
- C. Pores and cracks in concrete blocks
- D. Floor-wall joints
- E. Exposed soil, as in a sump
- F. Weeping (drain) tile, if drained to open sump
- G. Mortar joints
- H. Loose fitting pipe penetrations
- I. Open tops of block walls
- J. Building materials such as some rock
- K. Water (from some wells)



## **How can I reduce the radon concentration in my home?**

There are two basic approaches you can take to reduce radon concentrations in your home: 1) prevent radon entry into your home, and 2) reduce radon concentration in your home once it gets there. EPA generally recommends systems that prevent radon from entering the house. Figure 1 illustrates many potential radon entry routes into the home. EPA publication *Radon Reduction Techniques for Detached Houses—Technical Guidance* has a useful checklist that can be used to identify the source of radon in your home. Prevention of radon entry into a dwelling can be accomplished by any of several different methods including ventilation, sealing, isolation, pressurization, and reducing negative pressure.

Table 1 summarizes various radon reduction techniques, their applicability to building foundation types and initial radon concentrations, their effectiveness at reducing radon, relative installation costs, and some additional factors for consideration. Any combination of radon reduction techniques should be tailored to the unique characteristics of your home, such as foundation type, soil, and daily activity patterns of inhabitants.

Types of foundation design common in Nevada are slab-on-grade (concrete poured at ground level), crawlspace (stem wall), and basement. Slab-on-grade construction predominates in the southern part of the state where as many as 95% of the home foundations are of this type. About 85% of the homes in northern Nevada have crawlspace foundations, and the rest are about equally divided between basements and slab-on-grade. Mobile homes generally have low radon concentrations but, for radon reduction purposes, are treated the same as houses with crawlspaces. Some homes have a combination of foundation styles and thus may require a combination of radon reduction techniques.

It is generally much easier and less expensive to install most radon reduction systems during the construction of a new home than it is to add them to an existing home. If you are building a home, you should consult the EPA publication entitled *Radon-resistant Construction Techniques for New Residential Construction: Technical Guidance* which gives detailed information on radon reduction techniques to be used in new construction.

## **Radon reduction measures applicable to all foundation types**

**Sealing.** Sealing all accessible potential routes of radon entry into the house should be a part of any radon reduction system. Cracks, holes, joints, porous surfaces, open areas around plumbing and ductwork, open tops of block walls, and drains should all be sealed (refer to figure 1). In homes with slab construction, poorly sealed sub-slab cold air return ductwork may be a source of radon entry into the home. A contractor can insert a seamless impermeable sleeve into such ductwork to prevent radon entry. Cold air return ductwork in basements and crawlspaces should be well sealed to prevent intake of radon-laden basement air into ductwork. For homes with only slightly elevated radon concentrations, sealing and/or increased ventilation may be enough to reduce radon to an acceptable level. Sealing alone, however, is not recommended as a solution to most radon problems because of the limitations in identifying, accessing, and permanently sealing all entry routes. Consult EPA publication *Radon Reduction Techniques for Detached Houses—Technical Guidance* for details on what sealants to use for different types of sealing.

**Natural ventilation.** Opening all windows in your house will reduce radon concentrations by mixing outside air with the radon-laden indoor air and by neutralizing the lower pressure in the house that draws radon into the home from the soil below. Be sure to open windows equally on all sides of the house to avoid creating a pressure differential which could actually draw more

radon into the home. Although seasonally or temporarily effective, natural ventilation is impractical as a permanent, full-time radon reduction technique in Nevada due to the obvious disadvantages of having your house open all the time (heating/cooling costs, security concerns, and entry of dust and allergens).

For houses built over crawlspaces or uninhabited basements, simple ventilation of the crawlspace or basement can often dramatically reduce radon concentrations. Open all crawlspace vents, or add vents where they are not present. If you use this method and you live in a part of Nevada with cold winters, you should install pipe insulation, heat tape, and subfloor insulation to keep the water pipes in your crawlspace or basement from freezing, and to minimize heating costs due to the increased ventilation.

**Forced air ventilation (fans).** Forced air ventilation works the same way natural ventilation does to reduce radon concentrations, except that you use fans to control the air exchange rate. Existing heating or cooling ductwork may be used, but care must be taken not to use an exhaust fan to pull air out of the house because this depressurizes the house, increasing the influx of radon-laden air from the soil below. Forced air ventilation can also prevent the entry of radon gas by pressurizing your house. This method is subject to the same weather constraints as natural ventilation. Forced air ventilation of your basement or crawlspace can be an effective method

of reducing radon in your living areas if the two areas are effectively sealed off from one another. Consult EPA publication *Radon Reduction Techniques for Detached Houses—Technical Guidance* for guidance on size and location of fans for maximum effectiveness.

**Heat recovery ventilation (HRV).** A heat recovery ventilation system (air to air heat exchanger) increases ventilation from outside air while recovering heated air in the winter and cooler air in the summer. It reduces radon in your home in the same way that natural and forced air ventilation does, but it reduces the heating/cooling penalty with those methods. The energy savings of operating an HRV system over the years may outweigh its higher initial installation cost.

**Reduction of house depressurization.** Radon gas will enter your home if the air pressure inside the home is lower than that in the adjacent source of the radon gas, usually the ground beneath the home. The lower pressure inside the home is caused by the thermal stack effect of warm air rising in the house, drawing radon-laden air into the home from the soil below. This effect is increased

by the use of exhaust fans on indoor appliances such as clothes dryers and rangetop hoods, and by the lack of outside sources of makeup air for indoor combustion appliances such as furnaces, fireplaces, woodstoves, and gas water heaters and clothes dryers. Any measures that increase the air pressure in the home will reduce the entry of radon gas.

You can close off thermal bypasses (openings between floors) where heated air rises and draws radon-laden air into your home from the underlying soil. An outside makeup air supply should be available for exhaust fans and combustion appliances. *Before making alterations on the ductwork of combustion appliances, consult a professional contractor to avoid compromising the safety of such appliances or violating local building codes.*

**Air cleaners.** Air cleaners can remove cancer-causing radon decay products attached to dust in the air of your home. EPA does not recommend air cleaning as a proven radon reduction method, however, because it does not remove potentially dangerous unattached radon decay products from the air.

## **Radon reduction measures applicable to specific situations**

**Pressurization.** In houses with well-sealed basements or heated crawlspaces, fans can be installed to pressurize the basement or crawlspace that is in contact with the soil, maintaining a high enough pressure to prevent the entry of radon gas. The basement or crawlspace must be effectively sealed off from the living areas, and upstairs air is then blown into the basement or crawlspace to pressurize it. You must be careful not to cause backdrafting of any combustion appliances located upstairs.

**Suction systems.** If your home is constructed on a cement slab or has a cement-floored basement, a sub-slab soil suction system may be the most effective method of preventing radon entry into your home. Sub-slab suction or depressurization systems work by using a fan to suck soil gases out through pipes inserted into the soil or aggregate under the slab. The radon-laden air is then vented to the outside where it is quickly diluted and dissipated. Sub-slab suction is a common and generally reliable method of radon reduction when installed by a competent contractor. Variations of this type of system include sump hole suction, drain tile suction, and block wall suction. A sump located in a basement can be capped and used as the location of a radon suction pipe.

Existing drain tiles that direct water away from the foundation of a house can also be used to suck radon gas away from the foundation, especially if they form a complete loop around the foundation. If your home has base-

ment block walls, a block wall suction system can be installed to suck out radon gas from the hollow spaces in the concrete blocks through a pipe/duct/fan system. A combination of these suction systems may be used depending on the specific characteristics of your home's foundation.

All of these suction systems must have exhaust pipes that vent above roof level and away from windows, doors, or air intakes to prevent reentry of the vented radon into the house. The exhaust fan for any such system should be located outside or in an uninhabited portion of the home, such as in a garage or attic. For the system to work efficiently, cracks and holes in slabs and foundation walls should be sealed.

**Isolation and venting of source areas.** Sub-membrane suction or depressurization can be used to reduce radon in houses with dirt-floored crawlspaces where crawlspace ventilation is not the method of choice. The earthen floor of the crawlspace is covered with an impermeable liner of heavy plastic (6 mil polyethylene or heavier) and tightly sealed against the edge of the foundation. Alternatively, a false floor may be installed. Perforated vent pipes in the enclosed space between the liner or false floor and soil are connected to a fan to suck radon gas from below the membrane and vent it to the outside in a similar manner to that used in sub-slab suction.

Table 1. Summary of radon reduction techniques.

Method	Applicability	Effectiveness	Installation cost	Comments
Sealing of radon entry routes	All house types. All initial radon concentrations.	Extremely variable, up to 90% reduction of radon, dependent on accessibility, effectiveness of seal, and number of remaining entry routes.	low to high	Can be inexpensive for do-it-yourself sealing of major accessible entry routes. Contractor-installed coatings and sealants increase cost.
Natural ventilation	All house types. All initial radon concentrations. Limited by weather.	90% or more reduction of radon, depending on amount of outside air flow into house.	minimal	Easy, inexpensive short-term measure, but not a practical permanent solution to radon problems in most homes. Increased natural ventilation of a dirt-floored crawlspace may be an effective long-term solution in homes with crawlspaces.
Forced air ventilation (fans)	All house types. All initial radon concentrations. Limited by weather.	90% or more reduction of radon, depending on amount of outside air flow into house.	low to moderate	Installation costs can be reduced by using existing heating/cooling ductwork.
Forced air ventilation with heat recovery	All house types; best reductions in tight houses. Applicable when initial radon concentration is below 15 pCi/L. Works best in extreme climates (hot or cold).	Variable, but 50–75% reduction is typical, higher in tight house.	moderate to high	Installation cost may be less if existing ductwork can be used.
Reduction of house depressurization	All houses. All radon concentrations.	Variably effective, depending on amount of depressurization reduced.	low to moderate	Inexpensive for those measures easily implemented by the homeowner.
Air cleaning	All houses. All radon concentrations.	Up to 90% effective in removing the radon decay products attached to airborne dust but does not remove unattached radioactive particles.	high	Installation of air cleaners of sufficient capacity could be prohibitively expensive.
Pressurization	Houses with well-sealed basements or heated crawlspaces. All radon concentrations.	May be up to 90% effective, depending on how completely the basement or crawlspace is sealed from living area above.	moderate	Cost variable depending on type of fans installed and on heating/cooling penalty from increased ventilation.
Sub-slab suction	Houses with cement slab foundations or cement-floored basements and relatively good permeability below the slab. Moderate to high initial radon concentrations.	Up to 99% reduction of radon concentration depending on permeability of sub-slab soil.	high	One of the most effective and reliable methods of radon reduction for homes with slab foundations and significant initial radon concentration.
Drain tile suction	Houses with slab foundations and a relatively complete loop of existing drain tiles around the footings. Any initial radon concentration.	Up to 99% reduction of radon concentration depending on completeness of drain-tile loop and permeability of sub-slab soil.	moderate to high	Very effective method of radon reduction for homes with slab foundations and existing drain tiles around the footings.
Block wall suction	Houses with hollow block foundation walls where sub-slab suction is not sufficient. Moderate to high initial radon concentrations.	50 to 99% effective where walls can be effectively sealed.	high	Often used in combination with sub-slab suction.
Isolation and venting of source areas (sub-membrane suction)	Houses with dirt-floored crawlspaces where crawlspace ventilation is not the method of choice, or houses with badly cracked slabs or basement walls.	Variably effective.	moderate to high	Cost variable depending on type of liner installed.

**NOTE:** Be sure to retest your home for radon after performing any radon reduction work on your home to determine the amount of radon reduction and the need for additional measures.

## **Do it yourself or hire a contractor?**

EPA operates a Radon Contractor Proficiency Program to evaluate and train contractors in radon mitigation. A list of contractors trained by EPA in radon reduction methods may be obtained from the Radiological Health Division of the Nevada Division of Health. EPA does not recommend that average homeowners attempt radon mitigation techniques on their own; however, some of these radon-reduction techniques could be accomplished with a reasonable amount of time and effort by a person untrained in radon mitigation, while others require the services of a professional contractor trained in radon mitigation techniques.

The decision to do it yourself or hire a trained contractor is up to you. You should base that decision on a careful risk/benefit analysis of your particular situation, weighing such criteria as: the radon concentration in the home; amount of time to be spent in the home; presence of children, elderly, or ill persons in the home; cost of mitigation; and availability of trained radon reduction contractors. Some of the more simple techniques such as sealing obvious routes of radon entry and increasing ventilation could first be implemented by the homeowner, followed by additional radon testing using the same method employed to obtain the first radon measurement. This would indicate the need, if any, for installation of a more sophisticated radon reduction system by a professional contractor.

*Whatever method of radon reduction you use in your home, and whether you do it yourself or hire a professional contractor, it is imperative that you do follow-up radon testing to ensure that the system is doing what it was intended to do—reduce the concentration of radon in your home to less than 4 pCi/L. Conditions under which this follow-up testing is done should be as close as possible to those which existed for the initial testing*

(same type of radon detection device, same room, same time of year). The testing results will tell you if you have achieved an acceptable radon concentration or if you need to take additional measures to reduce the amount of radon in your home.

For information in determining what radon reduction system best suits your particular circumstances or for technical guidance on installing radon reduction systems in your home, consult the following EPA publications: *A Citizen's Guide To Radon; What It Is And What To Do About It*; *Consumers Guide to Radon Reduction (soon to be published)*; and *Radon Reduction Methods, A Homeowner's Guide (third edition)*.

## Sources of Information and Radon Detectors (1-13-09)

For more information on radon, including free copies of the brochures mentioned in this publication, free short-term test kits, long-term test kits for \$15, and regional lists of EPA-certified radon testers and mitigators, contact:

### **University of Nevada Cooperative Extension**

Nevada Radon Education Program  
University of Nevada, Mail Stop 408  
Reno, NV 89557

or

5305 Mill Street  
Reno, NV 89502  
Radon Hotline: 888-RADON10 (888-723-6610)  
775-856-8406 or 775-856-8408  
<http://www.unce.unr.edu/radon/>

### **U.S. Environmental Protection Agency,**

Region 9  
75 Hawthorne Street  
San Francisco, CA 94105  
(415) 947-4193  
<http://www.epa.gov/radon/>

or

### **Nevada State Health Division**

4150 Technology Way, Suite 300  
Carson City, NV 89706  
(775) 687-7531 or 687-7536  
Nevada State Health Division: <http://health.nv.gov/>  
Radon Program: [http://health.nv.gov/index.php?option=com\\_content&task=view&id=293&Itemid=453](http://health.nv.gov/index.php?option=com_content&task=view&id=293&Itemid=453)

For a free copy of *Citizen's Guide to Radon* only,  
call 1-800-SOS-RADON or download free at:  
<http://www.epa.gov/radon/pdfs/citizensguide.pdf>

Free information on radon is also available from:

### **American Lung Association of Nevada**

P.O. Box 7056  
Reno, NV 89510-7056  
(775) 829-5864  
<http://www.lungnevada.org>

or

### **American Lung Association of Nevada**

3552 W. Cheyenne Ave., Suite 130  
North Las Vegas, NV 89032  
(702) 431-6333

For information on geology, mineral resources, and geologic hazards, contact:

### **Nevada Bureau of Mines and Geology**

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(775) 784-6691  
<http://www.nbmgs.unr.edu>