Nevada Bureau of Mines and Geology
Educational Series No. 18

RADON IN NEVADA
— A Natural Hazard —

In January 1990, the Nevada Bureau of Mines and Geology (NBMG), in conjunction with the Nevada Division of Health (NDOH) and the U.S. Environmental Protection Agency (EPA), began a yearlong survey of radon in the indoor air of homes in Nevada. This brochure presents the preliminary results of that survey, and describes how radon is detected, how it is measured, how it enters buildings, and its effects on health.

What is radon and where does it come from?

Radon is a naturally occurring radioactive gas; it is colorless, odorless, and tasteless. Radon, specifically radon isotope-222, is produced as a natural decay product of radium, which, in turn, is a decay product of uranium. Uranium, radium, and radon occur in varying amounts in all rocks and soils, and being a gas, radon can gradually seep from the Earth into the atmosphere and may find its way into homes and other buildings. In outdoor air, radon is diluted to such low concentrations that it is usually not a concern. Inside buildings, however, radon can build up to high concentrations, especially in the lower levels.

What are the health effects of radon?

The only known health effect associated with exposure to elevated levels of radon is an increased risk of developing lung cancer. Not everyone exposed to elevated levels of radon will develop lung cancer, and the time between exposure and onset of the disease may be many years.

Radon causes lung cancer by breaking down into other radioactive decay products. Two of these decay products, polonium-218 and polonium-214, are solids. When inhaled, they can become lodged on tissue in one's airways and lungs, then damage surrounding cells by emitting alpha particles as they continue to decay radioactively. According to the EPA, radon is responsible for up to 20,000 lung cancer deaths per year in the United States.

How does radon get into a home?

Being a gas, radon can seep into a home through soil floors (as in a crawl space), through cracks in concrete floors and walls, floor drains, sumps, joints, and cracks or pores in hollow-block walls (see diagram). In addition, radon may be present in groundwater and can enter a home when the water is used. Normally, this is not a problem with large community water supplies, but it can be a problem for homes using water from a private well. For more information on radon in water, refer to the EPA brochure titled *Removal of Radon from Household Water*, available from EPA (addresses at end).

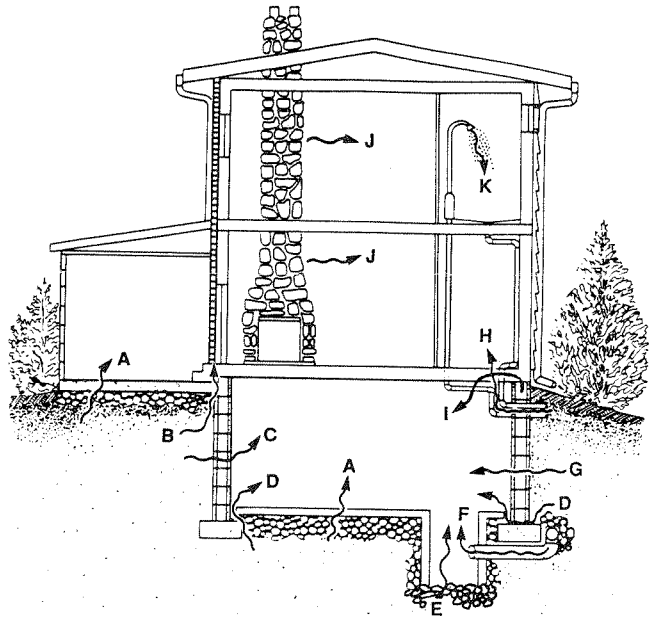
In some situations, radon may be released from materials used in home construction. For example, this may be a problem if a house was constructed using uranium-rich clays for the manufacture of cinder blocks, or if the house has a large stone fireplace, or uses a solar heating system in which heat is stored in large beds of uranium-containing stones.

How is radon detected?

Two types of commercially available radon detectors can be used to detect and measure radon in a home. One type of detector, the charcoal canister, is designed for short-term (2 to 7 days) detection of radon. The other type of detector, the alpha track detector (ATD), is designed for longer-term measurement (generally 3 months to 1 year). Both types can be used by individual homeowners, and cost about $12 to $30, including lab analysis and report. Lists of vendors who have met the EPA Radon Measurement Proficiency (RMP) Program are available from EPA and NDOH (addresses at end).

Both types of detectors are equally accurate, but since the amount of radon escaping from the Earth varies from day to day and season to season due to atmospheric and soil conditions, the longer-term ATD detector will give a more representative assessment of actual radon content in a home.

If you purchase a detector from a mail-order company or from a vendor, follow the instructions that come with the detector for its use and placement in the house. Based upon EPA guidelines, the directions will probably recommend that you place the detector in the lowest living level of your home (if you purchased only one detector). This is because if this level of your home is low in radon, you can be fairly certain that other levels of your home will also be low in radon. After exposing the detector to the air in your home for the required period, reseal the detector and promptly return it to the vendor for analysis. In a few weeks, the vendor will send you a report showing you the radon content of your detector.



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)

Source: EPA brochure *Radon Reduction in New Construction, An Interim Guide*

How is radon measured?

When you receive the report of the analysis of your radon detector from the vendor, it will report your measurements in one (or both) of two ways. Most will report concentrations of radon gas as "picocuries of radon per liter of air" (pCi/L). Other reports may express the measurement of radon decay products as "Working Levels" (WL).

The EPA has determined that remedial action should be taken if radon concentrations in your home equal or exceed **4.0 pCi/L** (or **0.02 WL**). EPA estimates that radon will cause between 1 and 5 lung cancer deaths per 100 people living for 70 years in a home with this concentration of radon. As the radon concentrations increase above this level, the chances of contracting lung cancer at some future date also increase.

If the initial measurement (the "screening" measurement) in your home exceeds 4 pCi/L of radon, you should consider either retesting your home to verify the results, and/or taking remedial actions to reduce the levels of radon in your home, especially if you plan on living in the home for a number of years. More information concerning measurement of radon, health risks at varying exposure levels, and what actions to take can be found in the EPA brochure titled *A Citizen's Guide to Radon*, available from EPA or NDOH (addresses at end).

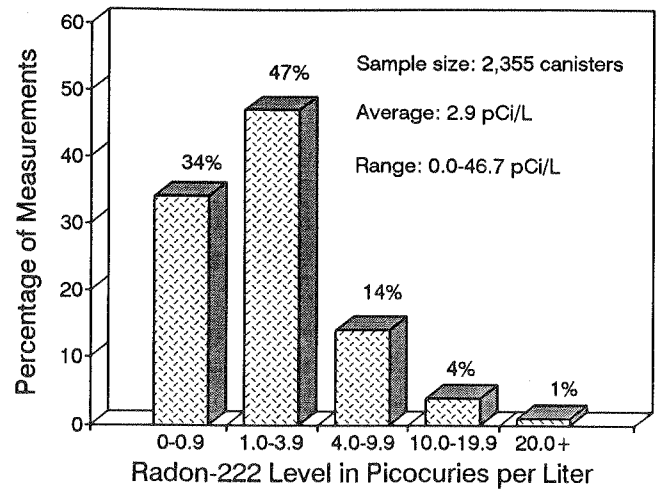
The Nevada Indoor Radon Survey

This project was undertaken by NBMG and NDOH to determine if radon poses a health hazard to Nevadans. In order to do this, the indoor concentrations of radon in many homes had to be measured across the state. Support and partial funding for this survey was provided by EPA, with the remaining funding being provided by the State of Nevada. Using a list of randomly selected telephone numbers supplied by EPA, telephone interviewers at NBMG began calling homeowners across the state in January 1990. Homeowners agreeing to take part in this project were sent short-term charcoal canister radon detectors to be placed in their homes for two days and then mailed to an EPA laboratory for analysis. Ten percent of the homeowners were also sent a longer-term ATD to place in their homes for one year, and were also sent a short-term charcoal canister every three months.

One month after the canisters were mailed to the laboratory, the homeowners were sent the results of their homes' individual radon measurements. Homeowners participating in this study incurred no costs for the detectors, and all radon data pertaining to each individual home is being kept confidential.

NBMG has received results of analyses on 2,048 of the 2,777 charcoal canisters mailed out during the year, most of which were mailed out during January and February 1990 (the results of the long-term ATD's are not available at this time). The individual indoor measurements for the state average 2.9 pCi/L (arithmetic mean) and range from 0.0 to 46.7 pCi/L. EPA's recommended guideline for remedial action (4 pCi/L) is exceeded by 19% of the analyzed detectors. However, on the basis of numbers of households, population centers were sampled less intensively than rural areas. For example, only 12% of the homes sampled were in Clark County where more than half of the state's population lives. When weighted to compensate for variability in sampling intensity (giving more weight to urban data), the data indicate that about 10% of Nevadans live in houses with radon levels greater than 4 pCi/L (considering only 1572 measurements from winter and early spring, 1990). The weighted average (of winter and spring 1990 results only) for the state is 2.0 pCi/L.

The 1990–1991 indoor measurements in Nevada compare closely with a smaller statewide radon survey conducted by NBMG the previous (1989) winter and spring. In that survey, of the 307 short-term radon detectors returned for analyses, 20% exceeded 4 pCi/L, and the statewide average (unweighted) was 2.9 pCi/L.



Graph 1.—Results of the 1989 and 1990–1991 surveys in Nevada (not adjusted for population variations).

The combined results of the 1989 and 1990–1991 surveys (total of 2,355 canisters) are shown in graph 1 and summarized by county in the table.

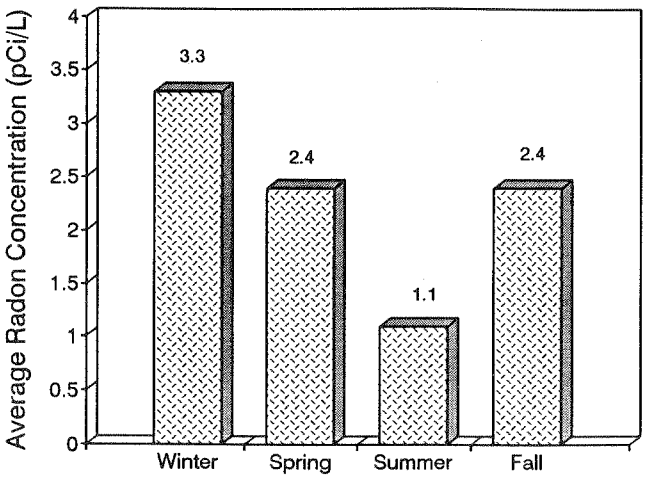
Some of the homeowners participating in the 1990–1991 survey received a short-term charcoal canister every 3 months. Analyses of these canisters show that there are wide variations in indoor radon concentrations at different times of the year. The average radon concentration in these homes was three times greater in the winter than in the summer (graph 2). Furthermore, there was considerable variation among the individual homes (graph 3). The radon concentration in home A was quite high in the winter and, although somewhat lower during the other three seasons, remained well above the EPA action level throughout the year. Home B also had a high radon concentration in the winter but it dropped below the EPA action level during the rest of the year. Radon concentrations in home C were greatest during the fall and winter but remained below the EPA action level throughout the year. Home A requires remedial action to reduce radon concentrations. The radon in home B may pose a health hazard and should be retested with a long-term ATD device. The radon in home C does not appear to pose a health hazard and would not need to be retested.

This seasonal variation is probably due partly to variations in home ventilation, which is generally greater in summer in northern climates, but may also be due in part to seasonal variations in soil and climatic conditions.

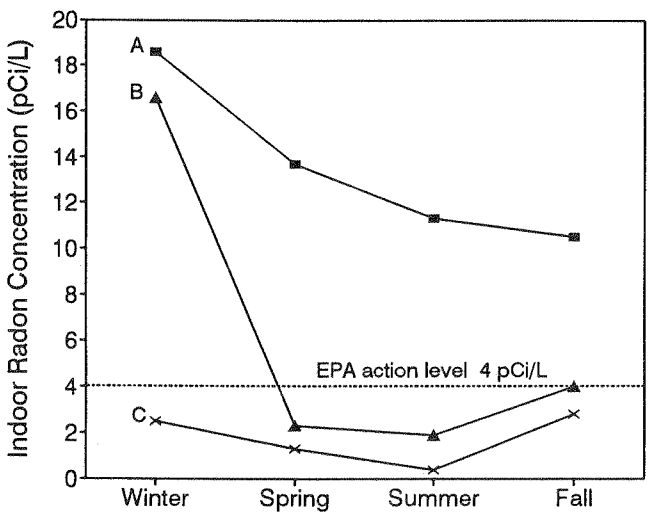
Summary of results of 1989 and 1990–1991 surveys

County	Number of measurements	High pCi/L	Average pCi/L	Percentage over 4 pCi/L
Carson City	98	31.6	3.9	27
Churchill	141	20.1	2.2	9
Clark	259	11.0	1.0	3
Douglas	85	21.9	4.6	38
Elko	258	18.0	2.9	22
Esmeralda	20	3.0	1.1	0
Eureka	34	35.4	5.0	29
Humboldt	250	43.4	2.4	14
Lander	68	46.7	3.1	18
Lincoln	143	41.8	4.5	37
Lyon	68	11.0	2.4	18
Mineral	74	23.6	4.2	41
Nye	161	15.0	2.9	10
Pershing	40	40.7	6.4	45
Storey	7	14.7	3.3	14
Washoe	407	40.6	2.8	18
White Pine	242	23.7	3.4	27
	2,355		2.9[1]	19[1]

[1]Unweighted averages



Graph 2.—Average radon concentration in seasonally measured homes during the winter (January-February and December 1990 and January-February 1991), spring (March-May 1990), summer (June-August 1990), and fall (September-November 1990).



Graph 3.—Seasonal variations in indoor radon concentrations in three Nevada homes during the 1990–1991 survey.

Radon concentration has been shown to vary by floor in the home as well, which the Nevada surveys have substantiated. That is, radon concentrations are generally higher in the lower floors of buildings. For example, in the 1990-1991 Nevada radon survey, it was found that basements of homes averaged 6.3 pCi/L (with a range of 0.0 to 46.7 pCi/L), while first (ground) floors of homes across the state averaged 1.9 pCi/L of radon (with a range of 0.0 to 28.4 pCi/L), or only one-third the concentration of basements on the average. Radon concentrations in crawl spaces averaged 3.1 pCi/L, and concentrations in second floors of homes averaged 1.6 pCi/L, only slightly less than first floor concentrations, but not enough second floors or crawl spaces have been measured for these figures to be statistically significant.

Radon and Geology

Some relationships between the occurrence of higher levels of indoor radon and local geology are indicated by the data collected in the Nevada surveys. Granite and related plutonic rocks can contain above-average amounts of uranium; some granitic rocks have been shown to be sources of high indoor radon in some parts of the country. From the survey data, there is a cluster of towns and cities in west-central Nevada with a relatively high proportion of elevated radon measurements, which may be due to the proximity of granitic rocks in the local mountain ranges. In central Nevada, the town of Austin is surrounded by granitic rocks, and the mountain ranges flanking the town of Lovelock contain some granitic rocks.

Other rocks that have been shown to contribute to elevated indoor radon levels in some parts of the country include some shales, some metamorphic rocks, and phosphatic rocks. Most of Nevada's shale is located in the eastern half of the state and may be contributing to some of the elevated radon content found in homes in east-central and northeastern Nevada. Metamorphic rocks occur in various mountain ranges of Nevada; their role in the state's radon picture is unclear but they may be a source of indoor radon in some communities such as Carson City and Hawthorne. Phosphatic rocks in Nevada are restricted mostly to northeastern Elko County; it is unlikely that phosphatic rocks are a source of radon in any of the communities involved in these surveys.

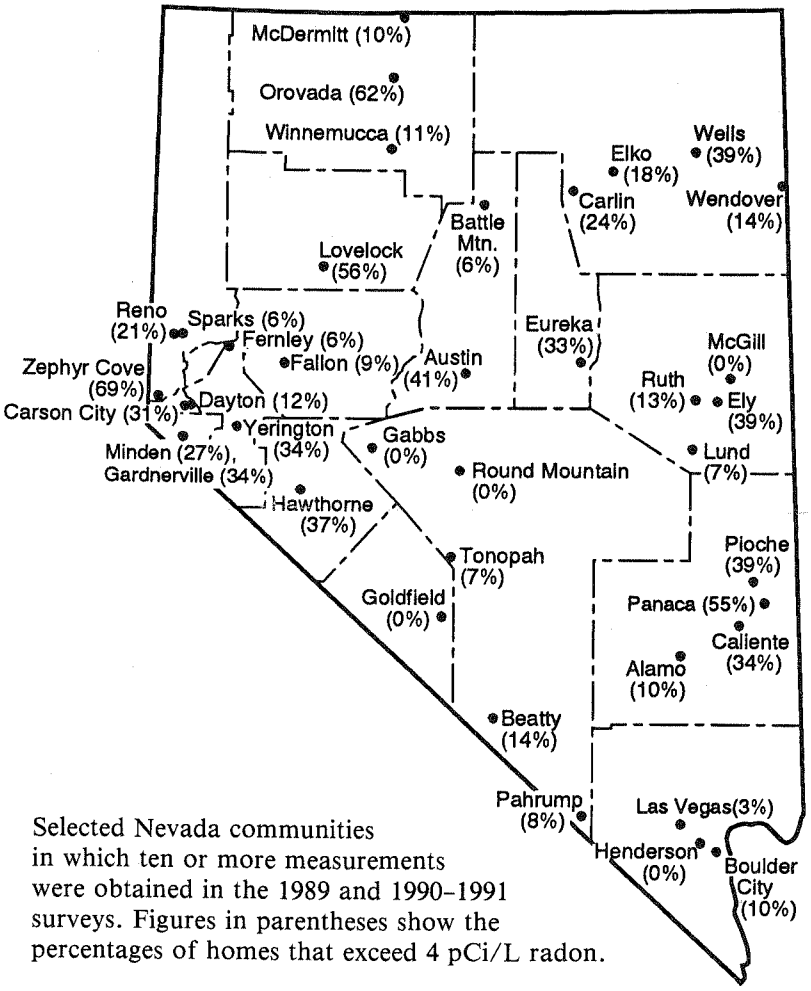
Because of their relatively high uranium content, silicic volcanic rocks have the potential to generate significant radon. Based on some of the radon data collected in Nevada and on some geochemical analyses, it appears that elevated indoor radon levels found in some Nevada communities may be due to certain kinds of volcanic rocks. Many of the elevated radon values in Lincoln County are likely due to nearby silicic volcanic rocks or sediments derived from them. Some of the higher indoor radon levels in homes in Elko County and in the towns of Lovelock, Eureka, and Yerington, among others, may also be derived from silicic volcanic rocks.

Summary

Thirty-four states have participated in the EPA's radon survey to date. Out of 47,598 homes measured for indoor radon in those states (including Nevada), 21% exceeded 4 pCi/L, and the weighted average radon value for all states was 3.3 pCi/L. Some homes in other states had readings as high as several thousand pCi/L, and in Iowa, radon in 71% of the homes surveyed by EPA exceeded 4 pCi/L.

Compared to some parts of the country then, the data from Nevada may not seem very high. However, some areas in Nevada contain radon in amounts substantially higher than the average radon value for the United States, and some areas contain high percentages of homes exceeding 4 pCi/L (see map, next page).

Results of this survey should be considered preliminary. Although over 2,000 homes in Nevada have now been measured for radon content under this program, this is far less than 1% of all Nevada homes. Furthermore, radon measurements made in your neighbor's house cannot be used to predict the radon content of your house. This is because radon concentration in buildings depends on many factors besides the type of underlying soil or rock. These other factors include the floor on which the measurement was made; the specific types of construction and building materials used in the design and construction of the building; the barometric pressure, wind speed, and outdoor air temperature; whether windows and doors in the building were opened or closed during the testing period; and whether the heating or cooling systems were being used during the testing period. For these reasons, the only way to determine the amount of radon present in a particular building is to test that building for radon using a radon detector. The Governor has recommended that all Nevadans test their homes for radon.



Selected Nevada communities in which ten or more measurements were obtained in the 1989 and 1990–1991 surveys. Figures in parentheses show the percentages of homes that exceed 4 pCi/L radon.

This brochure was prepared by the Nevada Bureau of Mines and Geology and the Nevada Division of Health

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

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