Radon

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INTRODUCTION: Radon is a colorless, odorless, and tasteless gas that comes from the radioactive decay of uranium (fig. 1). Radon in the outdoor air is diluted to such low concentrations that it is usually nothing to worry about; however, radon inside can accumulate to concentrations that can pose potential health problems. Exposure to elevated levels of radon can increase the risk of developing lung cancer (fig. 2). The Indiana State Board of Health (ISBH) is the organization charged with coordinating state and federal programs involving radon levels in Indiana homes. During the 1987-88 heating season the ISBH distributed radon detectors to more than 1,200 randomly selected homes in Indiana. About 26 percent of the homes tested exceeded the U.S. Environmental Protection Agency (EPA) action level of 4.0 picocuries per liter (pCi/L).

The radionuclide-bearing geologic materials (potential radon sources) found in Indiana are brownish-black shales, unconsolidated glacial materials that contain clasts of brownish-black shale, and residual soils. Variations in local geology, home construction, ventilation, and atmospheric conditions make it difficult to predict potential radon levels for individual homes.

Listed below are answers to some of the questions that are frequently asked about radon by homeowners.

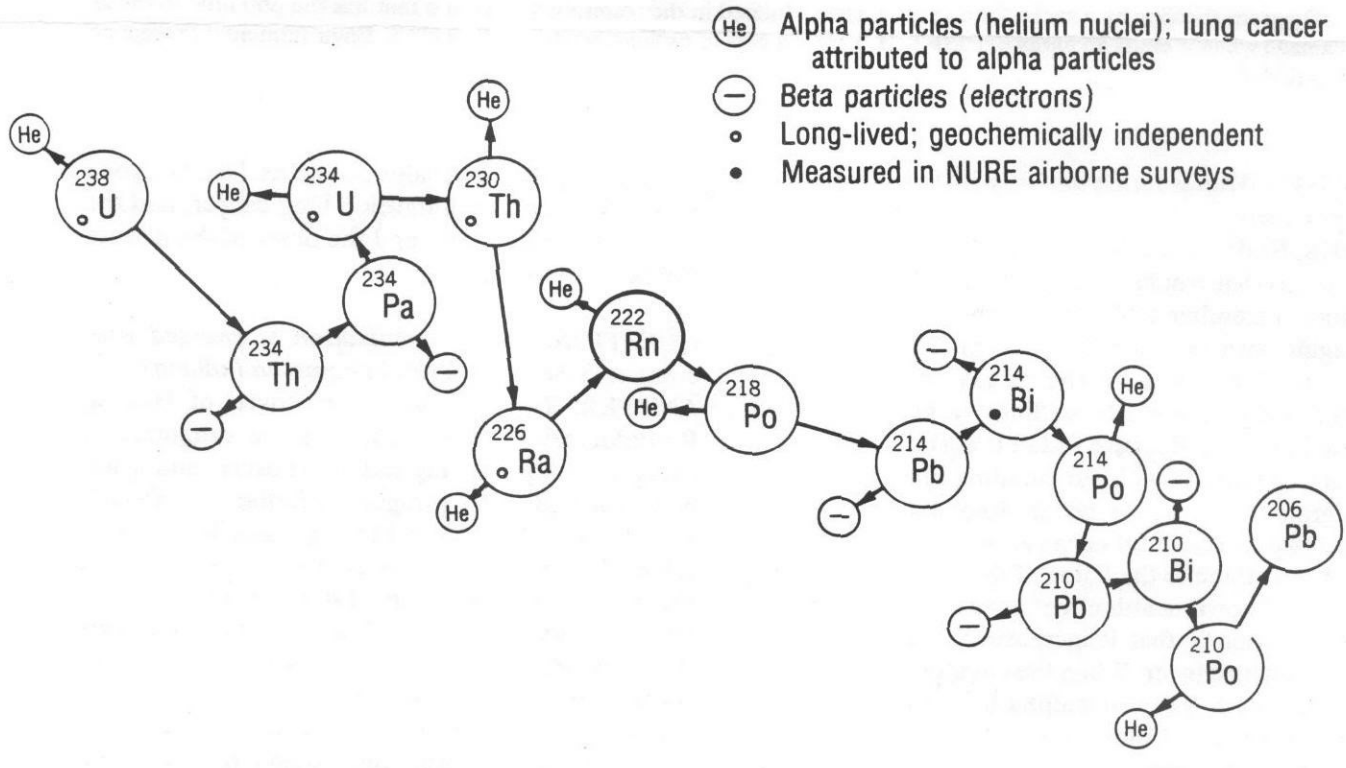

Figure 1. Simplified uranium-238 decay series. Because it has a relatively long half-life (3.8 days), is chemically inert, is a gas, and gives off a relatively large and heavy alpha particle during its decay process, radon-222 constitutes the greatest health hazard to the general population. From Tanner (1986).

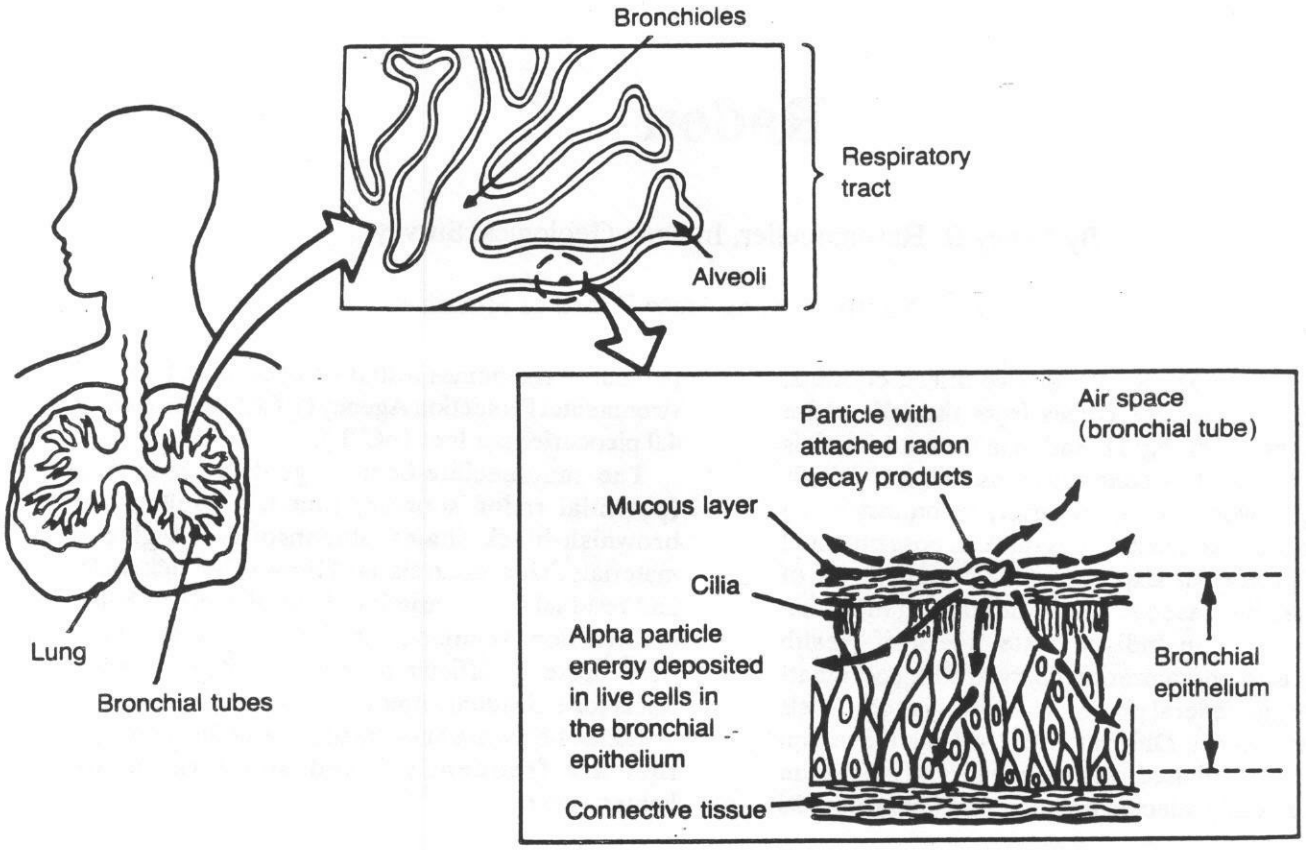

Figure 2. Diagram showing an attached radon atom that is lodged in the respiratory tract and that has the potential to cause cell damage when it emits an alpha particle during the process of radioactive decay. From U.S. Environtmental Protection Agency (1986).

QUESTION: *What is radon and why is it a potential health problem?*

ANSWER: Radon is a colorless, odorless, and tasteless inert gas that results from the radioactive decay of radium, a member of the radioactive decay chain that begins with uranium-238. Several isotopes of radon are derived from the decay of radium; however, only radon-222 ordinarily presents a problem in homes. Because radon is a gas and does not react chemically with surrounding materials, it can migrate in the air or water. Radon decays to isotopes that are harmful because they are radioactive and can attach to the lining of the lung.

The only known health effect associated with exposure to radon is that it increases the chance of developing lung cancer. When the daughter isotopes of radon decay, they can emit alpha, beta, and gamma particles. If breathed into the lungs, these isotopes can irradiate the surrounding lung tissue and increase the chance of contracting lung cancer. Radon outside in the atmosphere is diluted and dispersed, but radon indoors can build to concentrations that can create potential health problems. Not everyone exposed to radon will develop lung cancer, and the time between exposure and the onset of the disease will be many years.

QUESTION: *What organization is charged with evaluating the radon levels in homes in Indiana?*

ANSWER: The Indiana State Board of Health, Radiological Health Section, is the organization charged with evaluating radon exposure, and it has been involved in this program in Indiana for about 2 years. During the 1987-88 heating season Indiana was selected as one of the seven states to participate in the State/U.S. Environmental Protection Agency (EPA) Radon Assistance Monitoring Program. This survey is designed to locate areas in the state with consistently elevated levels and to determine the extent of the range of radon levels across the state.

As part of this program Indiana was allocated 3,000 radon detectors (charcoal canisters) by the EPA for deployment during the 1987-88 heating season. A total of 1,217 canisters were deployed

during that time; the rest of the canisters will be placed during the 1988-89 heating season. Of the 1,217 detectors distributed in 1987-88, 26 percent of the homes tested exceeded the EPA action level of 4.0 pCi/L; 2 percent of the homes exceeded 20 pCi/L. The highest level found was 71.8 pCi/L, and the arithmetic mean was 3.6 pCi/L of air.

QUESTION: *What factors influence the accumulation of radon in the home?*
ANSWER: Four major factors influence the accumulation of radon in the home. The first factor is geology: a source of uranium or radium must be in the ground. Uranium is found in a variety of rocks; therefore, the composition of the bedrock, unconsolidated materials, and soils adjacent to the home is important. The second factor is permeability: the greater the soil permeability, the greater the movement of radon. In an open fracture system in rock, radon-bearing air could conceivably move for distances of hundreds of meters, but it is not likely to move those distances in soils. The third factor is the kind of home construction: radon enters a house through surfaces in contact with the ground; therefore, cracks in the basement, slab, or foundation are entryways for radon. In addition, modern tight home construction can result in a lack of ventilation that could allow the buildup of radon. The fourth factor is atmospheric pressure: if the atmospheric pressure in a home is lower than that in the soil, the radon can move into the structure.

QUESTION: *What types of radionuclide-bearing geologic materials are present in Indiana?*
ANSWER: As mentioned previously, uranium is found in a variety of rocks. Rocks that commonly have high concentrations of uranium are igneous rocks (particularly granite), metamorphic rocks, rocks high in phosphate, and brownish-black organic-rich shales. Soils may also have high concentrations of radionuclides.

Igneous and metamorphic rocks do not crop out at the surface in Indiana. Although igneous and metamorphic rocks are found in some glacial deposits, they are not a major component. No major sedimentary sequences that are high in phosphate are known in the state. Extensive limestone bedrock units are at the surface in areas of southern Indiana; the unweathered limestones are not known to contain high concentrations of radioactive materials.

Brownish-black organic-rich shales of Devonian and Mississippian age, which contain higher concentrations of radioactive materials than most normal marine shales, are the major uranium-bearing geologic material in the state. One of these units, the New Albany Shale, crops out at the bedrock surface in a narrow band from northwestern to southeastern Indiana. The shale is at the surface in southeastern Indiana and is at or near the surface in limited areas of northwestern Indiana. Much of the rest of the outcrop belt is covered by deposits of unconsolidated materials more than 50 feet thick.

Direct determinations of uranium concentrations in the black shale range from 4 to 278 ppm (parts per million). The New Albany Shale is as much as 120 feet thick in the outcrop area and contains greenish-gray as well as brownish-black shale beds. The brownish-black shale is jointed, a characteristic that would facilitate the movement of radon.

Brownish-black shales of Pennsylvanian age also have higher than normal concentrations of radioactive materials. The middle part of the Pennsylvanian strata, which crops out in a north-south belt in southwestern Indiana, contains more beds of brownish-black shale than the upper or basal part of the Pennsylvanian strata. Because the shale beds are less than 10 feet thick and crop out in rather narrow, discontinuous bands, natural exposures of the shale influence radon potential only in very limited areas.

Depending on the source area, unconsolidated glacial deposits in the northern part of the state can contain clasts of brownish-black organic-rich Devonian and Mississippian shale. In some areas the concentration of these materials is sufficient to be of concern.

Finally, red residual soils or terra rossa may contain high concentrations of radium. Such soils are generally associated with areas of karst topography developed in Mississippian limestone units in southern Indiana. Residual soils and karst topography can result in elevated radon levels.

QUESTION: *How is radon detected in a home?*
ANSWER: Radon cannot be detected without special measuring devices. The two most popular and commercially available detectors are the charcoal canister and the alpha track detector. These detectors are exposed to the air in a home for a specific length of time and then sent to a laboratory for analysis. If an individual is going to test his own home, he should carefully follow the instructions as outlined by the manufacturer of the detector in order to obtain an accurate measurement of the radon level.

QUESTION: *What should a homeowner do to reduce high concentrations of radon in a home?*
ANSWER: The EPA indicates that most radon remedies require the services of a professional con-

tractor experienced in radon-reduction procedures. It emphasizes the importance of carefully selecting a contractor and reviewing any plans for radon mitigation in your home.

Because radon enters a home through the parts of a house that are in contact with the ground, covering any exposed earth and sealing cracks and openings in the basement or crawl space will reduce the flow of radon into a structure. For houses with marginal radon problems, sealing alone may be sufficient. Radon levels in a home can also be reduced by increasing the ventilation, which will result in radon-laden air in a home being replaced by outdoor air.

QUESTION: *Where can homeowners obtain additional information on radon and the availability of radon detectors?*

ANSWER: Two brochures, "A Citizen's Guide to Radon" and "Radon Reduction Methods," have been published by the EPA and contain additional information on radon in a home. Copies of these brochures and a list of companies that supply radon detectors are available without charge from the Indiana State Board of Health, Radiological Health Section, 1330 West Michigan Street, P.O. Box 1964, Indianapolis, IN 46204-1964.

A publication, Report of Progress 32, "Preliminary Geologic Characterization of Indiana for Indoor-Radon Survey," describes the geologic regions of the state and discusses the radon potential of the regions. It is available for $2.50 (cost includes postage and handling) from the Publications Section, Indiana Geological Survey, 611 North Walnut Grove, Bloomington, IN 47405.

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