NC Radon Program
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Radon Resistant New Construction (RRNC)

Advantages of Radon-Resistant Home Construction (RRNC)

Today's new home buyer is looking for health, environmental quality and comfort to be a part of their new home. Radon is one environmental concern that can be successfully dealt with in the building process. Other benefits of radon resistant new construction are less ground source moisture and reduced energy usage. In addition, building a radon resistant home can be a marketing tool in parts of the state where radon is more prevalent.

More Advantages of Radon-Resistant New Home Construction to both builders and new home buyers.

Radon Occurrence

How do you know if a planned home will have high radon? As a naturally occurring, radioactive gas, radon is present in all soils at different concentrations. Radon is produced from the natural breakdown of uranium and moves through the soil as a soil gas. As a soil gas, the movement of underground radon is determined by soil and rock characteristics. When radon reaches the surface of the ground it quickly disperses to low levels in the outside air.

Some builders have tested the building site for radon before construction. Although a soil radon test can be performed, the results will not indicate whether the home itself will have high radon levels. Radon poses a health threat when it builds up in enclosed buildings. The site preparation and construction process introduce too many factors for a soil radon test conducted before the building process to be useful.

Measured in picoCuries per liter of air (pCi/L), radon levels in the outside air are about 4/10 or .4 pCi/L. The U.S. Environmental Protection Agency (EPA) has set an action level of 4 pCi/L for radon in indoor air. By setting 4 pCi/L as the radon action level, the EPA recommends that indoor levels above 4 pCi/L be reduced. The health

risk from elevated radon exposure is lung cancer. This risk was determined by studies of miners exposed to radon through their work.
The EPA has produced state maps indicating the potential for radon. The EPA Map of Radon Zones for NC is based on geologic analysis of radon concentrations, soil types, indoor radon testing that has been completed for NC, and foundation styles. The EPA Map of Radon Zones for NC shows that eastern NC and the coastal plain are areas with low potential for radon. Piedmont and mountain areas of NC generally have the highest potential for radon. However, homes with radon levels more than 4 pCi/L have been found at the coast and many homes with levels below 2 pCi/L can be found in NC mountain areas. The NC Map of Radon Zones is useful to show the general trend of predicted indoor radon occurrence in NC.
Unfortunately, radon occurrence has been shown to be highly site specific. Two similar houses sitting side by side can have very different radon levels. This can occur because soil radon concentration and radon soil gas movement is variable depending on soil characteristics. Foundation construction practices and house operation also leads to variations in indoor radon levels between nearby houses.

How Radon Enters Homes/ Buildings

Radon needs both entry routes through the foundation and the driving force of low indoor air pressure pressure to draw the soil gas into a house. The air pressure in a house is generally lower than in the surrounding air and soil, particularly in the basement and foundation levels. This difference in pressure causes a house to act like a vacuum, drawing air containing radon and other soil gases in through foundation cracks and other openings. In addition, warm air in a home rises and will leak from openings in the upper portion of the house. This is called the "stack" effect. This causes unconditioned replacement air to enter the house from the lower portion of the house, or under the house when radon is more likely.
During the building process these two factors can be effectively addressed.

Five Elements of a Basic Passive System

Radon resistant construction techniques create a physical barrier to radon entry and a pathway for the radon to be redirected outside the house. The techniques used to accomplish this will vary for different home foundation and site requirements, but the basic elements of a simple passive (no-electric fan) system are:
A layer of gas permeable material under the foundation (usually 4" of course gravel)
Plastic sheeting over the gas permeable layer

Sealing and caulking all openings in the concrete foundation floor or the floor above the crawlspace (crawlspace homes should have 6 mil polyethylene sheeting covering the soil)
Installation of a gas-tight 3" or 4" vent pipe that runs from under the foundation (under the sheeting covering the soil in crawlspaces) through the house to the roof
A roughed-in electrical junction box for the future installation of a fan, if needed.

Active Radon Reduction Systems

The system pictured above is a passive radon venting system. Once the house is completely finished, radon testing should be completed. If testing reveals elevated levels, a fan will need to be added. Fans need to be placed in an unconditioned space usually the attic. In-line tube fans are easy to install by cutting a section in the pipe and using gaskets to secure the fan. A warning system is used to indicate operation of the fan.
The vent pipe should have a discharge vent located above the eave of the roof a minimum of 12 inches above the roof surface. The exhaust vent should also be at least 10 feet from any opening into conditioned spaces in the house, to prevent radon from reentering the house. Later, after the house is finished, a radon test can determine if a radon exhaust fan is necessary to further lower radon levels.
By reducing the stack effect, the major driving force that suctions radon into a house can be controlled. As a basic principle, the stack effect decreases when the number and size of air leaks in the upper surfaces of a building decrease. Exhaust fans usually increase the stack effect.

The following items should be addressed to limit the stack effect.
Openings around chimneys, plumbing chases, pipes, electrical wires, fixtures, and other air passages which penetrate the conditioned envelope of the house should be sealed.
Attic access stairs located in conditioned areas should be gasketed and designed to be tightly closed when not in use to prevent air leakage.
Recessed lighting should be the Type IC rated and designed to be sealed when installed on ceilings that connect to unconditioned spaces.
Fireplaces, wood stoves, gas heaters and other combustion appliances should be installed so that there is an adequate supply of combustion and makeup air.
Windows and exterior doors should be weather-stripped to conform with the CABO Model Energy Code.
HVAC systems should be designed and installed so supply and return air volumes are balanced. Special attention needs to be paid to sealing joints in ducts and plenums passing through unconditioned spaces.

Reducing the stack effect will not only limit radon entry but will make a home more energy efficient.
Limiting entry routes and reducing the stack effect in homes play central roles in radon resistant new construction. The same strategy can be used with retrofit applications but the process is more difficult and foundation modification may not be an option. Retrofit radon control systems typically rely on the fan and pipe system listed as items 4 and 5 above.

More Resources on RRNC

Books and websites on Radon Resistant New Construction and Architectural Drawings of system designs available for free download.
More information is available at the EPA Radon-Resistant New Construction Site

If you have any questions, please contact the NC Radon Program (919) 571-4141 or talytha.moore@ncmail.net