Concrete in Practice
What, why & how?
NRMCA

CIP 18 - Radon Resistant Buildings

WHAT is Radon

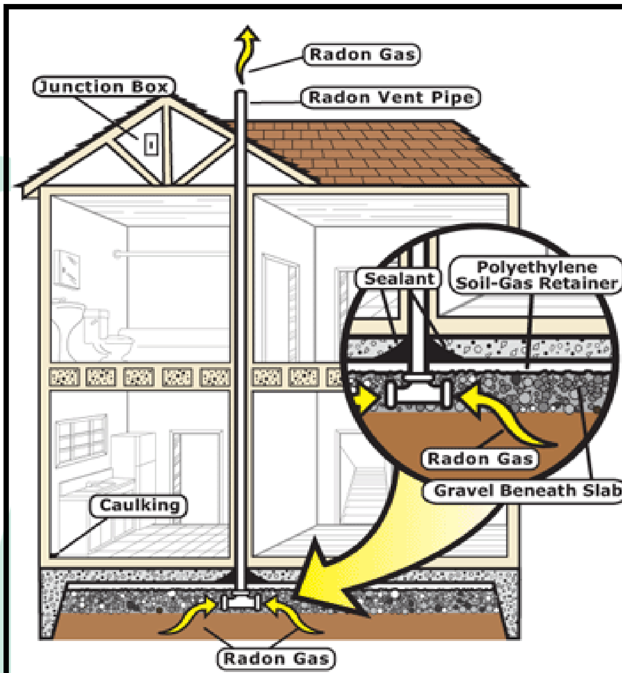
Radon is a colorless, odorless, radioactive gas that occurs naturally in soils in all parts of the US. Radon results from the natural breakdown of uranium and radium present in rock and soil. The rate of movement of radon through soil depends on the permeability and degree of saturation. Radon decays to other radioactive elements in the uranium series, called radon progeny. These radioactive charged particles attach to particles in the air that can be inhaled. Radon can also be dissolved in ground water.

The US and state agencies publish maps of potential for indoor radon concentration based on local geology. Radon concentration is measured in picoCuries per liter (pCi/L), or in Becquerels per cubic meter (Bq/m^3), which is a measure of radioactivity in a volume of air [1 pCi/L = 37 Bq/m^3]. The average concentration of radon in ambient air is about 0.4 pCi/L and about 1.3 pCi/L in homes. Action should be taken to reduce radon levels when concentration in enclosed space occupied by humans exceeds 4 pCi/L.

WHY is Radon a Concern

Radon is categorized as a carcinogen and is one of the leading causes of lung cancer. Radon progeny that are inhaled attach to the respiratory tract and deep in the lungs. Radioactive decay of these particles in the body release energy that can cause tissue damage, which has been linked to lung cancer. Radon levels in well water, used as drinking water, should be measured and treated as needed.

The level of health risk is related to the concentration of radon in the air and duration of exposure by humans. Radon potential maps may govern radon mitigation measures during construction in some regions. There are no recognized protocols for radon testing of soil in building lots that can reliably predict indoor radon concentration. The only way to determine the concentration of radon in living space is to perform a test after the space is occupied. Some aggregate sources used in concrete may be extracted from regions with higher radon concentration, but there is no evidence that radon is emitted from concrete containing these aggregates.



Radon-Mitigation System

Soil gas containing radon enters living space because the air pressure is less than the surrounding air and soil. Soil gas enters buildings through cracks, construction, contraction, or isolation joints, or utility openings in slabs and basement walls, and through suspended floors over crawl spaces.

HOW to Construct Radon Resistant Buildings

Solid concrete slabs and walls separate the soil from the internal living space and is essential in constructing radon resistant buildings. It is an effective barrier to soil gas penetration and attenuation of external sources of radiation if cracks and openings are sealed.

Radon mitigation can be addressed in existing and new construction. It is more economical to build in radon mitigation systems during initial construction. The system includes a process to capture soil gases from below the building, isolating the soil from the living space, and venting the soil gas outside the building. A passive system relies on the natural flow of soil gas from the soil through the vent pipe. An active system, referred to as an Active Soil Depressurization (ASD) system, includes a fan in the vent pipe to force the soil gases through the pipe. Builders may include contingencies to convert a passive system to an active system, if radon levels after occupancy are high. The construction of radon resistant buildings requires adhering to accepted construction practices with attention to a few additional details. Most of these systems are necessary for mitigating moisture entry into the living space and radon mitigation does not involve any significant additional cost in new construction.

Solid concrete slabs and basement walls are commonly used in residential and other buildings and provide resistance to radon penetration into living space. In concrete construction, the critical factor is to eliminate all entry routes through which gases can flow from the soil into the building.

The air gas collection system includes a 4-inch layer of clean coarse graded aggregate above the native soil that permits flow of soil gas towards the vent pipe. This layer also provides a drainage layer and capillary break for moisture control. The air gas collection system may consist of perforated pipe embedded in trenches in the soil subgrade or soil gas collection mats connected to the vent pipe. Plastic sheeting, at least 6-mil thick or thinner cross -laminated polyethylene sheeting is placed between the gas permeable layer and the concrete slab. Sheeting should overlap by at least 12 inches and sealed around utility openings. Plastic sheeting prevents concrete from clogging the gas permeable layer and bridges cracks and openings to reduce soil gas entry above the slab. It also functions as a vapor barrier for moisture control. Tears or punctures should be repaired before concrete is placed. The vent pipe should run vertically from the air gas collection layer to vent gas outside the house through the roof or other exit. Plastic sheeting should cover soil in crawl space with a vent pipe collecting gases from below the sheet in these areas.

References

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4. Building Radon Out – A Step-by-Step Guide on How to Build Radon-Resistant Homes, US EPA, EPA/402-K-01-002, 2001, 84 pp., www.epa.gov/radon
5. Radon Standards of Practice, Association of Radon Scientist and Technologists, AARST Consortium on National Radon Standards, www.standards.aarst.org or www.epa.gov/radon
6. Guide to Residential Cast-In-Place Concrete Construction," ACI 332R, American Concrete Institute, Farmington Hills, MI., www.concrete.org

Follow these Guidelines to Reduce Radon Entry

1. Design to minimize utility openings. Sump openings should be sealed and vented outdoors.
2. It is not recommended to place a layer of sand or compacted fill on top of the polyethylene sheeting. This layer traps moisture that may migrate through the slab. Similarly, the sheeting should not be punctured to drain water when placing the concrete slab.
3. Use concrete without excess water to minimize cracking. Concrete with larger aggregate typically has reduced shrinkage. Concrete for slabs should have a slump of 3 to 5 inches when placed.
4. Minimize random cracking by using control joints in walls and floors and isolation joints between slabs and walls. Cracks are intended to occur at the joints and can be easily sealed.
5. Monolithic slab foundations are an effective way to minimize radon entry and are common for slab-on-grade homes in warm climates. Foundation and slab function as a monolithic unit and minimizes openings.
6. Remove grade stakes after striking off the slab. If left in place, these can provide entry paths through the slab.
7. Construct the control and construction joints to facilitate caulking.
8. Cure the concrete adequately.
9. All control joints, isolation joints and any other openings in slabs and walls should be caulked with an elastomeric sealant, such as a polyurethane caulk. Random cracks should be chipped to widen them before caulking.

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