Radon mitigation

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Radon mitigation is any process used to reduce radon concentrations in the breathing zones of occupied buildings.

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Testing

ASTM E-2121 is a standard for reducing radon in homes as far as practicable below 4 picocuries per liter (pCi/L) (148 Bq/m³) in indoor air. [1][2] Radon test kits are commercially available. The kit includes a collector that the user hangs in the lowest livable floor of the house for 2 to 7 days. The user then sends the collector to a laboratory for analysis. The National Environmental Health Association provides a list of radon measurement professionals.[3] Long-term kits, taking collections from 91 days to one year, are also available. An open land test kit can test radon emissions from the land before construction begins. The EPA and the National Environmental Health Association have identified 15 types of radon testing.[4] A Lucas cell is one type of device.

Radon levels fluctuate naturally. An initial test might not be an accurate assessment of a home's average radon level. Transient weather can affect short-term measurements.[5] Therefore, a high result (over 4 pCi/l) justifies repeating the test before undertaking more expensive abatement projects. Measurements between 4 and 10 pCi/l (148 and 370 Bq/m³) warrant a long-term radon test. Measurements over 10 pCi/l (370 Bq/m³) warrant only another short-term test so that abatement measures are not unduly delayed. Purchasers of real estate are advised to delay or decline a purchase if the seller has not successfully abated radon to 4 pCi/l or less.

The National Environmental Health Association administers a voluntary National Radon Proficiency Program for radon professionals consisting of individuals and companies wanting to take training courses and examinations to demonstrate their competency.[6] A list of mitigation service providers is available.[7]

Methods of mitigation

Because high levels of radon have been found in every state of the United States[8], testing for radon and installing radon mitigation systems has become a specialized industry in the last two decades. Many states have implemented programs that affect home buying and awareness in the real estate community, however radon testing and mitigation systems are not generally mandatory unless specified by the local jurisdiction.[9]

Generally indoor radon can be mitigated by sealing concrete slab floors, basement foundations, water drainage systems, or by sub-slab de-pressurization and exhausting such radon laden air to the out of doors away from windows and other building openings[10]. Modern energy efficient construction that conserves energy by making homes air tight often exacerbates the risks of radon exposure. Less tightly constructed homes with greater air leaks are often just as likely to present elevated risks. Ventilation systems can utilize a heat exchanger or energy recovery ventilator to recover part of the energy otherwise lost in the process of exchanging air with the outside. Homes built on a crawl space can benefit from a radon collector installed under a radon barrier (a sheet of plastic that covers the crawl space).

The most common approaches are active soil depressurization (ASD) and mechanical ventilation (MV). Experience has shown that neither is applicable to all buildings with radon problems. A less common approach works efficiently by reducing air pressures within cavities of exterior and demising walls where radon emitting from building materials, most often concrete blocks, collects. \

- Above slab air pressure differential barrier technology (ASAPDB) requires that the interior pressure envelope, most often drywall, as well as all ductwork for air conditioning systems, be made as airtight as possible. A small blower, often no more than 15 cubic feet per minute (0.7 l/s) may then extract the radon-laden air from these cavities and exhaust it to the out of doors. With well-sealed HVAC ducts, very small negative pressures, perhaps as little as 0.5 pascal (0.00007 psi), will prevent the entry of highly radon-laden wall cavity air from entering into the breathing zone. Such ASAPDB technology is often the best radon mitigation choice for high-rise condominiums as it does not increase indoor humidity loads in hot humid climates, and it can also work well to prevent mold growth in exterior walls in heating climates.
- In hot, humid climates, heat recovery ventilators (HRV) as well as energy recovery ventilators (ERV) have a record of increasing indoor relative humidity and dehumidification demands on air conditioning systems. It is very clear that serious mold problems have originated in homes that have been radon mitigated with HRV and ERV installations in hot, humid climates. HRVs and ERVs have an excellent record in heating climates.
- A recent technology is based on building science. It includes a variable rate mechanical ventilation system that prevents indoor relative humidity from rising above a preset level such as 50% which is currently suggested by the U.S. Environmental Protection Agency and others as an upper limit for the prevention of mold. It has proven to be especially effective in hot, humid climates. It controls the air delivery rate so that the air conditioner is never overloaded with more moisture than it can effectively remove from the indoor air.
- It is generally assumed that air conditioner operation will remove excess moisture from the air in the breathing zone, but it is important to note that just because the air conditioner cools does not mean that it is also dehumdifying. If *delta t* is 14 degrees or less, it may not dehumidify at all even though it is cooling.

- Factors that are likely to aggravate indoor humidity problems from mechanical ventilation–based radon installations are as follows and an expert radon mitigator/building scientist will check for and correct any and all of the following when he or she performs radon mitigation procedures:

1. Air conditioner duct leaks located outside the breathing zone, such as in the attic.
2. Excessive exhaust fan operation
3. Oversize or over-capacity air conditioners
4. AC air handler fans that do not stop running when the air conditioner compressor stops running.
5. A radon system air intake located close to a clothes dryer exhaust.
6. Delta t (Δt), which is the amount that the air is cooled as it is passed through the air conditioner's

cooling coils. A good delta *t* performance figure for home air conditioners is about 20 degrees Fahrenheit (36 °C). In comparison, automobile air conditioners deliver Δ*t* performance of 32 to 38 °F (18 to 21 °C). A delta *t* of 14 °F (8 °C) will dehumidify poorly if at all.

In South Florida, most all radon mitigation is performed by use of fixed rate mechanical ventilation. Radon mitigation training in Florida does not include any segment addressing mechanical ventilation or of problems associated with mechanical ventilation systems such as high indoor humidity, mold, moldy odors, property damage or health consequences of human occupation in high humidity of moldy environments. As a result, most Florida radon mitigators are unaware of and do not incorporate existing building science moisture management technology into mechanical ventilation radon installations.

Home inspectors are generally *unaware* of the mold risks associated with radon mitigation by mechanical ventilation even though mold may make occupants sick, destroy their home and property, and/or be very expensive to clean up and then make the home difficult to sell. In Florida the lawsuits are just beginning.

It appears that in thousands of Florida condominiums and apartments, radon mitigation mechanical ventilation systems were installed in a concealed fashion,[*citation needed*] escaping even the recognition of professional home inspectors and real estate professionals.[*citation needed*]

Radon removal

Radon removal is carried out in order to reduce indoor radon levels. Radon can be removed by the use of air pipes and fans to exhaust sub-slab air to the outside. Indoor ventilation systems are more effective, but exterior ventilation can be cost-effective in some cases. Modern construction that conserves energy by making homes air tight exacerbates the risks of radon exposure if radon is present in the home. Older homes with more porous construction are more likely to vent radon naturally. Ventilation systems can be combined with a heat exchanger to recover energy in the process of exchanging air with the outside. Homes built on a crawl space can benefit from a radon collector installed under a radon barrier (a sheet of plastic that covers the crawl space).

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Nearly all mechanical ventilation-based radon control systems are of fixed rate operation, and even if the indoor relative humidity in the interior of a building goes high, they will continue to inject moisture-laden air into this wet environment increasing the likelihood of mold growth. This is especially risky in hot, humid climates. It is not an unusual practice for radon mitigators in hot, humid climates to warn of possible resulting mold problems by way of an easily removed warning sticker.

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