SHOULD ONLY ACTIVE RADON RESISTANT NEW CONSTRUCTION BE REQUIRED IN ALL ZONE ONE COUNTIES IN ALABAMA?

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Abstract

Some individuals within standards development groups involved with radon are discussing a possible revision of the existing Radon Resistant New Construction (RRNC) standards into a consensus national standard that would advocate the requirement that all new RRNC installations in Zone One counties be active radon systems which include a radon fan. This paper investigates the potential for needless installations of radon fans and associated energy waste that such a requirement might cause.

Many publications have documented that at radiation levels near natural background, the *Linear No Threshold Theory* of radiation risk is at best a weak theory. Some publications, including some directly related to radon exposure, have demonstrated no detectable risk to occupants of residences with radon concentrations in the range of the WHO reference level of 2.7 pCi/L. Certainly occupants of homes with radon concentrations at or below half of the WHO reference level are not subject to sufficient risk to justify an active radon removal system.

The author uses existing publications on the operational cost of an active system to investigate the wasted energy that would result in over half of the new homes constructed in Alabama's Zone One counties should the installation of active RRNC ever become required. This, plus the unnecessary expense of unneeded radon fans, leads to the conclusion that for the State of Alabama any RRNC standard should require both a passive system capable of being made active and an initial occupancy radon test to determine if a radon fan is needed. Requiring active-only RRNC would be an excessive waste of money and energy.

Introduction

The Alabama Radon Program is a partnership between the Alabama Department of Public Health (ADPH) and the Alabama Cooperative Extension System (ACES) with the latter being the primary supplier of information dessemination and outreach. As a public service ACES sells radon test kits to Alabama citizens at near wholesale prices for citizens to utilize to test their

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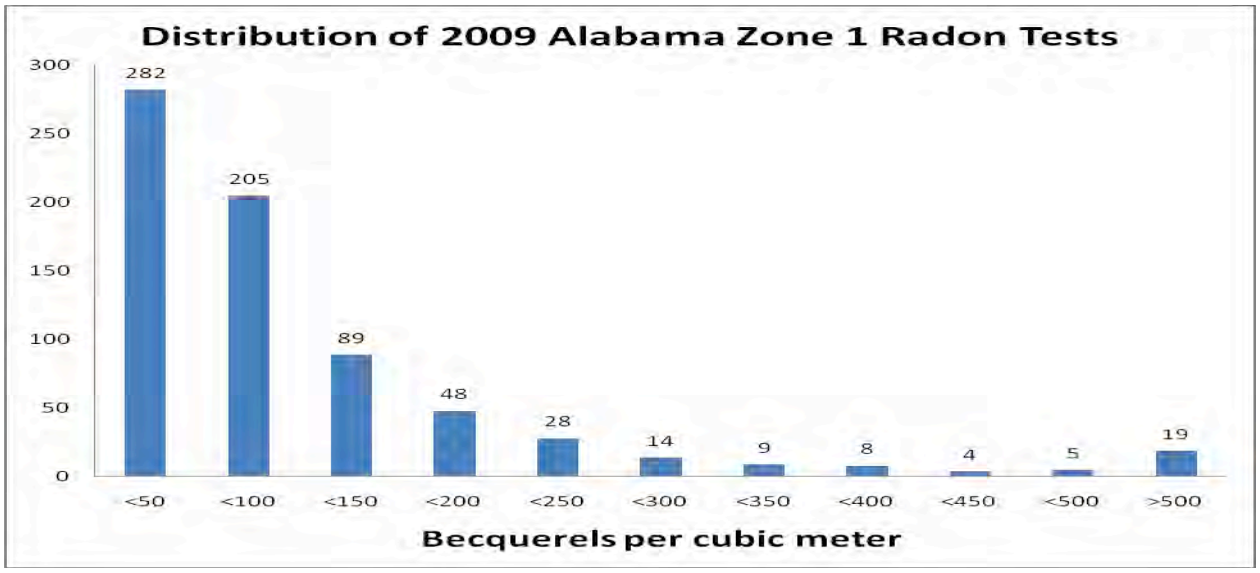
residences. The results of those tests are reported by the vendor to ACES which maintains a data base of results. Results are screened to remove repeat and post mitigation tests and to remove results where the citizen indicates that the residence has a radon mitigation system or was built with radon resistant construction features. These results are then tabulated by zip code and by county to provide information of the location and magnitude of Alabama's radon problem. This paper utilizes the Alabama Radon Program's 2009 test results as an indicator of the need for Alabama residences to be built with radon resistant new construction techniques that would mandate that an active soil depressurization system be installed at the time of construction.

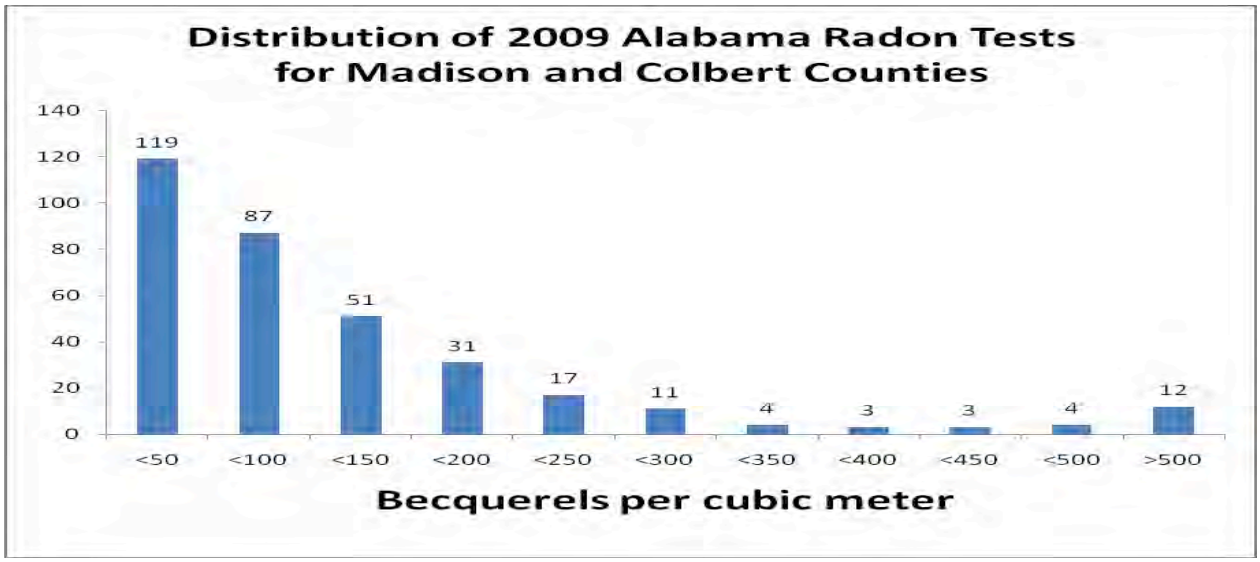
The assumption is made that the Alabama Radon Program's 2009 test results for a given county are representative of the radon levels that would be expected in new construction built in that county without radon resistant construction features. It is further assumed that if a passive RRNC radon stack and appropriate sealing were to be included in these houses, the radon concentration would be no greater than if no RRNC system were installed and can reasonably be assumed to be lower.

Radon Test Results

In 1993 the U.S. Environmental Protection Agency (EPA) designated 13 Alabama counties as Zone One. (EPA, 1993) As allowed by that document the State of Alabama added two additional counties, Jefferson and Shelby to the Zone One designation. In 2009 there were 711 radon test results from Zone One counties reported to the Alabama Radon Program that met the criteria for inclusion into the data base. Of those, 141 or 19.8% were greater than or equal to the EPA Action Level of 4.0 pCi/L and 235 or 33.1% were greater than or equal to the WHO Reference Level of 2.7 pCi/L. Conversely, for Alabama's Zone One counties 80.2% were less than the EPA Action Level and 66.9% were less than the WHO Reference Level. (Alabama Radon Program,2010) If two-thirds of the residences are already below the WHO Reference Level, the lower of the two action levels, is it justifiable to force the purchasers of new residences in all of Alabama's Zone One counties to be required to purchase a radon fan and then to pay for its operation?

Based on two decades of tabulation of radon test results, the Alabama Radon Program has established Colbert and Madison counties as the two Alabama counties having the greatest radon problem. In 2009 there were 38 radon test results from Colbert County that met the criteria for inclusion into the data base. Of those, 11 or 28.9% were greater than or equal to the EPA Action Level of 4.0 pCi/L and 19 or 50% were greater than or equal to the WHO Reference Level of 2.7 pCi/L. Conversely, for Colbert County, 71.1% were less than the EPA Action Level and 50% were less than the WHO Reference Level. In 2009 there were 304 radon test results from Madison County that met the criteria for inclusion into the data base. Of those, 78 or 25.7% were greater than or equal to the EPA Action Level of 4.0 pCi/L and 121 or 39.8% were greater than or equal to the WHO Reference Level of 2.7 pCi/L. Conversely, for Madison County, 74.3% were less than the EPA Action Level and 60.2% were less than the WHO Reference Level. (Alabama Radon Program,2010) Even in Alabama's two highest radon counties it is reasonable to expect that approximately half of the new residences built without RRNC will be below the WHO Reference level and two-thirds will be below the EPA Action Level.





Effect of a Passive Radon Stack

Currently the Alabama Radon Program recommends the installation of RRNC with appropriate sealing and a passive radon stack for new residential construction in our high radon areas, followed by a radon test at occupancy and then by another radon test in the opposite season if the initial test was made during the air conditioning season. If the initial test was done in the spring or fall the second test is recommended to be done in the winter heating season. Only if the radon test results indicate a radon problem should the resident be advised to purchase the installation of a fan for the system.

The reason for the opposite season retest is because Alabama has found that in Alabama's high radon counties that approximately one third of the residences that test below 4.0 pCi/L in the summer air conditioning season will have radon concentrations greater than 4.0 pCi/L if retested in the winter heating season. (McNees and Roberts,2007)

Alabama has only anecdotal data of the reduction in radon concentration resulting from the installation of passive radon systems. In several incidences over the last 30 years the author observed that passive ventilation reduced the radon concentration by about half. The author can find no published study on this matter except for the Finnish study published in 2010. In that study it was documented that passive radon stacks reduced the radon concentration by 55% when installed along with appropriate sealing in Finland's high radon areas. (Arvela,2010) The basic principle of warm air rising out the passive stack during winter is the same for both Alabama and Finland. However, there are differences in construction styles that could affect the soundness of applying the Finnish study to Alabama data. In Finland they utilize an insulation layer between the foundation and the soil. In both Finland and Alabama the predominate style of new home construction is a slab on grade. The difference being in Alabama the slab is on top of an aggregate layer which is on top of the soil.

At the 2008 AARST International Radon Symposium, Bernard Collignan presented evidence that a passive system can "run efficiently a significant part of the year if it is properly dimensioned, and mainly during cold conditions, where it is more necessary to have a good protection against radon." (Collignan,2008) This is the same situation as in Alabama where radon levels are typically highest in the winter. (McNees and Roberts,2007) Problems in Alabama with passive systems being unsuccessful when made active are most often a result of incorrect passive system installation and not with the fact that the system did not include a radon fan at installation. For the radon distribution found in Alabama the author advocates that local building codes should require that the system be in installed passive, with appropriate sealing, followed by a radon test at occupancy and then by another radon test in the opposite season if the initial test was made during the air conditioning season. If the initial test was done in the spring or fall, the second test is recommended to be done in the winter heating season. Then, if the radon test results exceed the national Action Level, a radon fan should be added and made active.

Alternative Action Levels

The EPA has established our national Action Level for radon to be 4.0 pCi/L. (EPA,2005) Some have suggested that for RRNC we should utilize the WHO Reference Level of 2.7 pCi/L. Others have suggested that we utilize what they call the Technically Achievable Threshold with a value of 2.0 pCi/L. In accordance with current national guidance, for an existing home to be acceptable for occupancy following a real estate transaction, the radon concentration should be below the EPA Action Level of 4.0 pCi/L. If our nation were to adopt a policy that for a newly constructed residence to be acceptable for occupancy it should have radon concentrations of less than some new lower concentration such as 2.0 pCi/L, such a policy would be a major inconsistency. Having such an inconsistent policy concerning the acceptable level of radon

concentration for occupancy would result in a tremendous loss of credibility for national radon reduction efforts.

The EPA national Action Level does not have universal agreement. In addition to the WHO Reference Level, it also differs from that of the National Council of Radiation Protection and Measurement (NCRP) and from that of the International Commission on Radiological Protection (ICRP). NCRP in their Report No. 77 recommends that for the purposes of remedial action the annual average exposure rate should be no more than 2 WLM per year. Where WLM is Working Level Months. The annual average exposure rate of 2 WLM per year can be translated into an average WL of 0.04, which using the 50% equilibrium assumption of Report No. 77, corresponds to 8 pCi/L. (NCRP,1984) Granted NCRP Report No. 77 was published in 1984, but it has not been rescinded by the NCRP. The ICRP in its 2007 recommendations established an upper reference level for residential occupancy of 600 Bq/m^3 or 16 pCi/l. (ICRP,2007) ICRP has since issued a statement on radon giving revised upper reference levels to take account for the more recent epidemiological analyses. (ICRP,2009) Their upper value of the reference level for radon gas has been revised to 300 Bq/m^3 or 8 pCi/L. The point being that there is not universal scientific acceptance that either the EPA national Action Level of 4.0 pCi/L or the WHO Reference Level of 2.7 pCi/L is the appropriate average annual radon concentration to justify an active radon mitigation system.

For the purposes of this paper the author assumes that our nation will reduce the national Action Level from the current 4.0 pCi/L to the WHO Reference Level of 2.7 pCi/L and that this revised Action Level will be consistently applied to both the previously occupied and the newly constructed residences with respect to if the radon concentration is acceptable for occupancy. If requiring RRNC to be installed "active-only" is not justified at an assumed future national Action Level of 2.7 pCi/L, it certainly is not justified at the existing national Action Level of 4.0 pCi/L.

Colbert and Madison are the two Alabama counties that have been shown to contain the greatest radon problems in the state, yet radon test results for houses in those counties are less than 2.7 pCi/L 50% and 60.2% of the time respectfully. These test results were for houses built with no radon control systems. Consider what the results would be if these houses had been built as the State of Alabama currently recommends, i.e. with proper sealing and a passive radon stack installed such that it is capable of being made an active ASD system. Because warm air rises everywhere in the world, the same stack effect that worked to remove radon in Finland would also reduce the radon in these houses. Thus, if they were constructed with RRNC having appropriate sealing and passive radon stacks it is reasonable to expect that more that half of the new homes built in Alabama's highest radon counties would be less than even the WHO Reference Level of 2.7 pCi/L or 100 Bq/m^3. Applying the results of the Finish study, half might well be less than 1.35 pCi/L or 50 Bq/m^3.

Does the risk really exist all the way to zero?

The argument is often made that there is still risk reduction to be achieved all the way down to zero radiation dose. Such is the premise of the *Linear No Threshold Theory* of radiation risk. We utilize the *Linear No Threshold Theory* extensively in the formulation and application of regulatory rules and practices. Scientific research however, produces many interesting results that cause the *Linear No Threshold Theory* to be questioned at doses near natural background.

As long ago as 1898 Atkinson observed that irradiated algae grew faster than nonirradiated controls. (Atkinson,1898) In 1919 Davey noted the increased life span of irradiated insects. (Davey,1919) Following the atomic bomb blasts it was observed that Japanese who received 11 to 120 R in 1945 appeared to live longer than those who received none or more. (Encyclopedia Britannica,1974) Numerous studies during the second half of the twentieth century demonstrated the increased life span in mammals receiving low doses of radiation. So many such observations were observed and published during the latter half of the twentieth century, that the increased life span of experimental animals exposed to low levels of ionizing radiation was acknowledged by the U.S. National Council on Radiation Protection and Measurements in their Handbook 39, entitled *Basic Radiation Protection Criteria.* (NCRP,1971) That Handbook outlined the basis of what became many of radiation regulations that are enforced today by regulatory agencies such as the Alabama Office of Radiation Control.

The nationwide study of radon concentrations by county by B. L. Cohen suggested a possible inverse relationship between residential low-dose radon levels and lung cancer mortality. (Cohen,1997) The more recent Worcester County, Massachusetts study of Thompson, et.al., found no increase in lung cancer when compared to radon concentrations in radon levels below 150 Bq/m^3 (4.0 pCi/L). In fact the Thompson's article concludes with the statement, "The possibility of a hormetic effect on lung cancer at low radiation doses cannot be excluded." (Thompson,2008)

While the modern publications of Darby, Krewski, and Lubin all demonstrate that breathing greater concentrations of radon are related to lung cancer, they all conclude that in the range of 1.35-2.7 pCi/L (50-100 Bq/m^3) that the effects of radon on the incidence of lung cancer is uncertain. (Darby,2005) (Drewski,2005) (Lubin,2005)

The scientific truth is that there is no conclusive evidence that Alabama citizens living in residences where the radon concentration is already below the 1.35-2.7 pCi/l (50-100 Bq/m^3) range would receive any benefit from the expense of the installation and operation of a radon reduction fan.

How much unnecessary expense would it be?

The State of Alabama is currently recommending the installation of a passive RRNC as outlined in the EPA publication *Building Radon Out* for new residential construction in their Zone One counties. (EPA,2001) Alabama builders have told the author that once adopted on a wide scale basis the increased cost of the passive RRNC as recommended would be in the range of $350 to

$500. A fan would then be added and operated only in the event the radon levels were found to be above the national Action Level.

If the building codes in Alabama were revised to require active-only RRNC for new residential construction in the 13 counties that the EPA designated as Zone One, then over half of the purchasers of those new homes would be paying for a radon fan, associated installation cost, and operational costs that they do not need. The EPA sponsored moisture study estimated the cost of operation of such systems to be between $83 and $191 per year. (Turk and Hughes,2008) In 2009, Leo Moorman presented and published a more rigorous analysis of estimated cost associated with the operation of an active radon removal system. For climates similar to the high radon areas of north Alabama, Moorman's methodology estimates a total energy cost of $300 to $325 per year. (Moorman,2009)

There are those who say that the occupants could turn the fan off and test for radon and then decide if the fan off radon level was acceptable for continued occupancy. But the author advocates that it would be wiser and more acceptable to the occupants to require installation of a passive system with appropriate sealing followed by a radon test at occupancy to determine if a fan needs to be purchased, installed, and operated continuously.

Conclusion

There may be some Zone One counties in the USA with a distribution of indoor radon concentrations such that the preponderance of new construction would be above the national Action Level if only passive systems were installed. In that case, requiring active-only RRNC might be justified. Even in the Alabama counties that have the highest occurrence of elevated indoor radon, such is not the situation. In all of Alabama's Zone One counties, a majority of newly constructed homes if correctly built with passive RRNC would have no need for an active radon fan. Thus, adoption of a building code requiring active-only RRNC is not justified anywhere in Alabama.

Each state or tribal government should examine the distribution of indoor radon concentrations within their own jurisdictions and determine if a building code requiring active-only RRNC is appropriate and justified.

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