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A COMPARISON OF THE RADON POTENTIAL MAP WITH REPORTED RADON DATA

Michael DeVaynes, James W. Krueger
Air Chek, Inc.
Fletcher, NC

ABSTRACT

Air Chek, Inc. maintains an extensive database of more than one million radon test results. These test results can be sorted, mapped and studied by zip code and, in most cases, by street address. A study was conducted comparing this radon testing data with the Environmental Protection Agency (EPA) Radon Potential Map. The EPA Potential Map assigns each of the 3141 counties in the United States to one of three different priorities. The data in the Air Chek database was sorted by zip code, assigned to the appropriate county and then compared with the EPA Radon Potential Map.

INTRODUCTION

The EPA Radon Potential Map was released in early December 1993 and was intended to represent a preliminary assessment of radon potential for the entire United States. It was designed to assist national, state and local governments and organizations to target their radon activities and resources. The map was also intended to help building code officials determine areas of the highest priority for adopting radon-resistant building practices. The EPA has repeatedly stated that the map should not be used to determine if individual homes in an area need to be tested for radon (Emanations 1994).

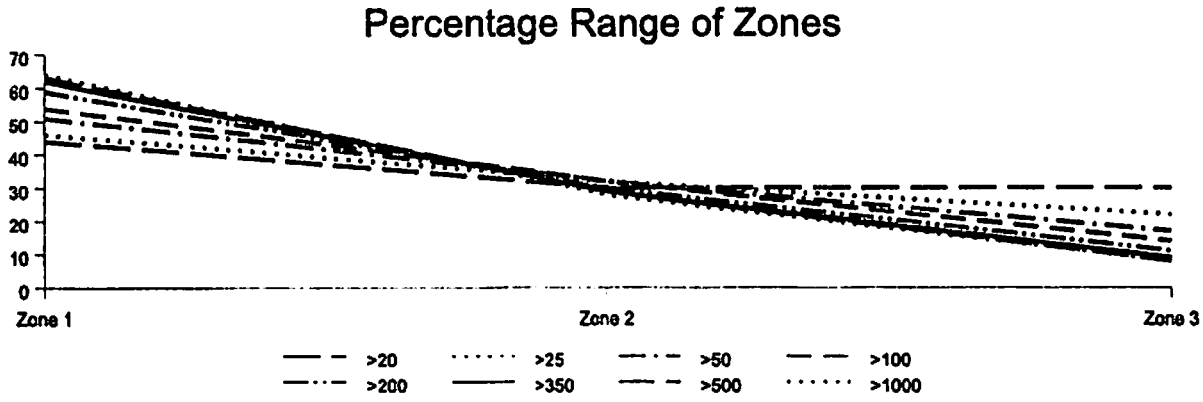
According to the EPA, Zone 1 counties have a predicted average indoor screening level of more than 4 pCi/L. Zone 2 counties have a predicted average screening level between 2 and 4 pCi/L while Zone 3 counties have a predicted average screening level of less than 2 pCi/L. The zone designations were determined using five primary indicators of radon potential which consisted of indoor radon measurements, geology, soil parameters, aerial radioactivity and structure (primarily foundation) type. The predictions made for each zone by the EPA were based on the radon potential in the lowest *livable* area of the structure. EPA noted that the zone designations were not statistically valid predictions and that elevated levels will be found in zone 2 and 3 counties just as homes below the EPA action guideline level will be found in all the zones. The EPA also advises that the Radon Potential Map should be supplemented with locally available data whenever possible.

A key factor hindering EPA's generation of a more concise radon map was their limited database of approximately 63,000 radon test results. The Air Chek radon database is comprised of over 1,000,000 homeowner-conducted radon test results. This database does not contain all of the radon test results generated by Air Chek as real estate transaction and multiple, single-site radon test data have been purposely omitted. All radon data in Air Chek's database pertains to the lowest livable area of a structure.

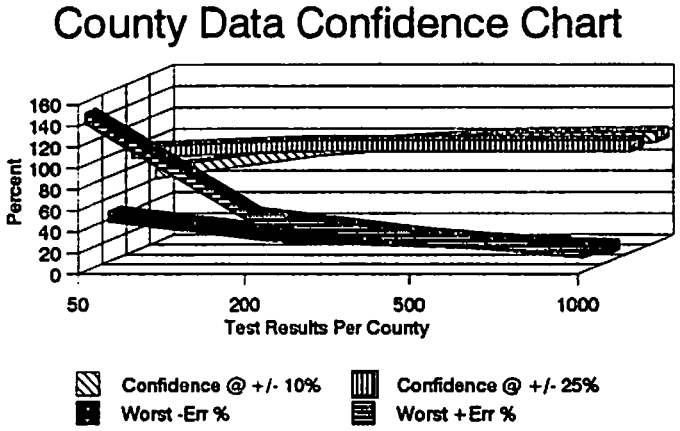
METHODOLOGY

To facilitate the comparison between the existing screening data and the EPA Radon Priority Map the data had to be sorted and analyzed. We initially analyzed the data to determine the number of tests required in a county to establish a statistically valid baseline. This process involved sorting the data base by the number of test results found in each county and assigning each of the counties to the proper EPA zone in accordance with the established EPA

parameters. Once the counties were assigned zone ratings, the zonal percentages for each data set were determined, the sets were compared and an upper and lower limit established. The mean value of the upper and lower limits for each zone were matched to the test results category that best reflected those values. The breakdown of this data is illustrated in the chart below.



The mean values of this chart most resemble the values of the counties in the database with 50 or more test results. For the purpose of this paper, those counties with 50 or more test results were directly compared to the EPA Radon Priority Map. The chart below shows how frequently the average radon level for a county is arrived at when calculated using a subset of the county's total test results.



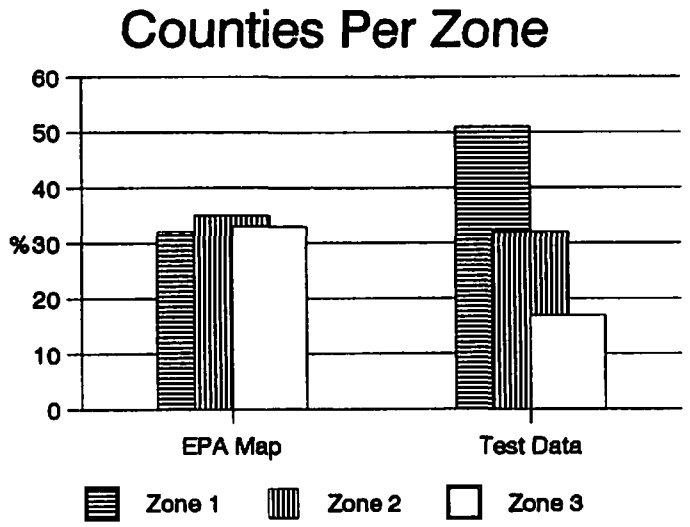
STATISTICAL REVIEW OF COUNTY PREDICTIONS

The EPA Radon Priority Map predicts that zone 1 counties will have an average indoor screening level greater than 4 pCi/L. The Air Chek database indicated that of 716,443 tests conducted in EPA Zone 1 counties, the average radon level was 7.8 pCi/L (40.9% of all tests conducted in Zone 1 counties were above 4 pCi/L). As a whole, the Zone 1 counties appear to meet the EPA's original prediction. However, upon closer examination 134 out of 647 (21%) Zone 1 counties have average radon levels between 2 and 4 pCi/L. In following the EPA predictive model

established for the Radon Priority Map, the 179 counties with average radon levels between 2 and 4 pCi/L would be more accurately depicted as Zone 2 counties. Additionally, 8 counties assigned the Zone 1 classification by the EPA have average radon levels more readily qualifying them for Zone 3 status.

The EPA Radon Priority Map predicts that Zone 2 counties will have an average indoor screening level between 2 and 4 pCi/L. The Air Chek database indicated that of 233,787 tests conducted in Zone 2 counties, the average radon level was 3.8 pCi/L (27.4% of all tests conducted in Zone 2 counties were above 4 pCi/L). As a whole, the Zone 2 counties appear to meet the EPA's original prediction. However, upon closer examination, 64 out of 457 Zone 2 counties (14%) have average radon levels below 2 pCi/L and 150 counties (33%) have average radon levels above 4 pCi/L. In following the EPA predictive model established for the Radon Priority Map, the 64 counties having average radon levels lower than 2 pCi/L would be more accurately depicted as Zone 3 counties while the 150 counties having average radon levels above 4 pCi/L would be more accurately depicted as Zone 1 counties.

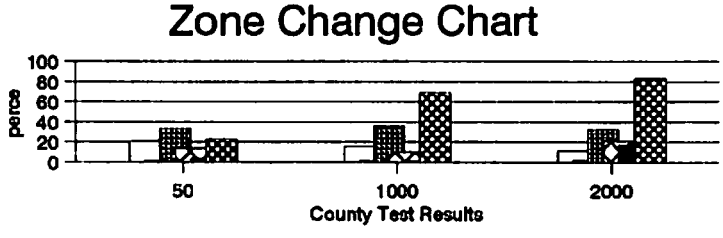
The EPA Radon Priority Map predicts that zone 3 counties will have average indoor screening levels less than 2 pCi/L. The Air Chek database indicated that of 96,800 tests conducted in Zone 3 counties, the average radon level was 2.3 pCi/L (9.8% of all tests conducted in Zone 3 counties were above 4 pCi/L). As a whole, the Zone 3 counties do not appear to meet the EPA's original prediction. Further examination shows that 45 out of 197 Zone 3 counties (23%) have average radon levels between 2 and 4 pCi/L. Additionally, 7 Zone 3 counties exhibited average radon levels over 4 pCi/L. In following the EPA predictive model established for the Radon Priority Map, the 45 counties wth average radon levels between 2 and 4 pCi/L would be more accurately depicted as Zone 2 counties while the 7 counties having average radon levels above 4 pCi/L would be more accurately depicted as Zone 1 counties.



This chart shows the percentage of counties EPA predicted would fall into Zone 1 and the counties meeting the EPA zone criteria based on actual test data.

ADDITIONAL DATA ANALYSIS

Due to the low confidence level (xx%) associated with using fifty or more test results to determine a county zone priority, additional comparisons of county-based radon levels were performed. The primary concern was to substantiate the percentage rate of change among the EPA Priority Zones. To accomplish this the percentage rates of change for Zone 1, 2 and 3 counties were determined for counties with 1000 or more radon results. Additionally, the percentage rates of change for EPA Radon Priority Zone counties with 2000 or more radon results were calculated. The chart and table below indicate that the percentage of EPA Priority Zone 1 and Zone 2 counties in need of reclassification are similar regardless of whether the counties studied have 50, 1000 or even 2000 radon test results.



Z1 to Z2	21	16	11
Z1 to Z3	1	1	2
Z2 to Z1	39	36	32
Z2 to Z3	14	10	21
Z3 to Z1	4	1	17
Z3 to Z2	29	69	83

DISCUSSION

The 1988 Indoor Radon Abatement Act directed EPA to identify areas of the United States with the potential to produce elevated levels of radon. EPA had fewer than 65,000 radon test results available in 1993 and had to resort to using additional factors such as geology and aerial radiation survey data to fill in where radon results were either too scarce or simply nonexistent. With these limitations in mind, even producing a county-based map was an awesome undertaking. But, if the Radon Priority Map is designed to assist national, state and local governments and organizations in targeting their radon program activities, as has been stated by the EPA, then a more refined priority map should be generated. If building code officials are to use the map to determine areas of the highest priority for adopting radon-resistant building practices then a zip code specific Radon Priority Map should be emphasized. Zip code-based mapping is available, but in order to produce a map with a high degree of confidence, a significant number of radon test results must be used.

Air Chek, Inc. is currently using its database to generate zip code based and even location-specific maps. Such mapping can be produced when adequate radon data is available for the area to be mapped. Air Chek has radon testing data for the majority of zip codes in the United States. Street level mapping can be accurately generated using this database for neighborhoods located in geographic areas where a significant number of test results have been recorded. This type of mapping would prove to be much more useful to local governments and building code officials than the current broad based county map which assigns a radon risk for hundreds and even thousands of square miles of often varying geologic and radiometric conditions.

The distribution of test results (68% Zone 1, 22% Zone 2, 10% Zone 3) in the Air Chek data base is indicative of a database derived of respondent driven results and not a random sampling of households within a county. The

EPA based it's predictions on a random sampling of households. With this in mind a direct comparison of the raw Air Chek radon data to the EPA Radon Priority Map, on a county level, is not necessarily a fair review. The raw data used in the initial analysis for this paper is not weighted for household distribution and as such may not be capable of accurately projecting risk based on county boundaries. However, the Air Chek radon data is effective in generating zip code based and local street level mapping to relate risk for the more defined areas within a county. Additionally, the raw data can be weighted for household distribution and then used to more accurately predict countrywide risk. The Radon Priority Map assigns zone ratings based on predicted average screening levels. Other predictive models have been and are being evaluated. Supplemental handouts specific to these results will be provided at the oral presentation.

CONCLUSION

Predictive models based on large geographic boundaries (such as counties) are impractical. The U.S. Environmental Protection Agency made a valiant effort to generate a Radon Priority Map to predict the average radon level for each county in the United States. An initial review of actual testing data indicates that many of the EPA predictions were correct. However, radon potential maps based on radon test results by zip code are significantly more accurate and can be more readily weighted to reduce any distribution bias that might exist. Zip code maps should be used in place of county predictive models whenever statistically significant data is available.