

Random vs. Self Select Participants In Radon Surveys

James L. McNees, CHP
Office of Radiation Control
Alabama Department of Public Health

The State of Alabama conducted two radon surveys in the winter and spring of 1987. One "random select" and one "self select" survey. The random select survey consisted of 1,299 completed radon tests where a name and address were picked from the telephone directory and the individual was mailed a 35-question questionnaire about how their home was constructed and weatherized. The individual was told that if they returned the questionnaire, they would receive a free radon test. Follow up telephone calls were made to those who were mailed questionnaires to encourage maximum participation. The self select survey consisted of 789 completed radon tests where an individual called a health department office to request participation and was sent the questionnaire. They would also receive a free radon test upon completion of the questionnaire. Both surveys utilized short-term charcoal canisters analyzed by the EPA laboratory in Montgomery, Alabama.

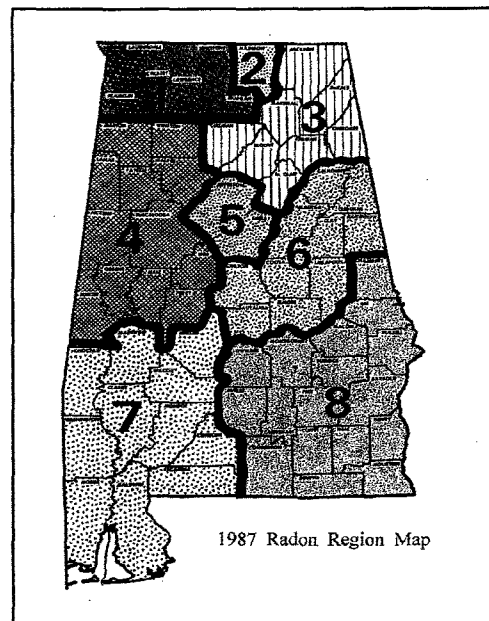
In areas of significant indoor radon, the occurrence of homes with radon test results greater than 4 pCi/l was about **twice** as great in the self select study as in the random select study!

Alabama was the first state to be accepted for EPA assistance in conducting a radon screening survey. The original plan submitted by Alabama was to have homeowners contact health department offices and request to participate. Each county in the state was assigned an allocation of test canisters based upon the county's population, land area, and estimated potential for radon. Participants were selected on a first come, first serve basis by zip code until all zip codes in the county had at least one test, then two tests, etc.

This survey, later known as the "self select survey," had a strong rural bias, but it would accomplish the objectives of finding local radon hot spots, and determining the effects of house construction styles and weatherization on radon concentration.

Since the estimation of average individual exposure to radon was not an objective of the survey, EPA's Science Advisory Committee objected to the original survey plan because it would not accomplish the objectives for their nation wide screening surveys. Since it was not a population based representative random sample, it could not provide an average individual exposure. Therefore, the State of Alabama agreed to modify its plans and reduce the size of the planned self select survey, as well as perform a random select survey. The same questionnaire would be required and provided the selection process was slightly biased toward the rural areas so that the lowest population counties should receive on average at least one canister per 50-square miles of land area.

In 1987, based upon the results of the random select tests, Alabama was divided into the eight Radon Regions shown on the map. This 1987 radon region map was later replaced by the current zone map. Both the self select and the random surveys correctly identified Madison County as being a geographical area of high potential for radon problems. With Madison County having 127 completed radon tests in the random survey and 73 completed radon tests in the self select survey, the state was confident enough to identify it as a radon problem area. It was given a region unto itself (Region 2 on the 1987 map). In contrast, there were not enough tests in Colbert County in the 1987 surveys to cause the agency to appreciate the magnitude of that county's radon problem. Colbert County, located on the south side of the Tennessee River on the Mississippi border, had only 13 completed radon tests in the random survey and 5 in the self select survey. In the 1987 map, Colbert County was grouped within Region 1. As the Alabama Radon Program continues to accumulate and analyze radon test results, the potential for radon problems in Colbert County has emerged to be as great as, if not greater than, that in Madison County.



A comparison of the percentage of homes testing above 4 pCi/l in each of the regions from the two surveys is shown in Table One. The vast difference between the two studies was amazing. It was about twice everywhere except Region 5, which consisted of the Birmingham area. Why so great? And why so much less difference in Region 5?

Table One

Percentage of Homes Testing $\geq 4\text{pCi/l}$

	<u>Self Select</u>	<u>Random</u>
Region 1	25.3	11.7
Region 2	51.7	27.5
Region 3	10.7	4.4
Region 4	4.1	1.6
Region 5	13.1	10.0
Region 6	15.8	6.8
Region 7	2.3	1.5
Region 8	2.4	0.5

One possible factor was the age of the house. Using the data from 1987 Radon Regions 1, 2, and 5, those with the most radon, the older homes, in general, showed a slight increase in the occurrence of elevated radon. See Table Two. It was also noted that the typical age of the homes in the self select study was slightly less than the age of the homes in the random study, as shown in Table Three. Therefore, age was not a factor for the big difference in the two surveys.

The next factor considered was weatherization of the houses, as determined by the presence of storm windows and storm doors. Houses in the self select survey had a slightly higher occurrence of home weatherization than houses in the random survey. This may correlate with slightly newer homes, however, no correlation could be shown between weatherization and increased indoor radon.

If fact, within the statistical limits of the surveys, storm windows and storm doors have no effect on the occurrence of elevated indoor radon.

The next consideration was style of home construction. There appears to be a strong correlation between construction with a basement and increased indoor radon concentrations. For example, in Region 2, the region identified as having the greatest radon problems, 33% of the self select homes had basements, and 63% of those had a radon test above 4 pCi/l. Only 44% of the self select homes without basements had a radon test above 4 pCi/l. In the random selects the difference was greater. Sixteen percent of the random selects in Region 2 had basements, but 57% of those with basements were over 4 pCi/l while only 22% of the random select homes without basements were over 4 pCi/l. Tables Four and Five show the percentage of homes with basements, the percentage of basement homes testing above 4 pCi/l, the percentage of non-basement homes testing above 4 pCi/l, and the ratio of those houses above 4 pCi/l percentages for basement to non-basement.

Using the random select test results and eliminating regions 7 & 8 as outliers due to their low incidence of radon, there were 651 random select tests completed. 194 were homes with basements. Of those, 42 or 21.6% tested >4pCi/L. Likewise there were 457 non-basement homes; 40 or 8.75% tested >4pCi/l. Thus, basement homes were $21.6 \div 8.75$ or 2.5 times more likely to have a radon problem than non-basement homes.

Why didn't the self selects in Region 5 test significantly higher than the random selects in Region 5?

The answer is building a home with a basement is more popular in Jefferson and Shelby counties than elsewhere in the state. In Region 5, 66% of the self selects had basements and 63% of the random selects had basements. This similarity appears to account for the fact that 13.1% above 4pCi/L for self select houses does not significantly exceed the 10% above 4pCi/L for random select houses.

The ratio of the percentages of self select homes with high radon to the percentages of random select homes with high radon is given in column one of Table Six. The ratio is approximately 2 for all regions except 5, 7, and 8. Regions 7 and 8 should be disregarded since there is not enough radon in these areas to be significant data. Column two of Table Six is the ratio of the percentage of houses with basements for the self selects to the percentage of homes with basements in the random selects. This ratio is approximately 2 for all regions except

<u>Age of House</u>	<u>Percent >4pCi/l</u>
1 to 10 years	11.7%
11 to 20 years	14.3%
20 to 40 years	18.7%

	<u>Self Select</u>	<u>Random</u>
Less than 1 year	2%	2%
1 to 5 years	12%	9%
6 to 10 years	16%	14%
11 to 20 years	29%	26%
21 to 40 years	30%	37%
Over 40 years	11%	15%

Table Four

Self Select Survey

	% with Basements	% Basement Homes \geq 4pCi/l	% Non-Basement Homes \geq 4pCi/l	Ratio of Percentages
Region 1	43	44	11	4.0
Region 2	33	63	44	1.4
Region 3	41	14	8	1.8
Region 4	32	7	2	3.5
Region 5	66	19	2	9.5
Region 6	38	29	8	3.6
Region 7	14	8	1	8.0
Region 8	16	5	2	2.5

Table Five

Random Survey

	% with Basements	% Basement Homes \geq 4pCi/l	% Non-Basement Homes \geq 4pCi/l	Ratio of Percentages
Region 1	23	32	6	5.3
Region 2	16	57	22	2.6
Region 3	26	11	4	2.8
Region 4	17	5	1	5.0
Region 5	63	12	5	2.7
Region 6	25	16	3	5.4
Region 7	4	0	1	---
Region 8	10	5	0	---

5, 7, and 8. Regions 7 and 8 are also outliers in this ratio because the percentage of homes with basements in Regions 7 and 8, the coastal plain, is small.

In the early 1980s, one theory held that residential radon problems were due to the use of concrete blocks manufactured using slag waste from the production of phosphate fertilizer. The radon was believed to be coming from the decay of the radium in the slag used to make the blocks. These blocks were widely used in north Alabama in the construction of foundations and basement walls. Although it was later proven that such blocks are not a major contributor to residential radon, this belief was widely held for years by many citizens.

	Ratio of % Excessive Radon <u>Self Select to Random</u>	Ratio of % with Basements <u>Self Select to Random</u>
Region 1	2.2	1.9
Region 2	1.9	2.1
Region 3	2.4	1.6
Region 4	2.6	1.9
Region 5	1.3	1.1
Region 6	1.9	1.5
Region 7	1.5	3.5
Region 8	4.8	1.6

The ratios in Table Six are explained by the fact that people owning homes with basements had a prior belief or awareness that basements were, because of block basement walls and foundations, suspected of being related to indoor radon problems and thus volunteered for the self select group in far greater proportions than did people owning homes without basements. Thus, the results of the self select survey are not representative of the radon exposure received by the public at large.

This raises questions as to the true randomness of the Alabama random select survey, or any other "random" survey that requires effort by and/or consent of the homeowner. The participants in the State of Alabama's random select study were required to complete a 35-question questionnaire and mail it, then deploy and retrieve the test canister, complete the data sheet and mail the canister with the data sheet in for analysis. It is unknown how much this effort, on the part of homeowners who did not have reason to believe they might have radon, discouraged participation. Conversely, how much did the belief that one's house was the type, or in a location that might have radon encouraged homeowners to persevere toward completion of the project?

Almost all radon test result maps currently developed by radon laboratories or government radon programs are from self select test results. These should only be used as indicators of the geographical areas where radon problems *do exist* or *can be anticipated to exist*. Maps and survey results obtained from self select participants are not necessarily representative of the true percentage of houses that exceed 4pCi/l, nor can they be used to accurately project the true population exposure to radon.