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**ATTITUDES ABOUT RADON EXHIBITED BY HOTLINE CALLERS:  
AN ILLINOIS STUDY**

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**ABSTRACT**

To follow-up on a small (N=157) survey, the Illinois Department of Nuclear Safety (IDNS) Radon Program conducted a larger survey (N=1326). One of the primary objectives of the study was to determine whether the reluctance to mitigate at radon levels between 4 - 9 pCi/L, as found in the small study, could be identified in a larger population sample of residents. A margin of error was estimated for each radon question by calculating the normal approximation to the binomial distribution. Calculation using the standard deviation and histogram plots revealed a positively skewed curve. Further, examination of the histogram revealed two distinct modal regions. The survey respondents with indoor radon levels between 4.0 - 9.9 pCi/L demonstrated less reluctance to mitigate than the respondents to the previous study. However, there is still greater reluctance to mitigate when radon levels are < 10 pCi/L than there is when the radon level equals or exceeds 10 pCi/L. The survey also indicated that most respondents with elevated radon levels do take mitigative action.

**INTRODUCTION**

In January, 1994, the Illinois Radon Program conducted a small (N=157) survey. Study questionnaires were mailed to every 10th caller to the radon information hotline. An interesting discovery in that study was that 75% of the residents who had elevated radon levels between 4.0 -9.9 pCi/L did not take mitigative action.

All the residents who participated in the January 1994 survey had either: (1) received information directly from the IDNS Radon Program staff, (2) received informational radon materials published by USEPA and/ or IDNS, or (3) combined (1) and (2) above. Compared to the average citizen, these residents could be considered "informed" about radon health risks and mitigation. Several reasons for the reluctance to mitigate could be offered, such as: (1) incorrect mental models, e.g., incorrect concepts and beliefs about radon and mitigation; (2) socio-economic pressures; and (3) the effects of living in a society that uses a base 10 number system. If one is accustomed to using base 10 then numbers such as 10, 100, 1000, etc., become subconscious thresholds which separate "small" from "large" numbers and "acceptable" from "unacceptable" levels.

To follow-up on the January 1994 survey, and determine whether the reluctance to mitigate at radon levels between 4 - 9 pCi/L could be identified in a larger population sample of residents informed about radon, the IDNS Radon Program undertook a larger study in September 1994. A survey questionnaire was mailed with a self-addressed, stamped return envelope to 1,326 residences throughout Illinois. These questionnaires were mailed to every residence requesting general information about radon from the IDNS Radon Program between January 1993

and August 1994.

The survey consisted of 12 essentially binomial (closed-ended) questions soliciting information about radon measurement, mitigation, post mitigation measurements, and regarding public opinion of the USEPA Action Level. Demographic questions were included for classification purposes and were completed at the option of the respondent. Illinois residents completed and returned 483 questionnaires to IDNS, a return of 36.4%.

A database was compiled by the radon program staff and a margin of error at the 95% confidence level was calculated for each of the radon related questions. The average margin of error for the study question ( $N=483$ ) is approximately  $\pm 5.68\%$  in 95 out of 100 cases (95% confidence level). This is to say that if the same survey were conducted among similar respondents, the result would be expected to fall within  $\pm 5.68\%$  in 19 out of 20 cases.

The margin of error was estimated by calculating the normal approximation to the binomial distribution. Treating the distribution as though it were a normal distribution made it much more mathematically tractable and thus simplified the determination of the 95% confidence level. Use of the normal approximation assumes that where only two answers are possible, a binomial distribution exists; further, the sample size was large enough to justify using a normal distribution to approximate the binomial distribution because the following two conditions were met for two-answer questions: (1)  $np > 5$  and (2)  $n(1-p) > 5$ .

In order to ascertain the degree to which IDNS hotline callers are representative of the general public, the demographics were compared with those described in the Conference of Radiation Control Program Directors (CRCPD) telephone survey reported April 22, 1994. The IDNS survey respondents appear to differ from the general population with regard to college education, income, smokers in the home, and gender of respondent, but compare closely with regard to the age classification of the respondents in their 30's and 60's + (see Table 1.)

The IDNS Radon Program constituency might typically be described as white, non-smoking, males between 30-50 years of age, with college degrees and incomes in excess of \$50,000. Black callers are notably few (1.5%) among the IDNS survey respondents compared with both the general population sample reported by CRCPD and the census data found in the U.S. Department of Commerce, Bureau of the Census, *County and City Data Book*, 1994.

## RADON TESTING AND MITIGATION

When asked "have you ever tested your house for radon?", 70% of those who responded indicated that they have. The majority of those respondents (79%) indicated that they had performed the test themselves. Of those who had tested, 9.7% indicated that they had done so as part of a real estate transaction. This observation agrees with the CRCPD finding in Illinois that 11% tested as part of a real estate transaction. However, a combination of media coverage and potential adverse health affects prompted the greatest percentage of residents (33%) to perform a radon test.

The results of initial indoor radon measurements were provided by about 64% of the respondents. Calculation using the standard deviation and histogram plots revealed a positively skewed curve. Further, examination of the histogram revealed two distinct modal regions. The higher modal region (6.8 and 10 pCi/L) is associated with measurements derived entirely from USEPA designated Zone 1 (high potential for elevated radon levels) observations. The lower modal value (3.9 pCi/L) is associated with measurements derived from a mix of USEPA designated Zone 1 and Zone 2 (moderate potential for elevated radon levels) observations. Thus it appears that the observed distribution is actually a combination of two separate distributions, one associated with areas expected to exhibit higher radon concentrations, and one associated with a composite of Zone 1 and Zone 2 observations. It would be anticipated that a large sample derived solely from Zone 2 would yield a lower modal value, since it would not be influenced by the Zone 1 observations.

The skew of the curve may be due to improper measurements resulting in elevated indoor radon levels that may be attributable to improper placement of detectors. The most dramatic example of this was provided by one respondent whose initial radon measurement was reported as 151 pCi/L. In her comments she indicated that after receiving the 151 pCi/L result, she had a contractor perform the measurement and the result came back within normal limits. However, this doesn't imply that all measurement contractors are infallible regarding detector placements. The skew of the curve may be an indicator that residents who perform their own measurements don't place the detectors properly. One reason for this may be that residents don't realize that the measurement is intended to be in the breathing zone, rather than at an entry point to see how much radon is getting into the house, as a worse case scenario.

When asked, "If your radon level was above 4 pCi/L, did you take action to lower it," 64% of those responding indicated that they had. The majority (57.2%) also indicated that they had performed the work themselves. The method employed by most residents (21.6%) for reducing indoor radon is sealing cracks and the sump pump. Sealing in conjunction with increased ventilation was employed by approximately 13% of the residents, while only about 11% employed sub-slab suction with sealing cracks.

Approximately 43% of the respondents with indoor radon levels between 4.0 - 9.9 pCi/L did not take action to reduce the radon levels. This compares favorably against the results of the previous study when 75% of the respondents with radon in the 4.0 - 9.9 pCi/L range did not mitigate. However, there remains more reluctance to mitigate when radon levels are in the 4.0 - 9.9 pCi/L range than there is when the radon level equals or exceeds 10 pCi/L.

In the range between 10 to 39 pCi/L, approximately 19.7% of the residents did not mitigate. This is consistent with the finding of the January 1994 survey where approximately 18% of residents with indoor radon levels > 10 pCi/L did not mitigate.

Residents with elevated radon levels who did not mitigate were asked to explain the reason for their behavior. The majority (69%) declined comment. Those who did comment indicated that the primary deterrent to mitigation is the cost. Lack of availability of honest, reliable contractors, lack of help in general, uncertainty about appropriate mitigation actions and being "too busy" were also contributing factors.

Of those who performed mitigation, 61% indicated that a follow-up test had been performed. About 50% of those who performed a follow-up test found the mitigation to be successful and the radon level lowered to <4.0 pCi/L.

According to the findings of our study, it may be necessary to re-evaluate the type of information that the public needs in order to be comfortable with radon measurements and mitigation. There appears to be a need to instruct residents in measurement protocols. The 50% failure rate for mitigation actions, based on follow-up tests, indicates techniques are often being applied that are not effective in reducing the radon level and may, in some cases, increase the potential for acute exposures. For instance, one resident covered the sump with sheet metal. This keeps the radon out of the house, but when he removes the sheet metal to perform maintenance on the sump, he may be subjected to a large radon exposure. Clearly, the resident does not understand the need to reduce the potential for such an exposure at the same time the indoor radon level is reduced. The resident felt proud that the radon reduction had been successfully accomplished at low cost.

### **ATTENTION, PUBLICITY AND THE USEPA ACTION LEVEL**

Residents were asked to indicate whether they agree that the level of attention and radon publicity is appropriate. Of the respondents, approximately 55% indicated that it was not appropriate. Approximately 82% of those respondents tell that too little attention is given to radon issues.

The USEPA Action Level found support from Illinois residents. Of those responding, the most common perception (44%) is that the action level, 4.0 pCi/L, is appropriate. About 28% of the respondents disagreed and about 28% said they "Don't Know."

Many of the respondents indicated that they did not feel educated enough to judge an appropriate radon level. Most indicated that such judgments should be left to the experts who have the knowledge necessary to make such policies.

There was little agreement among the 105 respondents who expressed an opinion regarding alternative action levels. The most common response (31%) was "Don't Know." The most common level indicated was 2.0 pCi/L (24%), with 22% favoring an action level above 12 pCi/L, but declining to indicate the level.

## CONCLUSION

The results of a small survey (N=157) conducted in Illinois in January 1994 revealed reluctance on the part of residents with indoor radon levels between 4.0 - 9.9 pCi/L to mitigate. The IDNS Radon Program was concerned that these residents might be ignoring the potentially adverse health impacts associated with radon exposure.

The results of the follow-up study presented here indicate that most radon hotline callers do perform indoor radon measurements. The study also indicated that most residents who discover elevated radon levels do take action to reduce the radon. The respondents with indoor radon levels between 4.0 - 9.9 pCi/L demonstrated less reluctance to mitigate than those of the previous study.

The skew of the measurement result curve may indicate that indoor radon measurements performed predominantly by residents are improperly placed. Respondent related experiences with measurement tend to suggest this is the case.

The survey also indicated that most respondents with elevated radon levels took mitigative action of some sort. However, there seems to be general confusion about what to do, where to find a qualified, honest contractor, and where to find information. The high failure rate of post-mitigation follow-up tests indicates that many of the mitigation actions taken by respondents are unsatisfactory.

Surveys such as this provide valuable insight into the radon related problems faced by the constituency served by the radon program. The survey data are being evaluated in order to design information services that are responsive to the needs of Illinois citizens.

**Table 1. Comparison of IDNS Respondent Population with the CRCPD General Population Sample**

<u>Category</u>	<u>CRCPD Illinois Statewide*</u>	<u>IDNS Statewide</u>	
<b>Education</b>			
<High School	11.8%	1.7%	
High School Graduate	35.6%	16.1%	
Some College	24.7%	20.1%	
College Graduate	<b>20.0%</b>	<b>28.6%</b>	
Graduate School	<b>6.3%</b>	<b>29.0%</b>	
Other	1.2%	1.0%	
Refused	0.5	3.5%	
<b>Income</b>			
<\$12,000	9.9%	2.5%	
12,000 - 24,999	21.3%	5.4%	
25,000 - 49,999	30.8%	24.2%	
50,000 - 74,999	<b>11.9%</b>	<b>27.3%</b>	
75,000 +	<b>6.9%</b>	<b>27.5%</b>	
Refused	19.2%	13.1%	
<b>Smokers in home</b>			
Yes	<b>36.8%</b>	<b>8.7%</b>	
No	63.2%	87.8%	
Refused	---	3.5%	
<b>Gender of respondent</b>			
Male	47.5%	54.4%	
Female	52.5%	44.5%	
Both partners responded	---	1.1%	
<b>Age</b>			
<20	4.1%	0.6%	
20-29	19.6%	3.3%	
30-39	<b>25.4%</b>	<b>26.1%</b>	
40-49	<b>17.4%</b>	<b>29.9%</b>	
50-59	10.1%	15.3%	
60 +	<b>21.7%</b>	<b>20.1%</b>	
Refused	1.6%	7.7%	
<b>Population Classification</b>			
Black	<b>14.9%</b>	<b>1.5%</b>	<b>Census Data**</b> <b>14.6%</b>
White	<b>75.0%</b>	<b>88.4%</b>	<b>77.1%</b>
Asian	2.0%	1.2%	2.5%
Hispanic	8.1%	0.2%	---
Native American	---	0.8%	0.2%
Other	---	2.9%	---
Refused	---	5.0%	---

\*Conference of Radiation Control Program Directors. *Radon Survey*, April 1994.

\*\*U.S. Department of Commerce, Bureau of the Census. *County and City Data Book*. 1994.