

1995_12

**ATTITUDES TOWARD RADON RISK:
FOLLOW-UP EVALUATION OF A RADON MEASUREMENT
AND INFORMATION CAMPAIGN IN NEW ULM, MINNESOTA**

Sylvia Fuoss
AIA, Inc.
Draper, SD

ABSTRACT

Reports of radon mitigation in response to measurement and information campaigns have been disappointing. This paper reports on a modified Q-Sort evaluation of attitudes and mitigation action taken by respondents in the five-year interim since the New Ulm, MN Radon Study. The modified Q-sort presents a variety of pre-identified attitudes toward radon risk where respondents can mark the response that most nearly matches their attitude toward radon risk, their memory of the radon measured in their house, and their mitigation response. Occupancy characteristics from the original Study are compared to those reported in this evaluation. Original participants were mailed a packet from representatives of the original sponsoring organizations: Minnesota Extension Service, Brown County and the New Ulm Energy Office. Response came from about 85% of those expected, allowing for mobility and attrition. The evaluation shows marked discrepancies between professed attitudes and beliefs and the mitigation and occupancy conduct of those persons whose houses had radon measured above the 4 pCi/L EPA action level. There is little evidence of respondent skepticism or hysteria, but denial may be present.

INTRODUCTION

Radon knowledge: Radon measurement: Radon mitigation where needed. These were the logical steps expected when the problem of radon as a household pollutant was brought to the scientific community (Puskin & Nelson, 1989). After more than 10 years of focus on scientific research, technological innovation, and public information campaigns, the results are disappointing -- people don't measure radon or mitigate radon in their homes in accordance with EPA recommendations. In reaction to this outcome, the researchers in the original New Ulm Radon Project began an evaluation of the five-year response from the participants in their study, with an emphasis on attitudes and beliefs as they relate to action. Researchers in the study had conducted blower-door tests for house tightness and energy efficiency, evaluated the heating equipment (including backdraft heat sensors placed in an earlier campaign), placed and picked up year-long radon measurement devices, delivered a survey questionnaire about their household activities to the occupants, and conducted a community radon information campaign. Respondents volunteered to purchase their own detectors and become part of the study, and, from these volunteers, researchers selected one representative house in each residential or mixed-residential section of the city. Radon measurement conducted on the lowest livable level were at or above 4.0 pCi/L ($M=4.76$, $SD=3.98$) in 55% of the 210 houses in the study. In 9.5% of the houses the radon measured at or above 10.0 pCi/L, and above 20.0 pCi/L in three houses (Fuoss, 1994). Because the participants demonstrated such high interest in the issue, and because the percentage of the houses with a radon problem was so great, but the actual amount of the elevation was relatively small, the effect of debate over radon risk and the participants' response to that debate is of particular interest.

MATERIALS AND METHODS

To examine and evaluate general health- and safety-related beliefs, called mass fantasies, researchers have

developed a technique they call a Q-sort (Bormann, 1985). Briefly, this technique asks one-hundred randomly chosen individuals to write a paragraph relating their beliefs and attitudes toward the issue under investigation. Researchers then sort those by their content into homogenous groupings that indicate the full range of the expected public response to this issue. All content of the responses of each grouping are condensed into a single paragraph or scenario and these are then compiled into a survey questionnaire that can be administered to a second randomly chosen group of participants, who have demonstrated a measurable response to the same issue. The attitudes and beliefs can then be correlated to their actions to develop statistical weights which can be generalized to the general population, and to which public information campaigns can be targeted. This is obviously a time-consuming and expensive process, not suited to evaluation of a small study. In a modification of this technique, scenarios can be written from widespread experience (with radon response, or another issue) regarding general public response. Unfortunately, this lacks the statistical validity produced when individuals in a randomly selected sample author the scenarios that make up the Q-sort. The distinct percentage of the attitudes and beliefs represented by these scenarios must therefore be assumed -- but it must be noted that many advertising dollars have been cast upon similar assumptions.

Table 1. Belief Scenarios Presented for the Respondent's Choice in the Evaluation Questionnaires

Scenarios	
Skeptic	I don't believe this fuss about radon in a house being harmful, because it's natural and has been here all along. It's not like a bomb that someone dropped on us. Minnesotans are really healthy, and I hear there isn't that much lung cancer. I believe the whole idea of there being health risk to me or my family from radon in this house is just nonsense.
Media	Radon isn't something I'm worried about. When I first began to hear news about radon, I was concerned, and decided to measure my house. The discussions died down, so I guess it's not too serious. I often hear on the news something is harmful and then I find out it isn't, so I've completely lost interest in the radon issue.
Science	I don't know what to believe about health risk from radon, and the people who are supposed to know don't agree. I think research into radon risk still has a way to go. Until they are sure, I'll just put it on hold. When they can agree, I'll have better information to use when deciding if I need to reduce the amount of radon that was measured in my house.
Official	I am sure too much radon can be harmful, if a person is exposed for a long time. I believe measuring your house is sensible, because if too much radon is found, it can be reduced. I think that action might be compared to checking on the condition of your house roof, as far as taking action to prevent serious damage. That's the procedure followed in this house.
Cost	I am sure radon can be a health risk, the testing is not hard, and radon reduction is worth the cost. But it must compete for the time, energy and money required for each family need. It's disquieting to think about radon, and new paint is more pleasant, so painting probably is done first. But if radon reduction is needed, it should get done, too.
Fixit	Radon is a health risk, I'm sure, but it's hard to believe there could be something really harmful in my own house. I do most repairs at home, so if the radon measurement was high, I'd just try tightening up and then remeasure. I'd really hesitate to spend money hiring someone else to remove something I can't even see, but if need be, I might.
Terror	I'm really afraid because radon was found in my house. I expect any amount could be very bad for my health, and the measurement might have even missed some. I want to be rid of it, completely, but I don't know how, and a contractor might cheat me. Besides, if I want to sell my house, having done that work could complicate the sale. I don't know what to do.

In the evaluation reported here, a set of scenarios was written that reflect generally expressed attitudes voiced by the public and repeated, with dismay, within the radon-technology industry. The scenarios written were subjected to review from five individuals active in the radon or information and education fields, then revised and re-reviewed by five other individuals. The final version, reproduced and named here in Table 1, contained scenarios reflecting 1) the radon skeptic (this group hereafter designated as Skeptic), 2) the person whose interest in the issue rose and fell in response to media attention (Media), the person confused by debate within the scientific community (Science), 4) the person who knows and accepts the EPA-influenced official response to radon within the home (Official), 5) the person who prioritizes the allocation of their resources of concern and cash according to housing norms that are visible (Cost), 6) the person with a strong territorial attitude toward their home, and therefore hires few outsiders for household work (Fixit), and 7) the person whose fears so paralyze their decision-making process that they have avoided radon decisions (Terror). Each scenario has been assigned a priori an equal amount of expected occurrence (12.5%), except the Official scenario, which has been assigned a double weight (25%) reflecting the assumption that logic and publicity will have effected this increase.

A questionnaire containing these scenarios, along with some basic questions that allow verification of the individual's case number, in order to run comparisons on before/after occupancy, and a group of questions related to their memory of and response to the measurement of radon in their house, was sent to all listed participants in the New Ulm Study. Open ended questions, with space for respondents' answers were included, to allow potential for a broader or more detailed response. A cover letter from representatives of the Minnesota Extension Service, Brown County and the New Ulm Energy Office, participants in the original Study, giving reasons for this evaluation, and verifying the credentials of the researcher, and a postage-paid, pre-addressed return envelope were included. About the time of the original Study the Energy Officer left his position, hence some detectors were not collected from the homes, and some questionnaires had not been completed. It was expected that only those who had completed the measurements, and those that had answered the original survey would respond and that in the five years since the study about 20% of the group would have moved from that residence, making a total of about 140 potential respondents.

RESULTS

The completed sample contained 115 cases. Questionnaires were returned in 119 cases, which is about 84.5% of the probable response. A follow-up letter urging return of the questionnaire produced negligible results, such as personal representatives notifying of the former homeowner's death. Of those responding, radon

Table 2. Beliefs and Occupancy of Cases Where Radon Measured ≤ 3.9 pCi/L

	Media	Science	Official	Cost	Fixit
Number cases	6 (10.5%)	6 (10.5%)	36 (63.1%)	4 (7.0%)	4 (7.0%)
Family basement occupancy time, in hours	\bar{M} =14.6 \underline{SD} =34.0 Min.=0.0 Max.=16.0	\bar{M} =35.2 \underline{SD} =34.0 Min.=0.0 Max.=168.0	\bar{M} =23.5 \underline{SD} =37.2 Min.=0.0 Max.=175.0	\bar{M} =27.2 \underline{SD} =29.6 Min.=5.0 Max.=70.0	\bar{M} =32.5 \underline{SD} =28.1 Min.=2.0 Max.=70.0
Individual in family, with greatest time in basement, in hours	One case reporting 20 hrs.	One case reporting 14 hrs.	\bar{M} =25.9 \underline{SD} =30.9 Max.=90.0	\bar{M} =34.0 \underline{SD} =31.7 Max.=70.0	One case reporting 25 hrs.

measurements were missing in four cases, and respondents took the opportunity to call attention to them. The original radon measurements in the 115-case sample had varied from 0.1 to 29.1 pCi/L (\bar{M} =4.9, \underline{SD} =4.2). The

sample was split in analysis with the 57 cases (49.6%) which were at or below 3.9 pCi/L in one segment and the 58 cases (50.4%) which were at or above 4.0 pCi/L in the other segment. In this paper the focus will be on the group with radon measurements above the EPA action level. The group with radon measurements lower than the action level had for the most part remembered the category of their house measurement, but in two houses action had been taken to reduce it further -- one before finishing off the basement for young family member's use. In this group there were no cases reporting either extreme Terror or Skeptic beliefs. In four cases (7.0%) each, respondents cited beliefs in the Cost category (one where radon was further reduced), and in the Fixit category. In six cases (10.5%) respondents cited beliefs in the Media category and the Science category. In 36 cases (63.1%) respondents cited beliefs in the Official category (one where radon was further reduced). See Table 2. When the segment of cases where radon was measured at concentrations greater than the EPA action level, all categories of belief scenarios are represented. See Table 3.

In the segment of the cases where radon measured at concentrations greater than the EPA action level the respondents exhibited a different response in belief scenarios. Although there are about the same number of cases in each category, all belief scenarios are represented, and the distribution of scenarios changes. The most extreme

Table 3. Beliefs and Occupancy of Cases Where Radon Measured ≥ 4.0 pCi/L

	Skeptic	Media	Science	Official	Cost	Fixit	Terror
Number of Cases	2 (3.4%)	4 (6.9%)	12 (20.7%)	22 (37.9%)	13 (22.4%)	1 (1.7%)	2 (3.4%)
House level measured ^a	B=2, M=0	B=4, M=0	B=9, M=3	B=14, M=2		B=1	B=2
Memory of report received ^b	B=2	C=3 D=1	C=1 D=11	B=3, C=5 D=14	B=3, C=2 D=8	D=1	C=1, D=1
Mitigation response reported ^c	F=2	E=2 F=2	B=1, C=2 E=6, F=2	A=2, B=1 C=3, D=2 E=7, F=7	A=1, B=2 C=3, D=2 E=3, F=2	E=1	E=2
Family total basement occupancy, in hours	<u>M</u> =45.0 <u>SD</u> =7.1 Min.=40.0 Max.=50.0	<u>M</u> =28.0 <u>SD</u> =13.7 Min.=10.0 Max.=41.0	<u>M</u> =29.9 <u>SD</u> =40.3 Min.=3.0 Max.=120.0	<u>M</u> =14.8 <u>SD</u> =31.4 Min.=0.3 Max.=135.0	<u>M</u> =32.2 <u>SD</u> =41.9 Min.=1.0 Max.=130.0	<u>M</u> =14.0	<u>M</u> =12.0 <u>SD</u> =11.3 Min.=4.0 Max.=20.0
Individual in family, with greatest time in basement, in hrs.	<u>M</u> =45.0 <u>SD</u> =7.1 Min.=40.0 Max.=50.0	<u>M</u> =35.0 <u>SD</u> =40.7 Min.=30.0 Max.=40.0	<u>M</u> =44.7 <u>SD</u> =40.7 Min.=3.0 Max.=90.0	<u>M</u> =19.9 <u>SD</u> =32.1 Min.=0.0 Max.=100	<u>M</u> =38.9 <u>SD</u> =42.4 Min.=1.0 Max.=130.0	<u>M</u> =6.0	<u>M</u> =12.0 <u>SD</u> =11.3 Min.=4 Max.=20.0

scenarios (Skeptic and Terror), that were not represented in the lower measurement group, each have a two adherents. Where 63.1% of those persons with ≤ 3.9 radon measurements professed their beliefs were congruent with EPA-influenced public information (Official), only 37.9% of those with ≥ 4.0 radon measurements professed that belief. At the same time the Science scenario nearly doubles, indicating concern about conflicting positions taken by scientists in debates about radon risk, and those who have professed confidence in their home workshop

^a B = Basement and M = Main level measurements

^b A = Don't remember receiving report, B = Don't remember amount, C = Amount below EPA action level, D = Amount above EPA action level.

^c A = Had radon reduced, B = Did some reduction, but no remeasurement, C = Investigated reduction, but took no action, D = Plan to investigate, but haven't done it, E = Have not taken any action or planning, F = Measurement small enough radon reduction not needed.

skills (Fixit) decline to one. That raises the question whether the reality of the size of these measurements induced denial of danger in the home to those most at risk. Clearly, the assumptions of distribution given these scenarios are not born out in this evaluation.

The mitigation strategy and the occupancy of the basement can be examined to refute or reinforce the possibility that a spurious effect has caused this re-distribution. With the file split into the lower and higher radon measurement groups, the means of the most hours spent by an individual in the basement are compared to the mean of those groups in the original study. The lowest radon measurement group had a t-value of 2.99 (df=24, p=.006) and a mean difference of 17.1 (95% confidence intervals: 5.3 to 28.0). The highest radon measurement group had a t-value of 3.75 (df=33, p.=0.001) and a mean difference of 22.4 (95% confidence intervals: 10.2 to 34.5). Although these tests do not indicate a statistically significant change in willingness to expose themselves to radon in their basements, they are not as conclusive as desirable, because of many missing values, and because these are retrospective estimates of time spent, and those estimates may not have been given much serious thought.

The most disturbing data in these results indicate that seven individuals who profess to concur with the EPA-influenced public information, such as that that was promulgated during the original Study, now indicate that their radon measurements -- three of which exceed 10 pCi/L -- are so small that they do not require mitigation. Two individuals each from the Skeptic, Media, Science, Cost, and Terror scenario categories share that response. Only three of the 58 individuals in this ≥ 4.0 pCi/L category indicate they have reduced the radon concentrations below the EPA action level, with four who have done some work on their home, but have neglected to re-test.

CONCLUSIONS

Conclusions drawn from this evaluation must contain mixed results. It clearly shows that the information given in the New Ulm Radon Study has not inspired these participants to action in reducing radon concentrations in their homes, nor has it induced terror, a common criticism of public health information campaigns. Further, it has not induced them to avoid using basements where, in many cases, radon will be found in greater concentrations. The message that can be drawn from this study is that people really believe their houses are safe, no matter what science debates, public health agencies promote, or business sells. If another modified Q-sort is ever conducted, related to radon or to other home safety concerns, one scenario should represent that attitude.

One encouraging outcome of the Study, one that was not originally intended, was that at least two households -- and notes indicate there may have been more -- have replaced furnaces found to be faulty when the auditors checked them during the home audits. While radon kills slowly, carbon monoxide does the damage quickly. It is also important to note that several other hazardous conditions were rectified as the result of an on-site visit from a knowledgeable and objective professional, or written information on the questionnaire. Along with the assurance that New Ulm, Minnesota is not a hot spot of radon, the Study team and the residents can take encouragement from those gains.

ACKNOWLEDGMENTS

The author wishes to take this opportunity to thank all those who made the original Study and this Evaluation possible, including Professors Evelyn M. Franklin, adviser, William J. Angell and Wanda W. Olson, supervisors, from the Department of Design, Housing, and Apparel of the University of Minnesota; Gail Gilman Waldner of the Minnesota Extension Service, Brown County; Steven D. Hamilton and Jon Fabre, past and present New Ulm Energy Coordinators of the New Ulm Public Utilities; and the residents of New Ulm who participated in the effort.

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