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**RADON AWARENESS IN CONNECTICUT: COMPARISON OF TWO STATEWIDE  
RESIDENTIAL SURVEYS AND THEIR USE IN SETTING NUMERICAL TARGET  
GOALS FOR INCREASING RADON AWARENESS, TESTING AND MITIGATION  
FOR THE YEARS 1995 AND 2000**

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**ABSTRACT**

Obtaining accurate baseline data is essential in setting practical numerical target goals. To this end, the State of Connecticut Department of Public Health and Addiction Services (DPHAS) Radon Program contracted in 1992 with the University of Connecticut Institute for Social Inquiry (ISI) to conduct a statewide residential survey. The results of this survey revealed levels of statewide radon awareness, testing, and mitigation of 85%, 17%, and 2%; respectively. These data are compared with the results of the Connecticut component of National Conference of Radiation Control Program Directors, Inc. (CRCPD) 1992 Survey which identified levels of radon awareness testing and mitigation of 80%, 18%, and 3%; respectively. Differences in these and other measures among various socioeconomic groups are compared. The process of using these data to set numerical target goals for increasing radon awareness, testing and mitigation for the years 1995 and 2000 are also discussed.

**INTRODUCTION**

The State of Connecticut Department of Public Health and Addiction Services (DPHAS) has long been actively involved in the development and use of the Healthy People Year 2000 objectives established by the Centers for Disease Control and Prevention (U.S. Department of Health and Human Services, 1990). The DPHAS Radon Program has used these goals in directing its education and outreach efforts. Therefore, it was not difficult for the Connecticut Radon Program to participate in the U.S. Environmental Protection Agency (EPA) process of setting numerical target goals for increasing radon awareness, testing and mitigation in Connecticut.

Three Year 2000 Objectives were identified as relevant to Radon Program Initiatives. The first, objective 11.6, stated: "Increase to at least 40% the proportion of homes in which homeowners/occupants have tested for radon concentrations and have either been found to possess minimal risk or have been modified to reduce risk to health or have been modified to reduce the risk to health." This objective actually combines both a goal for testing and mitigation. Moreover, it implies a certain level of radon awareness, at least on how it effects interest and ability to test. The second radon-based Year 2000 objective is number 11.12. This objective states: "Expand to at least 35 the number of states in which at least 75% of local jurisdictions have adopted construction standards and techniques that minimize elevated indoor radon levels in those new building areas locally determined to have elevated radon levels." This objective addresses a separate EPA Radon Division goal of requiring use of radon-resistant construction techniques in new homes. It does not directly address the numerical target goals of radon awareness, testing and mitigation. A final radon related Year 2000 objective also addresses a Radon Division goal but is not a part of the EPA's numerical target goals for radon awareness, testing and mitigation. This objective, number 11.13, states: "Increase to at least 30 the number of states requiring that prospective buyers be informed of the presence of lead based paint and the radon concentrations in all buildings offered for sale."

In order to develop a baseline of awareness, testing and mitigation data the Radon Program determined that a statewide survey was needed. The Program was aware of the EPA's plan to contract with the National Conference of Radiation Control Program Directors, Inc. (CRCPD) to conduct a national telephone survey during 1992/93 (Bruskin/Goldring Research 1993). To expand and verify the expected database, the Radon Program contracted with the University of Connecticut Institute for Social Inquiry (ISI). The resulting survey data were used in 1993 as the basis of our years 1995 and 2000 numerical target goals described later in this paper.

The third survey, the 1994 CRCPD survey was recently made available (Survey Communications, Inc. 1994). These data proved to be useful in assessing our initial achievement toward our numerical target goals and Year 2000 objectives.

## **MATERIALS AND METHODS**

### CRCPD Radon Study 1992

The survey was commissioned by the Conference of Radiation Control Program Directors, Inc. and conducted by Bruskin/Goldring Research (Bruskin/Goldring Research 1993). The study was conducted to obtain percentages of the population who were aware of radon, have tested for radon and/or have mitigated. This was completed on a state-by-state basis for all 50 states in order to establish benchmark data. An additional goal was to compile data so that state comparisons can be made to national and regional norms. Bruskin/Goldring Research utilized their 150+ Computer Assisted Telephone Interviewing (CATI) stations. Six hundred per state and 300 per High Risk Area (HRA) persons were interviewed by telephone from October 27, 1992 to January 14, 1993 during evening and weekend hours. In the case of busy signals and/or no answers, households were called up to six times. This, plus calling during evening and weekend hours offers the greatest diversity of people. The sample was built through the Genesis system of random digit dialing (RDD) selection. Respondents included in the survey are residents of the state for which the interview was conducted. Of course, all businesses and other public establishments were excluded from participating in the survey. To further ensure the projectability of the basic data, each state's basic data was weighted by race, age and education using census figures. State-by-state basic data was then combined and assigned a proportional weight (based on population figures) to develop the national basic data.

### ISI Radon Study 1993

The survey was commissioned by the Connecticut Department of Public Health and Addiction Services Radon Program and conducted by the Institute of Social Inquiry (ISI) at the University of Connecticut (University of Connecticut ISI 1993). The questionnaire was developed by the ISI which also administered the actual survey. Five hundred persons were interviewed by telephone in June 1993. A computer program generated the list of telephone numbers to call using a variation of random digit dialing (RDD). Using RDD ensures that new or unlisted telephone numbers have an opportunity to appear in the sample. Several attempts, scattered over evening and weekend hours, were made to reach each number. The study has a "margin of error" of around plus or minus five percent. This means, for percentages around 50%, that all potential respondents been asked a question for which 50% of the sample fell in a given response category, there is only a one in twenty chance that the results for the entire population would have been higher than 55% or lower than 45%. The "margin of error" shrinks for percentages much larger or smaller than 50%, but increases for subgroups smaller than the entire sample of 500.

### CRCPD Radon Study 1994

The survey was commissioned by the Conference of Radiation Control Program Directors, Inc. and conducted by Survey Communications, Inc. (Survey Communications, Inc. 1994). The study was conducted to obtain percentages of the population aware of radon, who have tested for radon and who have mitigated. This was completed on a state-by-state basis for all 50 states in order to establish benchmark data. An additional goal was to compile data so that state comparisons can be made to national and regional norms. Survey Communications, Inc. utilized their 54 Computer Assisted Telephone Interviewing (CATI) stations. Six Hundred Connecticut adults 18 years and older living within the state of Connecticut as well as 301 adults in pre-defined CRCPD High Radon Activity areas (HRA), encompassing the following counties: Fairfield, New Haven, New London and Middlesex,

were interviewed by telephone from January 14 - January 17, 1994 during evening and weekend hours. The calling during evening and weekend hours increases the probability of speaking with the largest variance of the targeted area's population. The sample was built through the random digit dialing (RDD) selection system. Businesses and other public/governmental phone numbers were screened out of the calling universe. Only households were interviewed. The statewide survey (N=600) has a  $\pm 4.0\%$  margin of error at the 95% confidence level. The over-sample in the High Radon Activity areas (N=301) has a  $\pm 5.6\%$  margin of error at the 95% confidence level. This is to say that, if the same survey was conducted among similar respondents, the results would fall within  $\pm 4.0\%$  in 19 out of 20 cases for the statewide and within  $\pm 5.6\%$  in 19 out of 20 cases for the HRA. To further ensure the projectability of the basic data, each state's basic data was weighted by gender & race using the most recent U. S. Census data.

Although the most sophisticated survey research procedures have been used to collect and analyze the information presented here, it must be emphasized that surveys are not predictions. They are designed to measure opinion within identifiable statistical limits of accuracy at specific points in time.

## RESULTS

### Characteristics of the surveyed population

Table 1 summarizes the demographic characteristics of the three radon telephone surveys respondents. All three surveys sampled populations are equally distributed across the age-established segments, each containing about one third of the total sample. On the average there was a higher proportion of whites (83.1%) than non-whites (14%) among all three surveys; 47% were males and 53% were females; about 22% were low to moderately low income, 28.5% middle income respondents and 28% had income higher than \$50,000. Approximately 44.3% were high school graduates or less and between 48.9 to 60.0% had more than a high school education. About one third were categorized as smokers and two thirds as non-smokers.

### General and knowledgeable awareness

Table 2 reveals that 80.2% of CRCPD 92-93 respondents had heard of radon gas. That percentage increased to 84.2% in the follow up CRCPD 94 survey. In 1993 however, 84.6% of ISI respondents were generally aware of radon; this apparently higher result may in part be due to this latter survey having a greater proportion of respondents in the higher income bracket and with a higher level of education. Indeed, all three survey data show that whites, individuals with some college education and/or those with a higher income to more likely have been cognizant of radon. This disparity shows its greatest gap in the race index in all three surveys but most significantly in the CRCPD 92-93 survey with non-whites being approximately 50% less likely to have heard of radon than whites (see Table 2).

Although the majority of the respondents claimed to be aware of radon, the level of knowledgeable awareness in all three surveys is notably lower than claimed awareness and ranges from 31.2% (ISI 93), 52.5% (CRCPD 92-93) to 70.1% (CRCPD 94) (see Table 3). The level of correct awareness is defined for our purpose as the ability of respondents to correctly identify radon origin.

The same discrepancy observed among socioeconomic variables in general awareness is also present with regards to correct awareness response rate. However, the greatest gaps appear in the education and income indices, with the lowest level of correct awareness identified as participants with less than a high school education and having yearly income of less than \$25,000. Non-smokers have a greater general awareness and score higher on questions related to the correct identification of radon source consistently across all surveys (see Tables 2 and 3).

### Radon testing in general and as part of a real estate transaction

Between October 1992 and January 1993 and again in June 1993 the incidence of radon testing in the CRCPD and ISI sampled respondents was 18.4% and 20.0%, respectively. In the subsequent CRCPD 1994 survey this incidence appeared to increase by about four percentage points to 23.4%. As with the awareness variable, the likelihood of testing is greatest in the white, well-educated and higher income groups. The incidence of testing shows its greatest gap in the race index, with whites being four times more likely to test than non-whites (CRCPD 92-93 20.1% vs 5.5 % & ISI 93

21.1% vs 3.7%). However, results from CRCPD 94 survey points to a narrowing of this gap, with whites now being twice as likely to test their homes than non-whites (24.5 % vs 14.3%) (see Table 4).

When testing is prompted by a real estate transaction the likelihood of testing is substantially higher than the general testing rates among the results of all three surveys. Respondents are at least about 10% more likely to perform radon testing when they are involved in the sale or purchase of a home. Here also, testing rates increase as income and level of education increase; whites are more likely to test during a real estate transaction than non-whites. The fact that the non-white sample was small and does not have readily access to property ownership may have affected the results. Only those people who had previously tested for radon were submitted to this filtered question. Finally, a greater proportion of non-smokers have conducted testing as well as performed a radon test during a real estate transaction (see Table 5).

#### Net Mitigation

Although radon awareness and testing show encouraging increased trends, mitigation or the ability to reduce radon concentration once its presence is known remains low. The CRCPD 92-93 and ISI 93 surveys had revealed mitigation rates of 2.7% and 2.0%, respectively. However, net mitigation rates are climbing and as seen by the CRCPD 94 results which display an increase to 4.1%.

#### High Risk Areas

Because CRCPD 92-93 incorrectly included Litchfield, Hartford and Windham counties in their high risk counties definition we are only reporting here and comparing results of ISI 93 and CRCPD 94 surveys. The demographic characteristics of the respondents from high risk areas that took part in these surveys are shown on Table 1.

The CRCPD 94 survey reported on an additional 301 interviews with residents of CT Zone 1 counties. The original 500 respondents of the ISI 93 survey were further reclassified into selected subgroups and their place of residence matched with Zone 1, 2 and 3 counties.

Results show that residents of high risk areas in the CRCPD 94 survey appear to be more likely than respondents of the ISI 93 survey to be aware of radon gas (87.2% vs 84.0%) and will correctly identify the source of radon gas (71.0% vs 60.3%) (see Table 6). The greatest disparity occurs in the general testing and testing as part of a real estate transaction, where respondents were more likely to test their homes when residing in a high risk area 33% vs 23.4% and 42.8% vs 34.8% (see Tables 4, 5 and 6). Respondents also appear to be more likely to take action to reduce the level of radon in their homes 4.1% vs 3.3%. In ISI 93, the differences between the general population surveyed and the high risk areas residents are not as consistent, with a higher proportion of ISI respondents having knowledgeable awareness 60.3% vs 31.2% and having conducted a radon test during a real estate transaction 43.8% vs 41.2%. Mitigation performed results are identical whether one resides in a high risk area or not.

## DISCUSSION

The DPHAS Radon Program, having identified high radon air and water levels in Connecticut, has developed a series of educational programs designed to reduce risk from air and water levels (Siniscalchi et al. 1990, Siniscalchi 1990, Siniscalchi et al. 1992). However, little information was available on the effectiveness of these programs.

The results of all three surveys reveal valuable information useful in both setting and achieving our Year 1995 and 2000 numerical target goals for radon awareness, testing and mitigation. First, the surveys reveal higher levels of radon awareness, testing and mitigation exist in Connecticut than seen on the national level. For example, the 1992/93 CRCPD and 1993 ISI surveys reveal simple awareness levels of 80% and 85%, respectively, higher than the 1992/93 national simple awareness level of 67%. National levels of testing during 1992/93 was limited to 9% as measured by the first CRCPD survey. Again, higher levels of testing were seen in Connecticut as measured by the 1992/93 CRCPD survey (18%) and the 1993 ISI survey (17%). Mitigation levels of 2% were observed in both 1992/93 Connecticut surveys compared to a level of 1% nationally. These higher levels of awareness, testing and mitigation were very similar

to New England regional levels of 80%, 16% and 2% respectively. Therefore they maybe more reflective of regional trends versus the result of specific Connecticut radon education programs.

Despite the good showing of Connecticut and New England in these statewide indicators, the results indicate a great disparity in radon awareness and testing existed among various socioeconomic groups. These differences, detailed in Tables 1-4 and discussed in the results section, motivated the DPHAS to focus much of its education and outreach efforts to target low income and minority populations.

The similarities between the results of the two 1992/93 surveys did give our Agency confidence in the resulting baseline data and supported our decision to develop numerical target goals. These goals were proposed during the summer of 1993 and incorporated into the Year 4 workplan of Connecticut's funding application and agreement with the EPA State Indoor Radon Grant (SIRG) Program. The numerical target goals for the years 1995 and 2000 are shown on Table 6. These goals are established for radon awareness, testing and mitigation for both the statewide population and for residents of Connecticut's high risk areas.

The results of the 1994 CRCPD survey indicates that progress is already being made toward achieving some of our 1995 numerical target goals. Table 8 compares the results of the relevant survey with our 1995 goals. For example, simple awareness has appeared to risen from the 1992/93 CRCPD level of 80% to a level of 84% in 1994. This seems to be approaching our 1995 goal of 86%. However, the results of basic awareness among the 1993 ISI survey was 85%. In fact, in consideration of the margin of errors on these surveys, the results of basic awareness among all three surveys may be not statistically different.

The results for levels of testing appear to have actually risen between the two 1992/93 surveys and 1994 CRCPD survey. For example, the levels of 1992/93 statewide testing was 18% as measured in the CRCPD survey and 17% in the ISI survey. The 1994 CRCPD survey shows an increase to 23%, very close to our 1995 numerical target goal of 25%.

The results of the 1994 CRCPD survey indicate that some numerical target goals have already been achieved. For example, the 1994 CRCPD survey of Connecticut's high risk areas revealed a level of 33% tested. This would appear to indicate that we have achieved our 1995 goal a year early.

## CONCLUSIONS

The use of telephone surveys appears to be a useful tool for assessing levels of radon awareness, testing and mitigation among statewide and regional populations. This has its value in increasing our understanding of Connecticut's baseline data in order to set accurate numerical target goals. Telephone surveys also have proven useful in assessing our progress toward achieving these goals.

This initial experience has also provided insight into means of improving the process of setting and achieving these goals and has resulted in a number of specific conclusions and recommendations described below:

1. Increase the numbers of racial and ethnic minorities polled in order to provide accurate results on the levels radon awareness testing and mitigation. This may result in cost increase of which radon program managers should be prepared to pay for. If necessary, separate numerical target goals should be established for these groups.
2. The surveys have revealed additional insight on the differences between simple or basic awareness of radon and correct awareness. While even simple awareness of radon may provide sufficient motivation to increase testing and mitigation, correct understanding of radon sources and health effects is ideal. States such as Connecticut should set separate goals for this characteristic.
3. Since a significant share of testing still occurs during real estate transactions setting of specific goals for this parameter may be useful in tracking our progress.

4. The analysis of the data from these surveys revealed differences in how some characteristics such as income groups and parameters such as "net" mitigation are defined and recorded. An accurate assessment of progress in achieving our numerical target goals requires uniform and consistent definitions.

Finally, this initial experience on use of numerical target goals also supports a consistent finding of other radon risk communication scientists, namely that people continue to have difficulty understanding the risks posed by radon at different levels (Kennedy et al. 1991, Evdokimoff and Ozonoff 1992, Weinstein and Sandman 1992, Sandman and Weinstein 1993). Government agencies and others must continue to improve their risk communication efforts to achieve the overall goal of reducing radon-related mortality.

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**Table 1. Demographic breakdown by percentage of the Connecticut radon telephone survey populations.**

	CRCPD <sup>a</sup> 92-93	ISI <sup>b</sup> 93	ISI 93 HRA <sup>c</sup>	CRCPD 94	CRCPD 94 HRA
<b>GENDER:</b>					
Male	48.4	44.4	43.0	48.5	49.8
Female	51.6	55.6	57.0	51.5	50.2
<b>AGE:</b>					
18-34 yrs. old	30.8	27.0		31.5	34.0
35-49 yrs. old	32.1	35.2		28.3	30.4
50 or more	33.9	32.8		38.8	29.7
<b>RACE:</b>					
White	82.5	82.8	81.0	84.0	84.9
Non-White	14.0	12.2	12.0	16.0	13.6
<b>INCOME:</b>					
< \$25,000	25.1	19.4	20.0	22.0	17.6
\$25K - \$50K	28.3	26.0	25.0	31.0	26.7
> \$50,000	26.3	31.2	31.0	26.3	35.8
<b>SMOKER:</b>					
Yes	33.6	34.0	36.0	34.6	26.9
No	66.4	66.0	64.0	65.4	73.1
<b>EDUCATION:</b>					
High school or less	49.4	38.0	38.0	45.9	42.7
Some College or more	48.9	60.0	47.0	53.5	56.4

<sup>a</sup> Council of Radiation Control Program Directors, Inc.<sup>b</sup> The University of Connecticut Institute for Social Inquiry.<sup>c</sup> High Risk Areas (HRA) are defined as EPA Zone 1 counties in Connecticut**Table 2. Percentage of general radon awareness among respondents of the Connecticut radon telephone surveys.**

	CRCPD 92-93	ISI 93	CRCPD 94
<b>ALL RESPONDENTS:</b>	80.2	84.6	84.2
<b>RACE:</b>			
White	85.8	89.0	89.2
Non-White	44.4	53.0	58.0
<b>INCOME:</b>			
< \$25,000	64.4	73.0	72.2
\$25K - \$50K	84.8	88.0	82.2
> \$50,000	91.4	94.0	94.5
<b>SMOKER:</b>			
Yes	73.9	80.0	76.2
No	83.3	87.0	88.4
<b>EDUCATION:</b>			
High school or less	72.4	74.0	77.5
Some College or more	88.0	91.0	84.8

**Table 3.** Percentage of correct radon awareness among respondents of the Connecticut radon telephone surveys.

	<b>CRCPD 92-93</b>	<b>ISI 93</b>	<b>CRCPD 94</b>
<b>ALL RESPONDENTS:</b>	52.5	31.2	70.1
<b>RACE:</b>			
White	65.7	33.8	72.4
Non-White	60.3	26.8	51.7
<b>INCOME:</b>			
< \$25,000	49.6	18.3	53.9
\$25K - \$50K	72.1	26.3	76.2
> \$50,000	75.5	43.2	78.8
<b>SMOKER:</b>			
Yes	62.2	30.8	63.5
No	67.0	31.4	73.1
<b>EDUCATION:</b>			
High school or less	49.4	15.7	62.1
Some College or more	79.5	40.2	67.4

**Table 4.** Percentage of radon testing among respondents of the Connecticut radon telephone surveys.

	<b>CRCPD 92-93</b>	<b>ISI 93</b>	<b>CRCPD 94</b>
<b>ALL RESPONDENTS:</b>	18.4	20.0	23.4
<b>RACE:</b>			
White	20.1	21.1	24.5
Non-White	5.5	3.7	14.3
<b>INCOME:</b>			
< \$25,000	7.2	4.1	15.1
\$25K - \$50K	18.8	9.1	22.8
> \$50,000	30.5	36.2	28.7
<b>SMOKER:</b>			
Yes	13.0	16.0	19.7
No	21.2	24.0	25.1
<b>EDUCATION:</b>			
High school or less	10.6	13.5	19.1
Some College or more	25.8	21.7	20.1



**Table 5. Percentage of radon testing during real estate transactions among respondents of the Connecticut radon telephone surveys.**

	<b>CRCPD 92-93</b>	<b>ISI 93</b>	<b>CRCPD 94</b>
<b>ALL RESPONDENTS:</b>	29.7	41.2	34.8
<b>RACE:</b>			
White	31.6	42.1	34.6
Non-White	9.7	--	36.6
<b>INCOME:</b>			
< \$25,000	10.2	33.3	25.1
\$25K - \$50K	26.0	37.5	23.8
> \$50,000	38.1	47.1	44.4
<b>SMOKER:</b>			
Yes	12.6	38.1	25.0
No	35.0	45.3	38.7
<b>EDUCATION:</b>			
High school or less	20.0	40.0	26.5
Some College or more	34.0	44.0	23.4

**Table 6. Percentage of radon awareness, testing and mitigation among respondents of the Connecticut radon telephone surveys in high risk areas<sup>a</sup> of Connecticut.**

	<b>ISI 93</b>	<b>CRCPD 94</b>
<b>General awareness:</b>	84.0	87.2
<b>Correct awareness:</b>	60.3	71.0
<b>“Ever tested”:</b>	19.4	33.0
<b>Real estate testing:</b>	43.8	42.8
<b>Action taken (net mitigation):</b>	2.0	3.3

<sup>a</sup> High Risk Areas (HRA) are defined as EPA Zone 1 counties in Connecticut

**Table 7. Connecticut numerical target goals for percentage of radon awareness, testing and mitigation.**

	1995	2000
<b>Radon awareness (statewide):</b>	86.0	90.0
<b>(high risk areas):</b>	90.0	95.0
<b>Radon testing (statewide):</b>	25.0	50.0
<b>(high risk areas):</b>	33.0	67.0
<b>Radon mitigation (statewide):</b>	3.0	5.0 <sup>b</sup>
<b>(high risk areas):</b>	5.0	10.0 <sup>b</sup>

<sup>a</sup> High Risk Areas (HRA) are defined as EPA Zone 1 counties in Connecticut

<sup>b</sup> approaching maximum need based on our current understanding of the percentage of homes with confirmed annual average living area levels in excess of 4 picocuries per liter

**Table 8. Progress toward achievement of 1995 numerical target goals in Connecticut.**

	Survey Data (%)			Projected 1995
	CRCPD 92-93	ISI 93	CRCPD 94	Goals (%)
<b>Radon awareness (statewide):</b>	80.0	85.0	84.0	86.0
<b>(HRA <sup>a</sup>)</b>	c	84.0	87.2	90.0
<b>Radon testing (statewide):</b>	18.0	17.0	23.4	25.0
<b>(HRA <sup>a</sup>)</b>	c	16.0	33.0	33.0
<b>Radon mitigation (statewide):</b>	2.7	2.0	4.1	3.0 <sup>b</sup>
<b>(HRA <sup>a</sup>)</b>	c	2.0	3.3	5.0 <sup>b</sup>

<sup>a</sup> High Risk Areas (HRA) are defined as EPA Zone 1 counties in Connecticut

<sup>b</sup> approaching maximum need based on our current understanding of the percentage of homes with confirmed annual average living area levels in excess of 4 picocuries per liter

<sup>c</sup> incorrect HRA areas were surveyed in the 1992/93 CRCPD survey