



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

May 22, 1992

OFFICE OF
THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-RAC-LTR-92-010

Honorable William K. Reilly
Administrator
U.S. Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460

SUBJECT: Review of the draft revised *Homebuyer's and Seller's Guide to Radon*

Dear Mr. Reilly:

In its January 10, 1992 memorandum to the Science Advisory Board, the Office of Radiation Programs asked the Radiation Advisory Committee to "review the scientific basis of the real estate testing protocol options" proposed in its December 23, 1991 draft revised document, *Homebuyer's and Seller's Guide to Radon*. In addition to the *Guide*, an Appendix on non-interference controls (methods to discourage tampering), options for real estate testing protocol, and a national profile of the real estate testing protocol options were transmitted with the memorandum. At the Committee's public meeting February 10-12, 1992, staff of the Office of Radiation Programs (ORP) briefed the Committee on the scientific basis for the *Guide* and distributed an analysis of misclassification results by season for single short-term measurements.

The Committee believes that all radon remediation decisions should be based on estimated exposure to individuals. Therefore, the Committee has for some time recommended a year-long integrated radon concentration measurement, taken in the lowest lived-in space, because this measurement most accurately reflects the annual average radon concentration in a home (exposure also depends on the time an individual spends in a particular area). However, the Committee realizes that the best option is not currently the most realistic option for real estate transactions where decisions may be made in matters of days or weeks.

The Agency's analysis recognizes that, in comparison to long-term tests, short-term tests for radon will greatly increase the numbers of false negatives and false positives relative to the EPA recommended action level of 4 pCi/L. The problem of false indicators is greatest near the action level. False negatives will result in failure to mitigate where mitigation is desirable, whereas false positives will result in homes being mitigated even though the annual average radon concentration is already below EPA's recommended 4 pCi/L action guideline. However, in proposing real estate test protocols, the Agency must also consider a number of practical concerns that are not strictly part of the science. For example, deliberate tampering with the test devices or otherwise interfering with the test will render it invalid. A testing protocol that is too complicated or costly will discourage testing. In addition, in warm weather, home sellers without air conditioning are unlikely to comply with requests to close up their houses for several days.

Overall, the Committee recommends that the Agency develop real estate testing protocols that are consistent with the recommendations in the *Citizen's Guide to Radon*, but because the home-owner and home-seller have different motivations in radon testing, the real estate testing protocols should not be constrained by those adopted for the *Citizen's Guide*. Where the protocols differ from those in the *Citizen's Guide*, the Agency should provide the public an explanation for this difference.

Discussion of Testing Protocol Options

In reviewing the proposed protocols (Attachment 2), the Committee considered that radon concentrations in homes vary with location within the home; with heating, ventilating, and air conditioning use patterns of the occupants; and over time. Radon concentrations vary with time of day, with weather, and by season. Radon measurement methods vary in their precision, ability to provide an integrated sample over time, susceptibility to tampering, and time periods for which they may be usefully deployed. The Committee also considered statistical analyses presented by the Agency at the February 10-12 meeting (Attachment 3) that address the percentage of false negatives and false positives under a variety of circumstances. In some cases, the Committee found that the data and analyses made available to it were insufficient to make decisions about the protocols and the Committee's recommendations therefore include the professional judgement of the Committee.

The Committee considered five protocols proposed by the Agency (Attachment 2). Options A and D consist of two simultaneous short-term tests; for Option A these tests are made in the lowest area that could be lived in (lowest "livable") and for Option D the tests are made in the lowest area the buyer plans to live in. Option E combines Option A plus Option D. Options B and C each consist of a single short-term test if the result is below 4 pCi/L with follow-up testing only if the first test result is above 4 pCi/L; for Option B the

test is made in the lowest area that could be lived in and for Option C the test is made in the lowest area the buyer plans to live in.

Options A and D, and likewise options B and C, differ in the location at which measurements will be made should the buyer decide to utilize a presently un-used basement as part of the living space of the home. The buyer's desire may not be known, or a potential buyer might change his or her plans. Because Options A and B measure radon concentrations in the lowest area that could be lived in, they are essentially independent of the buyer's intentions but such measurements are likely to overestimate annual average radon exposures if these areas are infrequently used. If the testing protocol requires that measurements be made in the lowest livable area (Options A and B), and this area is not occupied by the buyer, then the possibility of false positive results increases, so that a significant number of such homes may be mitigated even though the annual average radon concentration to which the occupants are exposed is in fact below EPA's recommended 4 pCi/L action guideline. Taken together, ORP's "Misclassification of Results By Season for Single Short-Term Measurement Analysis," and the graphs in "Attachment A: Options for Real Estate Testing Protocol" show that, on a national average, 65% false positives could occur and that for 41% of the false positives the annual average radon concentrations is estimated to be less than 2 pCi/L.

Testing in the lowest livable area does minimize the number of false negative test results. Also the radon concentrations in the basement may be more precisely measured because the concentration is higher and more stable than on the first floor, but the Committee does not believe these factors provide an overall advantage if the concentration measured is not the average concentration to which the home occupants are exposed.

Options B and C assume that annual average radon concentrations can be estimated, and thus potential mitigation decisions can be made, on the basis of a single short-term measurement if the first test result fell below 4 pCi/L. Option E, which requires two simultaneous tests on both the first floor and the basement, appears unnecessarily complex and more expensive than the others. The separate values that will be obtained for basement and first floor may provide opportunity for dispute between the potential buyer and the seller, and averaging all measurements might be misleading.

Two simultaneous tests run side-by-side would improve the precision of the measurement, applicable to the time period of the measurement. Two sequential tests improve the accuracy of estimating an annual average concentration by increasing the time period over which measurement is made. In the real estate transaction context, however, the sequential tests would usually be made close together in time during the same season of the year; therefore, the resulting improvement in accuracy would likely be small. The material

presented to the Committee did not provide a conclusive basis for choosing between simultaneous and sequential testing. The Committee was not able to quantitatively compare the precision and accuracy of these alternative measurement techniques. Committee members were concerned that if tests are done sequentially, a high initial test result might encourage--or be perceived as encouraging--interference with the second test, but this problem could be avoided by not reporting the data until both tests have been made.

Recommendations

Encourage longer tests whenever possible. Short-term testing is, by its very nature, subject to considerable uncertainty if used to represent long-term average exposures, even when done with great precision. Both false positive and false negative results will occur at a higher frequency than for long-term tests properly performed. The *Homebuyer's and Seller's Guide* needs to make these facts abundantly clear to all parties involved in real estate transactions, and that with a short-term test a seller may well incur remediation costs that could have been avoided if a reliable long-term test were performed. Likewise, a buyer cannot be assured purchase of a home that is below the EPA guideline annual average radon concentration, especially if the reported short-term test results are near this action level (4 pCi/L).

If short-term testing is chosen. In the situation of real estate transactions as described to the Committee, when there may not be time for a long-term test, the Committee recommends the following:

- a) Conduct short-term testing at the lowest level of the home that is finished in a manner suitable for occupancy, whether or not the seller lives in that area. This strategy would provide the buyer with the option of using that area as part of the livable area of the house with the knowledge that it had been tested for radon. Short-term testing is not recommended in unfinished areas that are currently not suitable for sustained occupancy. Thus testing, and possible resulting mitigation, would not be required for areas that will not be used without renovation. If the buyer elects to finish or renovate the area for occupancy, then it should be his or her responsibility to test to determine the need for mitigation before remodeling. Testing will also be appropriate subsequent to remodeling to ensure that none of the changes resulted in increased radon levels.
- b) Two measurements should be conducted if passive short-term integrating monitors are used. A single measurement is not sufficient, and should be discouraged. Simultaneous measurements would improve the precision of the

measurement. Sequential measurements should likely give a better representation of the seasonal average. Measurements over a sufficient time period should be required to minimize the effects of the daily and day-to-day variations in radon concentrations. Each measurement should span at least two days with an appropriate device or preferably longer. Time periods longer than two days are likely to provide better estimates of the annual average concentrations, but the Committee was not able to quantify this expected improvement from the data provided.

- c) A non-passive continuous radon monitor could also be used, with data collection over a time period sufficient to minimize the effects of the daily and day-to-day variations in radon concentrations. Again, the time period should be at least two days and preferable longer.
- d) Employ methods to reduce or eliminate inadvertent or deliberate interference with the measurement devices(s) or violation of closed house conditions to ensure the integrity of the results.
- e) The revised *Homebuyer's and Seller's Guide to Radon* should very carefully portray 4 pCi/L as the recommended EPA action level for an annual average concentration and that a 4 pCi/L short-term test result does not necessarily translate to an annual average concentration of this magnitude.

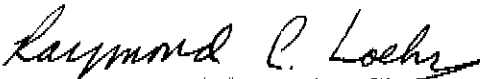
Alternative Approaches. The Committee recommends that the *Guide* address, as another option, long-term testing of the home after the sale has been completed. Although many buyers and sellers wish to finalize commitments at the time of the sale and not have the process continue following transfer of title, the significant advantages of having the time to do more accurate long-term testing may be an overriding consideration in some transactions. Possible methods of implementation of such post-sale testing include the establishment of an escrow account which could be used to pay for any necessary mitigation costs or be returned to the original seller depending on the long-term test result. Another possibility would be a home warranty or "radon insurance" type arrangement, where the long-term testing and any resulting mitigation would be conducted after the sale of the home and at no further monetary expense to the homebuyer. To the extent that it can, the Agency should encourage such approaches as a means of providing long-term and therefore more scientifically defensible means of testing radon concentrations in houses.


Research Recommendation. The Committee believes that, as the Agency revises and improves its recommendations regarding radon testing methodologies, it should conduct studies directed toward improving the analysis of both the precision and accuracy of the

various measurement methods, testing protocols, and interpretive procedures. These efforts should include more data on day-to-day and season-to-season variability for a variety of radon concentrations. It is also important to investigate how increasing integration time improves the accuracy of short-term test results in comparison to estimating the annual average radon concentration. Such research should include various testing techniques and a wide spectrum of houses and testing variables. The Committee is aware of at least two recent studies--conducted in Florida and in New Jersey--whose results appear to pertain to some of these questions.

We appreciate having been given the opportunity to conduct this particular review. We request that the Agency respond formally to the scientific advice provided herein, particularly in regard to the Committee's concern that short-term testing may not provide an adequate estimate of the long-term concentrations.

Sincerely,


Dr. Raymond C. Loehr, Chair
Executive Committee
Science Advisory Board


Dr. Oddvar F. Nygaard, Chair
Radiation Advisory Committee
Science Advisory Board

Attachment 1: Committee Roster
Attachment 2: Real Estate Testing Protocol Options: National Profile
Attachment 3: Analysis of Misclassification Results by Season, for Single Short-term Measurements, distributed February 11, 1992

**U.S. ENVIRONMENTAL PROTECTION AGENCY
SCIENCE ADVISORY BOARD
RADIATION ADVISORY COMMITTEE**

Roster

CHAIRMAN

Dr. Oddvar F. Nygaard, Division of Biochemical Oncology, Department of Radiology, University Hospitals of Cleveland, Cleveland, OH

MEMBERS

Dr. Stephen L. Brown, ENSR Consulting & Engineering, Alameda, CA

Dr. Kelly H. Clifton, Department of Human Oncology and Radiology, University of Wisconsin Clinical Cancer Center Madison, WI

Dr. James E. Martin, University of Michigan, School of Public Health, Ann Arbor, MI

Dr. Genevieve M. Matanoski, The Johns Hopkins University, School of Hygiene and Public Health, Baltimore, MD

Dr. H. Robert Meyer, C.N.S.I., Harrisburg, PA

Dr. Richard G. Sextro, Building Ventilation and Indoor Air Quality Program, Lawrence Berkeley Laboratory, Berkeley, CA

Mr. Paul G. Voilleque, MJP Risk Assessment, Inc., Idaho Falls, ID

Dr. James E. Watson, Jr., Department of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill, NC

SCIENCE ADVISORY BOARD STAFF

Mrs. Kathleen W. Conway, Designated Federal Official, Science Advisory Board (A-101F), U.S. Environmental Protection Agency, Washington, DC

Mrs. Dorothy M. Clark, Staff Secretary, Science Advisory Board (A-101F), U.S. Environmental Protection Agency, Washington, DC

REAL ESTATE TESTING PROTOCOL OPTIONS

National Profile

<p>NOTE: A single short-term test could be used in options A, D, and E.</p>	<p>PROTECTIVENESS</p>	<p>ACCURACY (based on 4 pCi/L action level)</p>	<p>OTHER</p>
<p>Testing Option A: Two simultaneous short-term tests in lower area that could be lived in (liveable).</p>	<ul style="list-style-type: none"> - True positives - 5.0% - False negatives - 1.3% - Number of homes fixed - 14.2% 	<ul style="list-style-type: none"> - "Unnecessary" mitigations - 8.3 million homes - Fixers without benefits - 3.4 M homes (mostly with basements) 	<ul style="list-style-type: none"> - Provides quick results - Applies to any potential homebuyer, regardless of living patterns - Consistent with testing and fixing before the transaction
<p>Testing Option B: One short-term test followed by a confirmatory short-term test in lowest area that could be lived in (liveable).</p>	<ul style="list-style-type: none"> - True positives - 5.1% - False negatives - 1.2% - Number of homes fixed - 13.9% 	<ul style="list-style-type: none"> - "Unnecessary" mitigations - 8.0 M homes - Fixers without benefits - 3.2 M homes (mostly with basements) 	<ul style="list-style-type: none"> - Two-step process more time consuming - Applies to any potential homebuyer regardless of living patterns - Consistent with testing and fixing before the transaction
<p>Testing Option C: One short-term test followed by a confirmatory short-term test in lowest area the buyer plans to live in (living or liveable).</p>	<ul style="list-style-type: none"> - True positives - 4.7% - False negatives - 1.6% - Number of homes fixed - 9.3% 	<ul style="list-style-type: none"> - "Unnecessary mitigations" - 4.1M homes - Fixers without benefits - 0.9 thousand homes (mostly with basements) 	<ul style="list-style-type: none"> - Consistent with Draft "Citizen's Guide" - Two-step testing process, more time-consuming - Testing or fixing would be contingent on buyer's preference for lowest living area (implies waiting until time of transaction)

MISCLASSIFICATION RESULTS BY SEASON FOR SINGLE SHORT-TERM MEASUREMENT ANALYSIS						
OPTION	Correct Classifications	Error Rate	False(-) (over all homes testing)	False(-) (over all true positives)	False(+) (over all homes testing)	False(+) (over all positive tests)
Lowest Livable Level						
<u>Winter</u>						
2 Day Charcoal	85.5%	14.5%	0.8%	10.8%	13.7%	67.5%
60-90 Day ATD	87.2%	12.8%	1.3%	17.6%	11.5%	65.3%
<u>Summer</u>						
2 Day Charcoal	93.4%	6.6%	2.0%	27.0%	4.6%	46.0%
60-90 Day ATD	92.6%	7.4%	2.8%	37.8%	4.6%	50.0%
Lowest Lived-In Level						
<u>Winter</u>						
2 Day Charcoal	90.5%	9.5%	1.1%	14.9%	8.4%	57.1%
60-90 Day ATD	91.9%	8.1%	1.5%	20.3%	6.5%	52.4%
<u>Summer</u>						
2 Day Charcoal	95.6%	4.4%	2.9%	39.1%	1.5%	25.0%
60-90 Day ATD	95.0%	5.0%	3.5%	47.3%	1.5%	27.8%

NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use.

Distribution List

Administrator

Deputy Administrator

Assistant Administrators

Deputy Assistant Administrator for Research and Development

Deputy Assistant Administrator for Air and Radiation

EPA Regional Administrators

EPA Laboratory Directors

EPA Headquarters Library

EPA Regional Libraries

EPA Laboratory Libraries