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Project Summary

Follow-Up Alpha-Track Monitoring in 40 Eastern Pennsylvania Houses with Indoor Radon Reduction Systems (Winter 1987-88)

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Between June 1985 and June 1987, developmental indoor radon reduction systems were installed in 40 houses in the Reading Prong region of eastern Pennsylvania. Most of these systems involved some form of active soil ventilation, although three involved heat recovery ventilators and two included carbon filters for removing radon from well water. The reduction in indoor radon concentrations achieved in each house was described in an earlier report.

The purpose of the current study was to make follow-up alpha-track detector (ATD) measurements of radon concentrations in these houses, approximately one year after the last of the installations was completed, in order to determine how well the radon reduction performance of the systems was being maintained. The ATD measurements were made over a 3-month period during the winter (December 1987-March 1988), to assess system performance when cold weather would be giving the systems a significant challenge. These 1987-88 ATD results are compared with comparable post-mitigation ATD measurements made during the previous winter (1986-87), and with those made prior to the installation of the radon reduction system.

Of the 34 houses where the radon mitigation system was in operation during the entire measurement period, the radon levels measured in 1988 compared well with those measured in 1987 (or any differences appeared explainable) in all but one house, indicating no significant degradation in system performance: in House 10, an exterior drain tile suction installation), levels had increased 50-70% from those measured in 1987, with no apparent reason. The well water radon removals achieved by the carbon adsorption units appeared not to have degraded since the previous water measurements.

Of the 34 houses having operating active soil systems, two have experienced fan failure or need for fan maintenance in the 1-2 years that the fans have been in operation.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The USEPA is conducting a program to develop and demonstrate cost-effective methods for reducing the concentrations of naturally occurring radon gas inside houses. As part of this program, EPA sponsored the installation of developmental radon reduction measures in 40 existing houses in eastern Pennsylvania having high initial radon levels - above 20 picoCuries per liter (pCi/L), or 740 Becquerels per cubic meter (Bq/m^3). These houses had substructures representative of the region - basements having block or poured concrete foundation walls, sometimes with an adjoining slab-on-grade or crawl space wing. Active soil ventilation systems, utilizing a fan - sub-slab suction, drain tile suction, or block wall suction or pressurization - were tested in most of the houses. Heat recovery ventilators were tested in three houses having only moderate radon elevations, and carbon treatment of well water was tested in two houses. The installations in these 40 houses, and the initial system performances, were reported in an earlier report.

To test the durability of these installations, 3-month ATD measurements of radon concentrations were made between December 1987 and March 1988 in the 38 of the 40 houses still having operating systems. Winter was chosen for this measurement to determine system performance when the system was facing the challenge of cold weather.

Of the two houses no longer having operating systems, one was moved from its original site after the system was installed; and the owner decided to discontinue participation in the project.

Measurement Procedures

The measurements were made using Terradex "Type SF" Track Etch ATDs. In each house, a cluster of 3 ATDs were hung together from a central floor joist in the basement; a second cluster of 3 was hung in the living area (the story above the basement), from an interior wall or ceiling. Clusters of three were used to reduce measurement uncertainties and facilitate identification of outliers. The exposed detectors were returned to the Terradex laboratories for analysis.

The detectors were deployed in December, and retrieved in March, by an experienced professional.

For quality assurance, 14 unexposed detectors were returned to Terradex as blanks, to determine the zero correction. Also, 13 detectors were exposed to known radon environments in a test chamber for selected durations, and returned to Terradex as blind spikes to determine the gain correction.

Results and Discussion

Of the 38 houses in which ATDs were deployed, it was found upon retrieval of the detectors that the mitigation system fans had been off in four houses during some portion of the measurement period. In one house, the fan had failed during the period; and in the other three, the owner had turned the fan off while on vacation. Thus, in only 34 houses do the ATD results give radon concentrations representative of uninterrupted system operation.

The results from these 34 houses are presented in Table 1. The radon concentrations listed in the column "1988" are from this 1987-88 measurement effort; each number (for the basement and for the living area) is the average of the three ATDs in the cluster. Results are also shown for comparable post-mitigation ATD measurements during the previous winter ("1987"); most of the 1987 measurements were made between December 1986 and March 1987, although some began later (due to the installation schedule) and extended into April. Results are also shown for post-mitigation measurements 2 years before ("1986"), where available. Premitigation results, usually from an ATD measurement during an earlier heating season, are also shown for each house

Comparison of the 1988 and 1987 radon levels indicates that concentrations have remained fairly steady in most houses during the year between the two measurements. Thus, the performance of the radon mitigation systems does not generally appear to be degrading. One house where a degradation is apparent is House 10, which has a draintile suction system; radon levels in this house have increased progressively since the 1986 measurement. Increases between 1987 and 1988 are also apparent in Houses 18 (a heat recovery ventilator) and 25 (a sub-slab suction system). Part of the increase in these houses could be because the 1987 measurements in these two houses were made between February or March 1987 and April 1987; these 1987 readings might be biased low since more of the measurement period could have included mild weather.

Radon concentrations were measured in the well water of House 30, entering and leaving the carbon treatment unit. Water concentrations were being reduced from 83,400 to 3,320 pCi/L (3.1 to 0.12 MBq/m^3) for 96% removal, consistent with the 95-99% removals measured on a number of occasions since the carbon unit was installed in August 1986. Thus, the performance this unit does not appear to l degrading.

Fans in 2 of the 34 houses with acti soil ventilation installations (Houses 2 a 4) have failed or needed repair in the 2 years that they have been operating.

Overall conclusions from an earl report still appear valid. Reductions 90-99+% are still being achieved w the active soil ventilation systems. H recovery ventilators give lower, le predictable reductions, usually no grea than about 50%; the apparent reducti of about 80% in House 28 is question since the ventilator gave reductions only 15-45% during short-term ba to-back measurements with the ve lator on and off. Carbon filtration c remove 95-99% of the radon in wa at least over the 16-month test per here.

Table 1. *Summary of Results to Date for Houses with Mitigation Fans Operating Throughout the 1988 Measurement Period*

House No.	House Type*	Final Mitigation System	Average Rn (pCi/L)** Pre-Mitigation	Average Rn (pCi/L) Post-Mitigation*** 1988		1987		1986	
				B	LA	B	LA	B	LA
3	1	Wall + sub-slab suction	350	3.5	2.3	3.5	2.1	4.4	1.7
5	1	Wall pressurization	(110)	5.0	4.4	4.3	4 3	–	–
6	1	Sub-slab suction	60	4.1	3.2	3.3	4.9	–	–
7	1	Sub-slab + wall suction	(402)	4.9	3.8	4.1	2.8	–	–
8	1	Wall suction	183	3.5	1.5	3.9	1.8	3.1	1.3
9	1	Wall + sub-slab pressurization (baseboard duct over French drain)	533	10.4	12.9	11.6	14.5	–	–
10	1	Drain tile suction (exterior)	626	15.2	9.9	9.0	6.5	3.3	3.0
12	1	Drain tile suction (exterior)	(11)	2.2	2.2	3.7	2.5	–	–
13	1	Sub-slab + drain tile suction (exterior)	64	2.6	3.9	2 3	2.0	–	–
14	1	Wall suction	36	1.1	1.4	0 5	0.7	0.7	0.6
16	2	Wall suction	395	5.7	2.5	5.4	1.7	–	–
17	1	Heat recovery ventilator	9	8.2	6.4	7.6	4.1	–	–
18	1	Heat recovery ventilator	12	13.5	3.4	8.8	2.1	–	–
19	1	Wall suction	32	33.5	0.8	32.0	0.6	–	–
20	2	Sub-slab + wall suction, + suction under slab in crawl space	210	6.5	10.0	5.8	9.9	–	–
21	1	Sub-slab suction	172	2.0	2.7	3.1	2.6	–	–
22	3	Sub-slab suction (basement + slab)	24	8.6	4.4	7.6	2.7	–	–
23	3	Sub-slab suction (basement + slab)	98	2.6	1 6	–	–	–	–
24	4	Sub-slab suction	66	3.6	3.8	4.3	4.6	–	–
25	4	Sub-slab suction	122	7.7	6.0	5.4	3.0	–	–
26	1	Drain tile suction (exterior)	(89)	1.1	1.6	2.1	1.5	–	–
27	1	Drain tile suction (exterior)	21	4.0	2.2	3.8	2.2	–	–
28	1	Heat recovery ventilator	21	4.1	4.4	2.4	5.3	–	–
29	5	Drain tile suction (interior sump) + suction under crawl space line	61	1.6	2.0	1.9	1.4	–	–
30	1	Carbon adsorption treatment of well water	17	4.0	1.6	3.0	1.3	–	–
31	1	Sub-slab suction	(485)	2.8	8.3	1.8	5.7	–	–
32	1	Sub-slab suction	(6)	1.2	4.4	1.0	3.2	–	–
33	4	Sub-slab suction	82	3.5	1.2	2.2	1.1	–	–

Table 1. *(Continued)*

House No.	House Type*	Final Mitigation System	Average Rn (pCi/L)** Pre-Mitigation	Average Rn (pCi/L) Post-Mitigation*** 1988 B	1988 LA	1987 B	1987 LA	1986 B	1986 LA
34	4	Sub-slab suction	470	5.4	5.5	5.5	3.7	—	—
35	4	Sub-slab suction	144	1.0	0.9	0.8	0.7	—	—
36	3	Sub-slab suction (basement + slab)	300	1.1	1.0	1.6	0.7	—	—
37	3	Sub-slab suction (basement only)	87	1.2	0.7	0.6	1.7	—	—
38	1	Sub-slab suction	309	8.7	7.2	—	—	—	—
40	4	Sub-slab suction	148	1.9	1.2	—	—	—	—

*House Type:
1 = Block basement walls
2 = Block basement walls + paved crawl space
3 = Poured concrete basement walls + slab on grade
4 = Poured concrete basement walls
5 = Block basement walls + unpaved crawl space

**Pre-mitigation radon concentrations reported here represent a single Terradex Track Etch alpha-track detector measurement arranged by the Pennsylvania Department of Environmental Resources during a heating season prior to installation of EPA's radon mitigation system. Where it is known that the pre-mitigation ATD was not placed in a representative location (e.g., was inside a sump), or where the ATD result is clearly not representative of subsequent Pylon measurements made by EPA, the pre-mitigation concentration shown here is the average of at least 48 hours of hourly radon measurements made in the basement during cold weather using a Pylon continuous radon monitor. Where Pylon measurements have been used, the pre-mitigation value is shown in parentheses. The Pylon measurements were made during the 1985-87 system installation period

*** Post-mitigation radon concentrations reported here represent the average of clusters of three alpha-track detectors exposed 3 months during the winter: 1988 measurements were made during this study (December 1987 - March 1988); 1987 measurements were generally made between December 1986 and March 1987; and 1986 measurements were generally made between December 1985 and March 1986. All results are modified for gain and zero correction. Absence of figures for 1986 or 1987 for a given house indicates that: ATD measurements were not made in that house that winter; or the radon mitigation system was changed significantly between that and the following winter; or the ATD measurement was made significantly outside the December - March window due to the system installation schedule. B = Track Etch measurements in the basement. LA = Track Etch measurements in the living area (story above basement).

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The complete report entitled, "Follow-Up Alpha-Track Monitoring in 40 Eastern Pennsylvania Houses with Indoor Radon Reduction Systems (Winter 1987-88)," (Order No. PB 89-110 035/AS; Cost: $13.95) will be available only from:
National Technical Information Service
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