

FIELD PLACEMENT OF ALPHA TRACK DETECTORS

OR

DOES RADON KNOW UP FROM DOWN?

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ABSTRACT

US EPA protocols for placement of alpha track detectors (ATDs) include some instructions that appear to be vestigial or carried over from other detector types. In addition, homeowners do not always follow instructions concerning placement. This paper looks at the variation in radon readings from ATDs placed for three winter months in three Pennsylvania homes known to have moderate radon levels (4 to 20 pCi/l). Each home had a basement.

Detectors were placed in first floor bedrooms at 14 locations including on the wall, on the ceiling, hanging from the ceiling and inside a drawer. Monitors were deployed in triplicate at each location. The results were normalized to the ATDs hanging 8" from the ceiling in the center of the room. No significant differences were found between any of the locations, including those detectors inside drawers. Thus, ATDs are quite robust with respect to monitoring location.

INTRODUCTION

This study was performed to explore the hypothesis that alpha track detector (ATD) placement within non-basement rooms is not as critical as has been suggested by the Environmental Protection Agency's Indoor Radon and Radon Decay Product Measurement Protocols and other published methods (US EPA 1989a and 1989b).

Currently these protocols recommend that, for convenience, detectors can be suspended from the ceiling but should be positioned at least 20 cm (8 inches) below the ceiling. Further, the protocols require that the detectors should not be placed close to outside walls or within 10 cm (4 inches) of other objects. No justification or support for these location protocols are referenced.

Alternatives to using these location protocols were investigated because in many cases homeowners do not follow instructions for detector placement. In addition, attaching alpha track detectors directly to the ceiling often offers the best deployment location, particularly in schools and commercial buildings.

While there have been many studies reporting differences in radon concentrations on different floors of houses (for example, Cohen 1991, Fleischer and Turner 1984, George et al. 1984, Morley et al. 1991, Pfister and Pauly 1984) there is little data available on variation of radon within rooms. In one Dutch study (Put and de Meijer 1988) alpha track detectors were placed in a living room at heights above the floor of 1.6 m, 1.8 m and 2.1 m. There was no significant difference between the three locations, although the relative standard deviations were as great as 20%.

ATD DEPLOYMENT AND HOUSE CHARACTERISTICS

Radon levels between 150 and 750 Bqm⁻³ (4 to 20 pCi/l) were known to be present on the first floor of the three Pennsylvania homes selected. Alpha track detectors were placed in 14 different locations of first floor bedrooms in each of the three homes. The exposures were done during the winter months from 14 December, 1990 to 15 March, 1991. 'Closed house' winter heating conditions existed during the 91-day exposure period.

Table 1 shows some of the general characteristics of each of the three houses. All of the homes have full block-wall basements with the main living area and bedrooms directly above the basement. The three houses also had storm windows in the closed position during the exposure period.

Table 1

House Characteristics

| | <u>House A</u> | <u>House B</u> | <u>House C</u> |
|----------|----------------------------|----------------------------|-----------------------|
| Type | Ranch | Ranch | Cape Cod |
| Age | 30 years | 29 years | 6 years |
| Heating | Oil-Baseboard Hot Water | Oil-Baseboard Hot Water | Baseboard Electric |
| Exterior | Brick | Brick | Siding |
| Soil | Clay | Gravelly | Loam |

Solid cap AT-100 (Radon Environmental Monitoring, Northbrook, Illinois) alpha track detectors were used. The detector is constructed of electrically conductive plastic to minimize charge effects and has a hemispherical housing for more uniform track distribution (Pollock 1987). The track registration foils were of dosimetry grade CR-39 and were electrochemically etched. Tracks were counted with an image analysis system described previously (Pollock 1986).

The detectors were deployed in triplicate at all locations. Monitoring locations included on the walls 1 and 2 meters above the floor and hanging 20 and 8 cm below the ceiling as well as attached directly to the ceiling, both in the center of the room and by the walls. In addition, sets of monitors were placed on furniture (dressers and bookshelves) and even inside drawers.

RESULTS

After the three-month exposure the alpha track detectors were returned to the laboratory for analysis. The resulting radon concentration results for each room were normalized to the mean of the detector group hanging 20 cm from the ceiling in the center of the room. These relative results are shown in Table 2.

When compared using the students t-test, none of the locations differed significantly at the 95% level from the center of the room. The most significant difference was in House B where three detectors were placed on a window sill. While not recommended placement, even here the lower readings were significant only at the 75% level and not at the 95% level.

Even detectors placed inside drawers showed no difference from the reference readings. This uniformity is not unexpected, given that radon is an inert gas. Both diffusion and mass transport act to eliminate differences in concentration. In addition alpha track detectors, unlike activated charcoal devices, do not act as radon sinks and do not change the radon level around them.

Thus, alpha track detectors are quite robust with respect to monitoring location. Placement directly on the ceiling is often a convenient alternative and can make a detector less conspicuous, thus reducing the loss rate in institution monitoring. Placement in drawers opens whole new vistas in monitor deployment by avoiding drafts and inquisitive children and pets. Bedside stands often contain a drawer and would be ideal for measuring radon levels in the bedroom. However, care should still be exercised when placing ATDs in basements or first floor rooms without basements. Rooms with a strong source term can create a permanent radon concentration gradient before the air becomes well mixed.

Table 2.

Relative ATD results, normalized to ATDs hanging 8" from the ceiling in the center of the ground-floor bedrooms. Monitors were placed in triplicate. Uncertainties indicate one standard deviation. There was no significant difference between 8" from middle of ceiling and other locations.

| <u>Location</u> | <u>House A</u> | <u>House B</u> | <u>House C</u> |
|--|----------------|----------------|----------------|
| Center of room | | | |
| Hanging 8" from ceiling | 1.00 ± 7% | 1.00 ± 3% | 1.00 ± 6% |
| Hanging 3" from ceiling | 0.97 ± 10% | 1.00 ± 3% | 1.00 ± 7% |
| Attached to ceiling | 1.04 ± 4% | 0.97 ± 2% | 0.99 ± 6% |
| By inside wall | | | |
| Hanging 8" from ceiling | 1.05 ± 11% | 0.97 ± 2% | 1.01 ± 4% |
| Hanging 3" from ceiling | | 1.02 ± 3% | 1.10 ± 10% |
| Attached to ceiling | 0.98 ± 11% | 1.01 ± 2% | 1.04 ± 2% |
| Inside wall | | | |
| 2 meters from floor | 1.00 ± 2% | 0.99 ± 2% | 0.94 ± 5% |
| 1 meter from floor | 1.00 ± 1% | 1.08 ± 4% | 1.04 ± 3% |
| Outside wall | | | |
| Hanging 8" from ceiling | | | 1.03 ± 6% |
| Attached to ceiling | | | 1.01 ± 8% |
| 2 meters from floor | | | 0.97 ± 7% |
| 1 meter from floor (on window sill) | | 0.93 ± 2% | |
| On furniture | 1.15 ± 21% | 1.00 ± 2% | |
| In drawer | | 1.00 ± 4% | 1.03 ± 3% |

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