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Radon testing in schools in New York State: a 20-year summary

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ABSTRACT

For nearly 20 years the Department of Health has conducted programs to assist in the measurement and reduction of indoor radon concentrations in 186 schools located primarily in Zone 1 areas of New York State. Although many schools had few or no rooms containing radon above 148 Bq/m^3, some rooms had >740 Bq/m^3 and remediation techniques were utilized to reduce exposure. Short-term radon measurements in the schools showed little correlation to basement and first-floor radon results from single-family homes in the towns.

1. Introduction

Indoor radon and its progeny contribute the majority of the dose received from naturally occurring radiation. As indoor radon can reach elevated concentrations in some homes and buildings, the New York State (NYS) Department of Health (DOH) has conducted programs for 30 years to encourage radon measurements and remediations. The programs have been primarily directed toward reducing radon exposure to occupants of homes and schools. Measurements of single-family homes has shown the widespread presence of elevated radon in NYS (Kitto and Green, 2008), with over half of the counties designated Zone 1, or high-risk, by the U.S. Environmental Protection Agency (EPA). Over half of the houses located in eight of the highest-risk counties are predicted to contain basement-level radon concentrations above the EPA-recommended action level of 4 pCi/L (148 Bq/m^3). Consequently, the DOH has continued to implement programs to reduce the radon-related health risk to occupants of buildings (e.g., homes, schools, workplace) in these and other high-radon counties. The potential for elevated radon levels in schools, and the significant amount of time children spend in classrooms, prompted the DOH to measure radon in schools during multi-year projects. The purpose was to obtain information regarding the extent and magnitude of radon in NYS schools, examine radon entry and distribution in large buildings, raise radon awareness among school administrators, and provide instructions to school staff so they were able to conduct radon tests in other school buildings. As a result of these efforts, the aims of this study were to (1) compare results of short- and long-term radon measurements at the schools and (2) examine the correlation of radon levels measured in schools with those in local housing.

Although schools are sometime reluctant to measure for radon, as remediation can be costly and funding may not be available, the NYS Education Department put forth regulations (NYSED, 1998) which dictated that “districts shall take responsibility to be aware of the geological potential for high levels of radon and to test and mitigate as appropriate”. Prior to this regulation some schools followed inappropriate testing protocols, measured an inadequate number of rooms and locations, and utilized unqualified radon analysis laboratories. Due to the questionable validity of these data the DOH designed and conducted regional training sessions across the State to educate staff of schools on the proper protocols for radon testing in schools and other large buildings. Measurements conducted as a result of these training sessions and remediation efforts to reduce indoor radon levels are summarized herein.

In the late 1980s, short-term radon measurements were conducted (USEPA, 1989) in 3000 rooms in 130 schools in 16 states (not including NYS). Over half of the schools had at least one room with radon levels above 148 Bq/m^3 and all states had some classrooms with radon above 148 Bq/m^3, with the highest classroom measured

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at 5040 Bq/m^3. As schools in NYS have not been required to measure for indoor radon, and children spend roughly 20% of their time in classrooms, the primary objective of the DOH programs was to measure radon in public and private schools throughout the State, with the exception of those located in New York City and on Long Island. The latter areas were omitted due to the low radon potential (i.e., occurrence) and the large number of schools located in the areas.

2. Materials and methods

There are approximately 8260 public and private schools in NYS, of which over half are located "upstate", outside the low radon-potential area that encompasses New York City and Long Island. Many (~90%) of the 4290 upstate schools are located in 34 counties designated by EPA as Zone 1 or having an average indoor radon potential greater than 148 Bq/m^3 in homes. These counties comprise the area of highest radon potential as confirmed by mapping of measurements conducted in single-family homes (Kitto and Green, 2008) and a database maintained by DOH (NYSDOH, 2014). Of the 186 schools, located in 41 counties, measured during the 18 years of radon testing, the number of schools measured in each county varied from 1 to 33 (Fig. 1). In general, schools that participated in the DOH studies were located in areas with an elevated potential for radon, and were distributed among as many school districts as possible. Participation by the schools was voluntary and over half of those solicited agreed to participate. Detectors were deployed and retrieved by trained school staff, then sent to the laboratory for analysis.

The indoor radon measurements were conducted predominantly in basement-level and first-floor rooms according to EPA-recommended protocols for schools buildings that are summarized in Table 1. Short-term measurements were primarily completed during the heating season. For the first two years, short-term measurements were completed using electret-type detectors deployed for 2–5 days. These passive radon measurement devices are commercially available (Rad Elec Inc., Frederick, MD) and have been described elsewhere (Kotrappa et al., 1993). The voltage reader was calibrated using electrets exposed at a calibration chamber and were periodically checked with reference electrets. In the later studies, charcoal canisters contracted through a commercial laboratory (Radon Testing Corp. of America, Elmsford, NY) were used, rather than the electret devices, for short-term

Table 1
School-testing guidance following initial short-term screening measurement.

Screening test result	Follow-up procedure
<148 Bq/m^3	Leave long-term detector for ≥10 months
>148 Bq/m^3 and <740 Bq/m^3	Analyze long-term detector after 3 months
≥740 Bq/m^3 and <3700 Bq/m^3	1. Confirmatory short-term measurement 2. Analyze long-term detector after 1 month 3. Consult health officials; may inspect school
≥3700 Bq/m^3	1. Confirmatory short-term measurement 2. Analyze long-term detector within 1 month 3. Consult health officials; inspect school

measurements. At several schools, confirmatory measurements of 30–90 days were conducted in rooms that had short-term screening results above 148 Bq/m^3. Initially, long-term electrets were used for the confirmatory measurements, but were replaced with alpha-track detectors in the latter studies. These confirmatory data allowed school staff to avoid areas with elevated radon levels until long-term results were available and until remediation could commence. Long-term measurements that utilized alpha-track detectors were typically deployed for 9–12 months and were contracted through the commercial laboratory.

A series of blanks and duplicate measurements, both short- and long-term, were utilized during the projects. Blank detectors were included in the shipment of detectors to each school and returned with the exposed detectors. Over 90% of the blanks for the short-term detectors met the criterion of measuring <20 Bq/m^3, while >98% of the long-term detector blanks were below the criterion. Typically, duplicate detectors were deployed in every tenth room of a school. Results for a representative year (Fig. 2) showed a much better correlation of long-term duplicate data (r^2 = 0.98) than observed for the short-term measurements (r^2 = 0.71). Criteria for acceptance required the duplicate results to be within 20 Bq/m^3 for radon concentrations below 148 Bq/m^3, or produce a covariance less than 15% for radon concentrations exceeding 148 Bq/m^3. Overall, about 90% of the duplicate measurements met the studys' criterion.

3. Results and discussion

Over the 21-year period since 1992, the DOH conducted programs for 18 years to measure the radon concentrations in 186

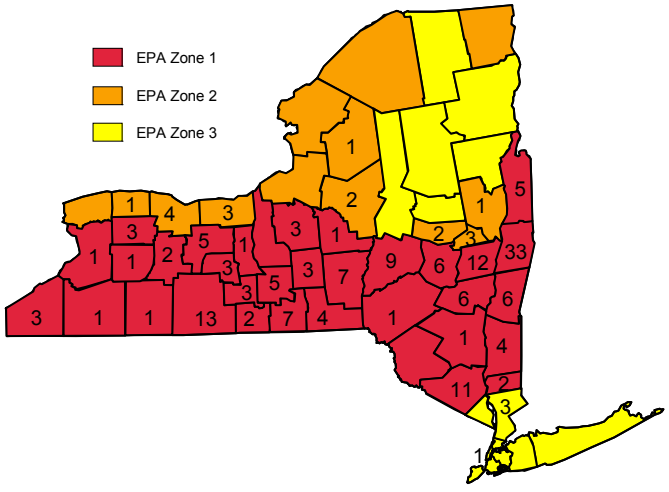

Fig. 1. EPA radon-zone designations for counties in New York and the number of schools measured in each county.

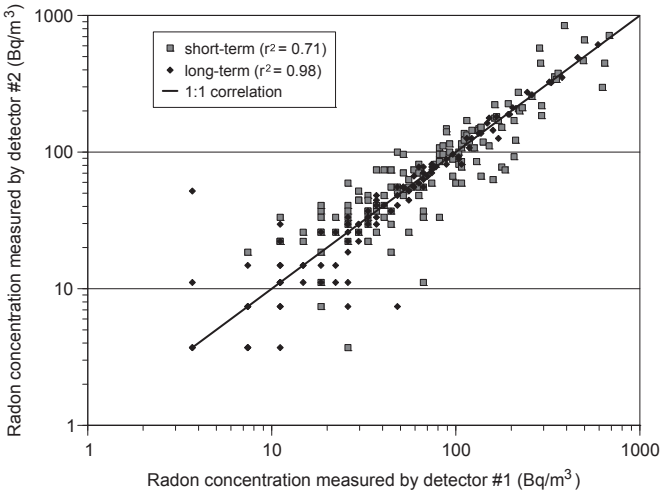

Fig. 2. Comparison of duplicate radon measurements in schools.