THE STATE OF MAINE SCHOOL RADON PROJECT: PROTOCOLS AND PROCEDURES OF THE TESTING PROGRAM

by: Lee Grodzins, Professor of Physics
Massachusetts Institute of Technology
Founder and Chairman of the Board
NITON Corporation, Bedford, MA 01730

Henry E. Warren, Director
Division of Safety & Environmental Services
Bureau of Public Improvement
Augusta, ME 04333

Ethel G. Romm, President
Chief Executive Officer
NITON Corporation
Bedford MA 01730

A comprehensive radon test was done in every public school in the state of Maine by NITON Corporation using its liquid scintillation vials. For each school, NITON made up individual packages containing instruction sheets, test vials, data sheets, and a copy of school floor plans marked with locations for placing the test vials. Every occupied room on or below grade was tested over a week-end under closed-building conditions. Quality control procedures compared NITON vials with independent tests. School personnel set out and retrieved the tests and returned them to the NITON Laboratory using next day UPS service, a procedure that worked for even remote one-room school houses, schools on islands, and in Indian reservations. We will discuss the detailed procedures and close communication that resulted in the successful and reliable testing of some 14,000 rooms; fewer than 200 tests had to be rerun due to faulty procedures or late returns.

INTRODUCTION

A comprehensive radon test was done in every public school in the state of Maine by NITON Corporation using its liquid scintillation vials, with school personnel placing and harvesting the tests.

The type of test chosen (light-weight, short-term charcoal liquid scintillation) and the use of non-professionals greatly reduced the costs of testing and made it possible to follow the best EPA guidelines for testing for radon in schools.

A short-term (week-end) screening test was done in (a) every, (b) frequently occupied (c) room (d) on or below ground level, under closed building conditions. This follows the recommendations of EPA's Interim Report in Radon Measurements In Schools (1). The few rooms over crawl spaces were also done. In addition, Maine uses many trailers for classrooms, some with rather permanent skirts; after the first few dozen showed no radon in their rooms, no further testing was done in trailers.

Tests were placed and retrieved by local school personnel. Using school personnel at each site to do this task so lowered the costs that it became possible for Maine to test every school room in the state within one year. It was necessary only to design, implement, and manage a protocol that would make it possible for non-professionals to do the work reliably. A detailed description of the procedures follows. In general, it follows the outline of another presentation: The Design Study (2).

IMPLEMENTING THE PROTOCOLS

A school poses far fewer problems of judgment in placing radon tests than a home or commercial building. The conditions for which professionals require training and much experience are largely missing in schools. For example, every classroom or school office has a desk, which is exactly the height EPA calls for, 30". Questions about avoiding open sumps, foundation walls, stone fireplaces, and such, never come up. No one is interested in cheating—quite the contrary—so no steps need be taken to prevent or reveal tampering.

The problems of using non-professionals, while onerous, are almost entirely logistical—getting each stage done, and done on time. The protocol removed the technical burden from the test placer by having NITON make all the scientific and technical decisions.

NITON had already had substantial experience in helping public schools to test. Although its products are used almost exclusively by professionals, the company had devised a low-cost system for a number of Massachusetts public school systems. Having very little money, they would not have been able to test if they had needed to use professional testers. The program NITON developed for those Massachusetts schools non-professionals was further refined for Maine.

OPERATIONAL MONITORING

RECEIVING THE PLANS

Roy Nesbitt, Director of School Facilities, sent out a "Form-1" to the superintendent of every Administrative School Unit. It requested a set of ground floor plan sketches plus information: The name of each school in the unit, its principal, and the number of "Ground floor Instruction

Spaces." These forms and plans were sent directly to NITON, where each one was marked up to show where a radon test should be placed. Problems at this stage:

• Many schools did not return their Form-1. New ones were sent with a letter and in many cases, the schools were called by NITON. If they still did not respond, Nesbitt called. In a few cases, no form was ever received and the information was taken over the phone.

• The instructions on the Form had described the rooms to be tested as "Instructional Spaces," although every office, library, gym, etc. on the ground also had to be counted. Some schools figured this out and sent expanded figures. The estimates were rarely accurate, nor were they expected to be. They served to get the schools to think about the radon testing. The count was ultimately determined by NITON from the plans. (Not surprisingly, in the final results, radon had made no distinction between classrooms and offices and high levels were found in both types of areas.)

• When schools sent in Form 1, many did not include plans. They were each called, sometimes more than once. Eventually, some 95% of the plans were received by NITON.

READING THE PLANS

The floor plans of each building were marked to show which rooms required a radon test, and which ones should have the side-by-side QA/QC test, either a Maine 4" canister or a NITON vial, or both. Problems at this stage:

• The usefulness of the plans NITON received varied greatly. Some plans were simple hand sketches that were very clear; others were formally drafted asbestos schematics that were not. When plans were unclear, NITON called the school. A. McGuineas, NITON Vice President, and E. Romm, with many years of experience in construction, found someone knowledgeable about the building and they walked through it over the phone. About 30% of the schools needed to be called.

• A few schools had no plans. The same procedure was followed.

SCHEDULING THE TESTS

Even with professionals, schedules need to be set up and monitored. With non-professionals, schedules had to be more detailed, and people need to be monitored closely and continuously.

In each package of tests to a school (see section below on packaging and shipping of tests) a schedule was included that gave the test placer different date options for testing. This was done both to give a deadline, which tends to focus people, and to assure that NITON did not receive thousands of tests all in one day, which, together with its normal business would have violated its strict QA, which calls for analyzing every test on the day it arrives. (NITON's Standard Deviation (σ) at 4 pCi/L is less than 5%, twice as good as required by the EPA.)

The easy-to-follow instructions called for setting out tests on Friday afternoon and harvesting them early Monday morning, shipping them immediately UPS 2nd Day. More than 98.5% of the schools finally followed instructions to the letter. There were, however, difficulties. Problems at this stage:

• Package did not get to the proper person, although addressed properly. When followed up by phone, the packages were all found and tests proceeded.

• Contact person or test placer ignored the dates and never started the tests. When followed up by phone, new schedule dates were given and tests were done.

MANAGING NON-PROFESSIONALS

SCHOOL-SPECIFIC PACKAGING OF TESTS

School-specific packages were assembled. This was possible because NITON liquid scintillation vials are small and light, weighing but 3-1/4 pounds per 100 (in contrast to 4" canisters that, depending on the numbers of small boxes used, weigh from 40 to 60 pounds per 100 and cannot easily be bagged.)

Each building's detectors and supplies were packed separately in bag(s) labelled with the name of the school. Inside each bag were the marked-up floor plan of the school, the number of vials required, and specially written instruction, data and radon information sheets. Extra NITON vials and Maine 4" charcoal canisters were added where required for QA/QC.

In addition, there were bright, easy-to-spot NITON place mats that say, "Radon test is in progress," on which to set the tests. Assembling and checking these school-specific packages was labor-intensive, but was critical to the success of the program.

TESTING

Maine schools were tested from late Friday afternoon to early Monday morning. This time period assures that outside windows are closed and all doors are closed most of the time. Moreover, no overtime is required of school custodians, and no special arrangements need to be made for access to the building. (NITON detectors are calibrated from 24 hours to 72 hours for screening.)

There were surprisingly few problems at this stage, due to two factors:

1. School-specific packs and clear instructions. Every school was packaged individually and everything was spelled out. While it is true that if anything can go wrong, it will, there was not much that could go wrong. The stages of the testing were carefully described, limited, and monitored.

2. An 800 number. Prominently listed on the instruction sheet was the NITON 800 number. It is company policy to spend time with callers no matter what their questions are. Maine people were not shy about calling. When they had doubts, they called, and things went more smoothly because of it. Problems at this stage:

• The largest number of calls came in to ask questions about doing the QC tests. They were particularly complicated to do because the test retriever had to mail the 4" canister to an address different from the NITON vials. All labels and return boxes were provided, and NITON rewrote instructions many times, but the concept was evidently difficult. Because, however, there was such close personal contact, the work was very well done and the results gratifying (3).

• Handwriting on data forms was sometimes nearly undecipherable, but this is not unique to Maine folk. There seems to be no remedy.

• Occasionally, parts of the data form were unfilled. A follow-up call answered most questions.

• The question sometimes unanswered was in connection with the heating and ventilating systems. Protocol called for them to be on continuous cycle, to replicate as closely as possible occupied conditions. Schools with facilities managers or custodians answered these questions. Smaller ones were sometimes at a loss: They could not find the controls, they did not how to change the cycles, they changed them and weren't sure they were right.

In the winter, if the protocol was not followed, a system on a set-back cycle in Maine is likely to give a too-high reading, since the radon builds up without ventilation of any kind. That is, the screening test is likely to give a false high. In the summer, the systems are shut off, and their influence cannot be discovered. In comparison testing of identical Massachusetts school rooms in winter and summer, NITON found slightly higher readings in the summer (4).

Two schools goofed. Of 186 tests that had to be redone, 126 were from one school who exposed vials for six days instead of a week-end (then promptly returned them to the lab). The other 60 null tests were from a second school.

DATA REPORTING

QUALITY ASSURANCE/QUALITY CONTROL

To test the tests, two procedures were used. Side-by-side NITON vials were set out in some 150 designated rooms. In addition, (50) 4" charcoal canisters (75 gr) were supplied by the State of Maine and analyzed in the Maine Radon Laboratory. Some 30 NITON vials were checked with an electronic monitor. Preliminary analysis shows the degree of agreement was extremely satisfactory (3).

The NITON QA/QC protocol was in force at all times: All tests are analyzed the day they are received. At 4 pCi/L, the Standard Deviation (σ) is less than 5%; at 1 pCi/L, SD (σ) is 10%. All first round tests showing more than 3 pCi/L are recounted—Standard Deviation (σ) = 2% at 3 pCi/L.

USING DATA TO DETERMINE ROOMS TO RETEST AND/OR MITIGATE

Some areas of Maine were known to have high radon. When the first high readings in those area schools showed up, the EPA was called in and mitigation begun.

The decision was made to retest every room over 3 pCi/L, the placement and retrieval to be done by Maine officials. A cost-effective way to do this is to use the NITON vial to ascertain day and night readings. The NITON vial is calibrated to 8 hours for this purpose, and is extremely sensitive as well as accurate at low levels, since the liquid scintillation counter counts 100% of 5 decaying particles. Thus, a reading may be taken during the school day, when the building is occupied, and another in the same room at night when the systems are set back. Preliminary data corroborate the screening tests.

REPORTING THE DATA TO THE STATE OF MAINE

Results were sent to Warren within two business days of the arrival of the tests at the lab. Results greater than 3 pCi/L were highlighted. All graphs and tables produced by NITON will be sent upon completion of the work. In addition, NITON is making available the original laboratory data on discs for further analysis.

PUBLIC RELATIONS

The wise decision was made to tell the public of results as they were learned. When well framed, even high readings can be disclosed without alarming the public. The wisdom of this policy was demonstrated in the towns around Sebago Lake. Where in several schools the radon was in excess of occupational levels in uranium mines, yet there was no hue and cry to close the schools, as there has been in areas where high results are kept secret for too long.

ACKNOWLEDGEMENTS

E.R. wishes to acknowledge the cheerful, problem-solving, unflappable assistance of Christopher Collins, Vicki Grzybinski, Lori Tamaro, and Anne McGuineas, all of NITON Corporation, in converting ideas into the actual carrying out of the protocols and procedures of the Maine program.

The work described in this paper was not funded by the U.S. Environmental Protection Agency and therefore the contents do not necessarily reflect the views of the Agency and no official endorsement should be inferred.

REFERENCES

1. EPA Radon Measurements in Schools: An Interim Report. U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC. EPA 520/1-89-010. Sect. VI.D.1.

2. Warren, H.E. and Romm E.G. The State of Maine School Radon Project: The Design Study. EPA 1991 International Symposium on Radon and Radon Reduction Technology, Philadelphia, PA. April 2-5, 1991.

3. Grodzins, L., Bradstreet, T., Moreau, E. The State of Maine School Radon Project: Results. EPA 1991 International Symposium on Radon and Radon Reduction Technology, Philadelphia, PA. April 2-5, 1991.

4. Grodzins, L. Radon in Schools in Massachusetts. EPA 1990 International Symposium on Radon and Radon Reduction Technology, Atlanta, GA. February 19-23, 1990.