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EPA

Project Summary

Summary of EPA's Radon Reduction Research in Schools During 1989-90

Kelly W. Leovic

This report details EPA's radon mitigation research in schools during 1989 and part of 1990. The major objective was to evaluate the potential of active subslab depressurization (ASD) in various geologic and climatic regions. The different geographic regions also presented a variety of construction types and heating, ventilating, and air-conditioning (HVAC) system designs that are encountered in radon mitigation of school buildings. A secondary objective was to initiate research in difficult-to-mitigate schools. Depending on the school, various levels of diagnostics and mitigation were performed in the schools discussed in the report.

In the Maryland, New York, and two of the Tennessee schools, the mitigation systems were generally installed by the joint efforts of the EPA Contractor, EPA personnel, and school personnel following diagnostics and mitigation system design by EPA and/or its contractor. In the Alabama schools and in four of the Tennessee schools, recommended mitigation system designs were provided to the schools for installation by school personnel. This report is organized into sections by state, and each of the 13 schools is discussed separately.

This research led to the following major conclusions on radon diagnostics and mitigation in schools: (1) Schools have many physical characteristics that typically make their mitigation more complex than house mitigation. These characteristics—which can influence radon levels in the building since they affect radon entry routes, building pressure differentials, and radon mitigation approach—include building size and substructure, subslab barriers, HVAC systems, and locations of utility lines. (2) Important school diagnostic procedures and measurements include review of radon measurements and building plans, investigation of the building to assess potential radon entry routes and confirm information in the building plans, analysis of the HVAC system and its influence on pressure differentials and radon levels, and measurement of subslab pressure field extension to determine the potential applicability of ASD. (3) ASD can be applied successfully in schools where the slab is underlain with a clean coarse layer of aggregate if subslab communication barriers are limited. (4) If all block walls surrounding the classrooms extend to footings that create subslab barriers, a minimum of one ASD point for every two rooms will probably be necessary. ccccpIf the walls between rooms are thickened slab footings, rather than below-grade walls, ASD from one point will extend under the thickened slab if aggregate is continuous. (5) ASD systems in schools typically require greater fan capacities and suction pipe diameters than those in houses.

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 U.S. EPA initially became involved with the radon problem in schools by assisting three counties in Maryland and Virginia in reducing elevated levels of radon in 1988. Active subslab depressurization (ASD)—a technique which had been demonstrated successfully in existing houses—was modified and installed in these schools. Where design permitted, heating, ventilating, and air-conditioning (HVAC) systems were also used to pressurize some of the school buildings to control radon levels prior to installing the ASD system. These initial efforts are detailed as case studies in an earlier document.

In 1989 and early 1990, EPA's Radon Reduction Research/Development/Demonstration Program in schools was expanded to include projects in Alabama, New York, and Tennessee, and research in some of the Maryland schools continued. The major objective of this research was to apply ASD in varied geologic and climatic regions. The different geographic regions also presented a range of construction types and HVAC system designs. A secondary objective was to initiate research efforts in difficult-to-mitigate schools. Three schools that had been identified in the initial research efforts in Maryland in 1988 were selected for additional research. Characteristics addressed included schools with very poor subslab communication (limiting the application of ASD), schools with return-air ductwork located under the slab, schools with utility tunnels, and schools constructed over crawl spaces.

Three schools in Alabama, three in Maryland, one in New York, and six in Tennessee were selected for these research projects. Depending on the objectives of the project, various levels of diagnostics and mitigation were performed in the different schools. In the Maryland, New York, and two Tennessee schools, the mitigation systems were generally installed by the joint efforts of the EPA Contractor, EPA personnel, and school personnel following diagnostics and mitigation system design by EPA personnel and/or their contractor. In the Alabama schools and in four of the Tennessee schools, mitigation system designs were provided to the schools based on diagnostic measurements. System installation was up to the school personnel.

The diagnostics and mitigation for each of the 13 schools are discussed separately and organized into sections by state. As applicable, discussion of each school is organized into 13 sub-sections: (1) Background Information, (2) Building Description, (3) Pre-Mitigation Radon Measurements, (4) Building Investigation, (5) HVAC System, (6) Diagnostic Measurements, (7) Mitigation Strategy, (8) ASD System Details, (9) Results of Initial Mitigation System, (10) Additional Phases of Diagnostics/Mitigation, (11) Final Radon Levels, (12) Estimated Cost, and (13) Summary. The state and general location of each school are provided in the report.

Diagnostic Measurement Techniques

School buildings have a number of physical characteristics that make them different, and typically more complex, than residential houses. These characteristics include building size, substructure, subslab barriers, HVAC system design and operation, and locations of utility lines. These physical characteristics can influence radon levels in the building since they affect radon entry routes, building pressure differentials, and radon mitigation approach.

The radon diagnostic procedures and measurements for the schools discussed in this report generally included: a review of all radon screening and confirmatory measurements; a review of all available building plans and specifications including structural, mechanical, and electrical; a thorough building investigation to assess potential radon entry routes and to confirm and to supplement information cited in the building plans; an analysis of the HVAC system design and operation and its influence on pressure differentials and radon levels; measurement of subslab radon levels; and measurement of subslab Pressure Field Extension (PFE) to assess the potential for ASD. Depending on the objectives of each project, varying levels of diagnostics were performed in the schools discussed.

Summary and Conclusions

The radon diagnostics and mitigation conducted in 13 schools, in Alabama, Maryland, New York, and Tennessee, led to the following conclusions on radon diagnostics and mitigation in schools: (1) School buildings have a number of physical characteristics that make their mitigation different, and typically more complex, than houses. These characteristics include: building size and substructure, subslab barriers, HVAC systems, and locations of utility lines. These physical characteristics can influence radon levels in the building since they affect radon entry routes, building pressure differentials, and radon mitigation approach. (2) Radon measurements in schools can vary dramatically over time (seasonally and diurnally), and this variation must be considered when conducting radon diagnostics and designing mitigation systems. (3) Radon mitigation research in schools has shown that the following diagnostics procedures and measurements are important in understanding a school's radon problem and potential solution: review of radon measurements; review of building plans including structural, mechanical, plumbing, and electrical; investigation of the school building to assess potential radon entry routes and confirm information cited in the building plans; analysis of the HVAC system and its influence on pressure differentials and radon levels; and performance of subslab PFE measurements. (4) ASD can be applied successfully in schools where the slab is underlain with a clean coarse layer of aggregate of narrow particle size range as long as subslab barriers to communication are limited. (5) ASD in schools typically requires greater fan capacities and suction pipe diameters than does ASD in houses. The capacities of the fans used (or recommended) in these schools were typically around 310 cfm (at 0.75 in. WC)* compared to capacities of about 150 cfm (at 0.75 in. WC) for fans commonly installed in house ASD systems. In schools where the slab was underlain with at least a 4 in. layer of clean, coarse aggregate enhancing subslab air flow, fan capacities of about 470 cfm (at 0.75 in. WC) were often installed. Suction pipe diameters used (or recommended) in these ASD systems were typically 4 in. or greater, compared to 4 in. or less in typical house ASD systems. (6) If all block walls surrounding the classrooms extend to footings that create subslab barriers (or compartments), it is necessary to have one ASD point for every two rooms and, in many cases, one point for each room. If the walls between rooms are set on thickened slab footings rather than on below-grade walls, ASD from one point will extend under the thickened slab especially if the aggregate is continuous underneath. PFE measurements will provide essential data on the nature and extent of subslab barriers and implications for ASD system design. (7) In general, the correlation between classroom radon concentrations and subslab radon "sniffs" was not particularly good. (8) Most of the schools studied so far include slab-on-grade substructures, although portions of some of the schools had basements and/or crawl spaces. (9) HVAC systems in the schools studied so far include unit ventilators, fan coil units, radiant heat, and central-air handling systems. Many of the schools are not designed to deliver conditioned outdoor air to the occupied space. As a result, radon

* For readers more familiar with metric units: 1 cfm = 0.00047 m^3/s; 1.0 in. WC = 248.8 Pa; and 1 in. = 2.54 cm.

control using the existing HVAC system was often not a mitigation option. Increasing the outdoor air supply in schools could reduce the driving force for radon entry.

(10)The utility lines of many slab-on-grade schools are in subslab utility tunnels. It may be possible to reduce radon levels by depressurizing these tunnels; however, many of them contain asbestos, limiting the feasibility of this approach.

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__Kelly W. Leovic__ (also the EPA Project Officer, see below) is with Air and Energy Engineering Research Laboratory, Research Triangle Park, NC 27711.

The complete report, entitled "Summary of EPA's Radon Reduction Research in Schools During 1989-90," (Order No. PB91-102 038/AS; Cost: $39.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Air and Energy Engineering Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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