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Project Summary

Case Studies of Radon Reduction Research in 13 School Buildings

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This report details 13 case studies covering radon mitigation research in school buildings from 1990 to 1992. The 13 schools are in Colorado, Maine, Minnesota, Ohio, South Dakota, Tennessee, and Washington state. Diagnostics were carried out in all of these schools, and suggested mitigation plans were developed for each based on the diagnostic measurements. Mitigation systems were installed in 5 of the 13 schools as part of the research project.

The major objective of these research projects was to better understand the conditions under which heating, ventilating, and air-conditioning (HVAC) systems in existing school buildings could be used for effective radon reduction. Criteria used to evaluate system effectiveness included: radon reduction; long-term reliability of operation; installation, maintenance, and operating costs; and impact on the indoor air quality in the school. An additional objective, studied in three of the schools, was to compare the effectiveness of HVAC system control of radon with active subslab depressurization control in the same building.

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 purpose of the Environmental Protection Agency's (EPA's) Air and Energy Engineering Research Laboratory's (AEERL's) school radon research program is to develop and demonstrate low-cost radon mitigation options for existing and new schools and other large buildings. These mitigation options must address the unique features of these structures (i.e., large size, different types of heating, ventilating, and air-conditioning (HVAC) systems, and varying occupancy patterns) because these features can affect radon entry routes and building pressure differentials.

Since 1988 AEERL's Radon Mitigation Branch has conducted radon mitigation research in 50 school buildings in 13 states. Initially, AEERL's radon mitigation research in schools focussed on active subslab depressurization (ASD), the most successful radon control technique in residential houses. Because of complicated subslab structures and subslab fill material that sometimes make ASD systems expensive to install in large buildings, and because of indoor air quality concerns, AEERL has concentrated part of its recent research efforts in schools on the use of HVAC systems for radon reduction. Using the HVAC system to control radon can be beneficial in schools where

ASD is not applicable, and can also be used as a supplemental radon reduction technique in schools where ASD systems are installed to further reduce radon levels. In addition, the HVAC system can also provide improved indoor air quality in addition to radon reduction through the introduction of additional outdoor air.

This report details case studies of radon mitigation research in 13 school buildings. The research was conducted by AEERL's Radon Mitigation Branch from 1990 to 1992. The 13 schools are in Colorado (two), Maine (two), Minnesota (one), Ohio (four), South Dakota (one), Tennessee (one), and Washington state (two). The schools were selected based on a number of parameters including radon levels, type of HVAC system, building substructure type, and location. Measurements to diagnose the radon problem were made in all of these schools, and suggested mitigation plans were developed based on the diagnostic measurements. Mitigation systems were then installed in 5 of the 13 schools as part of the research. In addition, continuous dataloggers were installed in a number of the schools to monitor several parameters simultaneously.

Objectives

The major objective of this research was to better understand the conditions under which HVAC systems in existing school buildings can be used for effective radon reduction. Use of the HVAC system as a radon control technique depends on the specific building, but in general, it may be considered in any school that has a HVAC system that supplies outdoor air. However, restrictions on the use of the existing HVAC system may apply where the HVAC system does not consistently supply outdoor air during all seasons, and radon control/indoor air quality concerns in the school system are overridden by energy cost concerns. The criteria used to evaluate the HVAC system's effectiveness for radon control included: degree of radon reduction; long-term reliability of operation; installation, maintenance, and operating costs; and impact on the indoor air quality in the school.

An additional objective, studied in three of the schools, was to compare the effectiveness of HVAC system control of radon with ASD control in the same building. The objective was addressed because school facility managers may sometimes be faced with a decision to use either ASD, HVAC control, or a combination of the two techniques for radon reduction.

This report also presents results from the first wide scale use of continuous dataloggers to study the interactions of various radon mitigation systems with school operation and use. Dataloggers were installed in seven of these research schools to continuously monitor relevant parameters including: radon concentration, differential pressure, differential temperature, percent open of outdoor air damper, operation of exhaust fans, opening and closing of doors in the building, and carbon dioxide levels.

Radon Diagnostic Measurements

The radon diagnostic procedures used in the schools discussed in this report include: 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 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; and measurements of pressure field extension (PFE) to assess the potential of an ASD system. Depending on the objectives of each project, varying levels of diagnostics were performed in the 13 schools discussed in this report.

Conclusions

Several conclusions can be drawn from the radon mitigation research in schools conducted in the case studies discussed in this report:

- If PFE measurements indicate that an ASD system will be effective, this would be the preferred system for consistent, trouble-free, and economical radon control.
- If in addition, improvement in indoor air quality or further radon reduction is desired, the amount of outdoor air supplied through the HVAC system should be increased. Increasing the amount of outdoor air will help to approach the long-term national goal of ambient radon levels in buildings established in the 1988 Indoor Radon Abatement Act.
- Some existing central HVAC systems are not designed to supply conditioned outdoor air and hence are not suitable for use as year-round radon mitigation systems because of energy cost and/or comfort concerns.
- Since it appears that unit ventilators (UVs) reduce radon levels more by dilution than by preventing radon entry, their successful use as mitigation systems is generally restricted to buildings with initial levels in the 4 to 10 pCi/L of air range.
- For schools constructed over crawl spaces with exposed soil, the most successful mitigation system is a variation of ASD—submembrane depressurization—which depressurizes the area under a plastic membrane covering the soil. Crawl space depressurization was also effective in reducing radon levels in the building; however, this technique increased radon levels in the crawl space.
- Where central HVAC or UV systems are used for radon mitigation, careful attention must be given to the operation of these units in setback mode at night and over the weekend. They must be turned on early enough to lower the radon levels before the building is occupied. In some of the research schools, HVAC system start-up at 7 am did not reduce the radon levels to below 4 pCi/L limits until after 12 noon.
- Carbon dioxide levels (an indicator of indoor air quality) were well above the American Society of Heating, Refrigeration, and Air Conditioning Engineer's (ASHRAE's) guidelines of 1000ppm in most of the schools where levels were measured. Typical carbon dioxide levels during school occupancy averaged from 1000 ppm to 1700 ppm.

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The complete report, entitled "Case Studies of Radon Reduction Research in 13 School Buildings," (Order No. PB94-130010/AS; Cost: $36.50; subject to change) will be available only from:

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