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Office of Research and Development
Air and Energy Engineering Research Laboratory
Research Triangle Park, NC 27711
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EPA

Radon Mitigation Research Update

Introduction

The *Radon Mitigation Research Update* is a series of research summaries intended to provide information on EPA's Air and Energy Engineering Research Laboratory (AEERL) radon mitigation research programs. This update is the third of the series and summarizes recently completed or ongoing Radon Mitigation Branch (RMB) research activities focused on achieving AEERL's stated radon mitigation research objectives. Research projects summarized in this update are listed in the table of contents below.

Radon Mitigation Research Updates published in December 1990 and March 1991 provide summaries of AEERL's radon mitigation research objectives and the RMB's strategic research plan for meeting these objectives. Copies of these earlier *Updates* may be requested by writing RMB Research Updates at the address below.

AEERL plans to publish subsequent updates approximately two times a year. If you would like more information about specific research activities or programs, you may contact the appropriate RMB project officer at MD-54, U.S. EPA, AEERL, Research Triangle Park, NC 27711, or at the number listed below.

Radon Mitigation Research Contacts

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- Mechanisms of radon entry

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- Innovative and supporting research
- Radon reduction in attached housing

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Project Highlights

RMB project highlights are summaries of completed or ongoing research projects intended to provide the radon mitigation industry with timely and useful information. This information may be based on regional or preliminary findings and should be viewed as such. As research programs progress, RMB will publish details of its findings as technical reports, manuals, and papers.

Radon Prevention in the Design and Construction of Large Buildings

Based on research results over the past 3 years, RMB has begun incorporating radon control measures into the design and construction of new schools and other large buildings. The goal of the designs is twofold: (1) to prevent elevated radon levels in the completed building, and (2) to provide this protection at a fraction of the cost of retrofit systems. A case study of one such installation is discussed below, and a summary of the recommended radon prevention steps

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Case Study of Radon Prevention in Tennessee Hospital

A single-point active soil depressurization (ASD) system has successfully depressurized under a 60,000 square foot (5580 square meter) slab in a new Tennessee hospital for less than $0.10 per square foot (or about $1.00 per square meter). In fact, the results indicate that the system, as designed, would be able to depressurize a much larger space. The incremental cost for the ASD system compares favorably with a sample from eight northeast U. S. schools where radon prevention systems were installed during construction. In this sample, estimated installation costs ranged from about $0.30 to $1.00 per square foot (about $3.00 to $11.00 per square meter). (Refer to Update of RMB Publications on page 7, "Cost and Effectiveness of Radon Resistant Features in New School Buildings.")

The hospital was constructed in a radon-prone area where the soil is highly impermeable. The building is post and beam construction, with no subslab barriers to communication. The slab was poured over a vapor barrier that was underlain with a continuous 4 inch (10 centimeter) layer of crushed aggregate. The slab, exterior walls, and footings were poured monolithically, and no expansion joints were used. This resulted in a relatively "tight" area between the soil and the slab.

After RMB review of the building plans, the following recommendations were made to the architect for radon prevention purposes: 1) good compaction of the clay layer under the aggregate, 2) minimum of 4 inches (10 centimeters) of crushed aggregate (ASTM #5) carefully placed so as not to include any fine-grained soil, 3) sealing of all control saw and pour joints and slab penetrations with polyurethane caulking, 4) installation of a centrally located ASD system with a suction pit, 6 inch (15 centimeter) diameter piping, and a suction fan rated at 300 cubic feet per minute, cfm (141 liters per second, L/s) at 1 inch water column, WC (248 pascals), and 5) continuous operation of the heating, ventilating, and air-conditioning (HVAC) fans to pressurize the building.

The incremental costs of these additional features were covered by four change orders, and the total capital cost was $5,300. These costs included installation of the suction pit and radon vent pipe to the roof, sealing (as specified above), and installation of the suction fan and failure-warning system. The aggregate was already specified in the plans, and the HVAC system was intended to operate continuously because of the hospital occupancy patterns.

Radon measurements were first made with both the ASD and HVAC systems off, and radon levels as high as 50 pCi/L were measured. The measurements were then repeated with the ASD system fan off and the HVAC system on: the highest level measured was 16 pCi/L. This indicates that, because of the radon source strength (measured to be about 1800 pCi/L under the slab), continuous operation of the HVAC system (which includes exhaust fans) did not reduce radon levels below the current EPA guideline of 4 pCi/L. The final set of measurements was made with both the ASD and HVAC systems operating: all 30 rooms measured were below 0.5 pCi/L.

Pressure field extension measurements showed a negative pressure of 0.45 inch WC (112 pascals) in the suction pit and 0.18 inch WC (45 pascals) at the farthest corner of the building—185 feet (56 meters) away. Extrapolation of these data suggests that properly designed and installed single point ASD systems can effectively control radon levels in buildings with much larger footprints.

A more detailed description of these research findings is found in the paper listed in the Update of RMB Publications on page 7, "Design of New Schools and Other Large Buildings Which Are Radon Resistant and Easy To Mitigate."

Summary of Recommended Radon Prevention Features

RMB research to date has shown the following features to be most important in cost effective radon prevention in the construction of schools and other large buildings:

1) **Subslab Aggregate**—A 4- to 6-inch (10- to 15-centimeter) layer of clean, coarse aggregate (ASTM #5 is preferred) should be evenly placed under the slab with care taken not to include any soil.
2) **Barriers to Subslab Communication**—Internal barriers to subslab communication—such as subslab walls—should be avoided. If subslab walls must be used, they should be minimized and openings through them to all slab areas should be included.
3) **Suction Pit and Radon Vent Pipe**—The radon vent pipe should extend beneath the slab into a suction pit that is open to the aggregate. The suction pit should have an exposed aggregate surface area of 5 to 7 square feet (about 0.5 to 0.7 square meter). Six inch diameter polyvinyl chloride (PVC) vent pipes are typically used.
4) **Major Radon Entry Routes**—Sealing of major radon entry routes during construction (such as utility penetrations and expansion joints) will help to increase ASD effectiveness.
5) **Suction Fan**—If elevated levels of radon are measured in the building, a suction fan should be attached to the radon vent pipe outside the building. Typical fans used in these installations are rated at about 400 cfm (188 L/s) at 1 inch WC (248 pascals).
6) **HVAC System**—The HVAC system should be designed and operated in accordance with ASHRAE Standard 62-1989, "Ventilation for Acceptable Indoor Air Quality." Proper operation of the HVAC system will help to reduce radon levels and maintain indoor air quality through both pressurization and dilution.

Note: Applications of the radon prevention techniques above are currently being studied in other buildings in the U.S. RMB is searching for additional schools and other large buildings where the effectiveness of these features can be further evaluated. For more information on the application of these features in large footprint buildings being constructed in radon-prone areas, please contact A.B. Craig.

Active Soil Depressurization Cost Analysis

Cost analyses of active soil depressurization (ASD) systems suggest that low-cost mitigation technology other than ASD will be required if lung cancer deaths due to radon are to be reduced by more than about 14 to 22%.

An in-house parametric cost analysis has been completed to determine the importance of various system design and operating variables on the installation and operating cost of ASD systems in houses. The analysis found a potential ASD installation savings several times larger than the potential operations savings, indicating that innovative design research should be given a higher priority.

The analysis indicated that various modifications to ASD system designs offer potential for reducing installation cost by up to several hundred dollars but would not reduce total installed cost much below $800 to $1000. Reductions of this magnitude would probably not be sufficient to dramatically increase voluntary use of ASD technology in houses with premitigation levels below 4 pCi/L.

See ***Analysis***, p. 3.

Analysis, continued from p. 2

Since the only way to reduce annual lung cancer deaths due to radon by more than about 14 to 22% is to motivate people with houses at or below 4 pCi/L to mitigate, some innovative and inexpensive mitigation approach other than ASD would appear to be necessary.

Innovative and Supporting Research

AEERL's Strategic Research Plan places increased emphasis on Innovative and Supporting Research (ISR) projects directed at accelerating improvements in mitigation technologies, lowering the cost of these technologies, and facilitating their delivery to larger and broader audiences. ISR projects/ concepts developed through bench or pilot scale efforts which show promise will ultimately be demonstrated in research buildings and the findings incorporated into technical guidance documents.

AEERL's ISR Work Group (headed by David Sanchez and staffed by Bruce Harris, Tim Dyess, Ron Mosley, John Ruppersberger, and Marc Menetrez) has identified and selected several projects for work plan development and peer review. The projects to be conducted by RMB personnel include:

Bench-Scale Task Area Projects:

Testing of concrete for diffusive and convective radon transport—The objectives of this study are to provide an initial analysis of the permeability and the diffusivity of typical Florida concrete and to relate these measured parameters to the physical properties of the concrete. Tests will be conducted by exposing various concretes to both pressurized and static radon environments and measuring radon transport through the materials. Parameters to be evaluated include cement/ water ratios, types and amounts of sand, cement, and aggregate used, and how the concrete is mixed, poured, and finished.

Testing and evaluation of radon transport blocking substrates—This project is designed to evaluate and recommend one or more subslab barrier materials which would limit soil radon transport when used in innovative building foundation preparations. The materials to be tested for radon retardation potential include numerous zeolites, Indian red pottery clay, bentonite clay, synthetic silica, and barium sulfate. Each material will be exposed in radon test chambers and its radon blocking capability and adsorption coefficient evaluated.

Testing and development of performance curves for small fans—Many fans installed in radon mitigation systems are being required to operate beyond the manufacturer's recommended range. This research effort will evaluate the durability of a number of typically used small fans and develop performance curves for each. A test procedure has been established to measure the stator temperature (a common cause of motor winding failure is overheating) as a function of static head against the fan. The data obtained will be used to establish maximum operational head settings for each fan.

Testing of atmospheric radon monitoring equipment—Atmospheric levels of radon are typically less than 1 pCi/L. However, atmospheric levels can be higher and may need to be evaluated as part of a radon mitigation strategy. Phase one of this project will include identifying, calibrating, and bench testing a field monitoring device which is capable of reliably measuring radon levels as low as 0.1 pCi/L. Phase two will include constructing an in-house test chamber and protocols for evaluating this and other EPA owned atmospheric monitoring devices.

Pilot-Scale Task Area Projects:

Radon transport and entry studies—The long term objective of this project is to acquire fundamental knowledge of radon transport and entry through pilot scale studies. A pilot test unit will be designed and constructed this year. Data resulting from subsequent studies of radon transport through soils and entry into building substructures will be used to construct new and/or validate existing radon transport and entry models.

Florida Radon Research Program—The FRRP is a joint effort between the Florida Department of Community Affairs and AEERL, where AEERL consults and assists in managing ongoing state-supported research projects. The second year of the FRRP began March 15, 1991, and covers radon research in the following areas:

- Development of a geological and lithological data base and correlations of such data with indoor radon for use in radon potential mapping algorithms.
- Completion of an 80-house short-term and long-term indoor radon monitoring study and development of statistical correlations of short-term (24 hours) to long-term (up to 1 year) indoor measurements for selected monitoring devices.
- Provision of laboratory analyses and the construction of a data base of (a) the soil properties affecting the strength and radon availability of soils, and (b) the radiometric and radon transport properties of concrete and its aggregates.
- Development of integrated research house studies in three distinct geographic (Florida) regions for the purpose of (a) developing and validating radon control techniques and construction practices to (1) limit radon emanation, transport, and availability at building sites, (2) provide enhanced substructure radon barriers, (3) provide guidance for the design and operation of residential central forced air heating and cooling systems, and (4) provide guidance on superstructure infiltration effects on radon entry, and (b) developing an integrated model and algorithm of the house system for evaluation of the interactive effects of (1) through (4) above on radon entry and accumulation in residences.

Full-Scale Task Area Projects:

Determining the effects of the vertical distribution of building shell openings on soil gas driving forces—The objective of this project is to determine the effect of leaks in building envelopes on floor/slab level pressures under given stack effect conditions. Research will be carried out largely by EPA personnel in an existing FRRP test house constructed on radium-rich soils in Bartow, Florida. Data will be collected for both heating and cooling situations and will be used to construct new and/or validate existing house dynamics models.

Modeling of interior house dynamics—The long-term objective of this project is to develop and verify a simplified physical model to predict radon concentrations in residences. The model will be based on measurable/ estimatable parameters and is ultimately intended to cover crawl space, slab-on-grade, and basement houses.

Model variables will include convective soil-gas entry, diffusion from soils and materials, air infiltration, natural ventilation, and mechanical system dynamics.

Radon Mitigation Research in Schools

RMB has conducted radon mitigation research in 47 schools in 12 states since 1988. Initial research focused on the application of ASD techniques. More recent research has been directed at the ability and limitations of using school HVAC systems to reduce radon levels. A goal of future projects is to compare the effectiveness of the two techniques in the same buildings.

School Structures and Subslab Pressure Field Extension

Most of the 47 schools studied have slab-on-grade substructures (91%), although some basement (19%) and crawl space (15%) substructures have been studied. (Note that this distribution includes combination substructures; for example, a school with both a basement and slab-on-grade substructure would count as both.)

A rough analysis of pressure field extension (PFE) data collected in 72% of the 47 buildings shows an average PFE radius of about 40 feet (12.5 meters). This implies an average coverage of slightly more than 5000 square feet (490 square meters) per suction point and roughly equates to the area of seven 25-by-30-foot (8-by-9-meter) classrooms. However, in addition to subslab permeability's being a determinant of PFE, it appears that subslab walls are also an important limiting factor in PFE in a number of these schools. This is important both in the mitigation of existing schools and in the design of new buildings.

HVAC Systems and Indoor Air Quality

The types of HVAC systems found in the 47 RMB research schools are relatively evenly distributed: 45% of the schools have central air handling systems; 43% have unit ventilators; 30% have radiant heat; and 11% have fan coil units. (Note that this distribution includes schools with combination HVAC systems; for example, a school that has both unit ventilators and radiant heat would count as both.) Of the schools, 17% have only radiant heat (11%) or only fan coil units (6%), indicating that the other 83% have been designed to provide conditioned outdoor air. In practice, however, most of these 83% are not designed or operated to supply at least 15 cfm (7 L/s) of outdoor air to each occupant as recommended by current ASHRAE guidelines.

To illustrate the ventilation in a sample of schools, Figure 1 presents the average carbon dioxide measurements made in 67 rooms in seven schools. All seven schools use typical unit ventilators (UV in figure) for HVAC. As seen in the figure, the average carbon dioxide levels in all 67 classrooms is 1423 ppm. As would be expected, the average carbon dioxide level in the 32 classrooms where the unit ventilators were operating was lower than in the 35 classrooms where there was no unit ventilator or where it was off, measuring 1118 and 1702 ppm, respectively.

It is interesting to note that the average carbon dioxide levels in the 32 classrooms where the unit ventilators were operating still exceeded the ASHRAE guideline of 1000 ppm. This is not surprising since the average carbon dioxide level in the unit ventilator air supply in these 32 rooms is 933 ppm. These results are typical of those found in many of the research schools, indicating that unit ventilator outdoor air dampers are often closed, only bringing in minimum outdoor air through leakage.

Current School Research Projects

AEERL currently has research projects in existing schools in Kentucky, Maine, Ohio, and South Dakota, and projects were recently completed in Colorado, Maryland, Virginia, and Washington State. In addition to evaluating the regional applicability of ASD by measuring PFE, these projects are typically designed to collect continuous data on the effects of HVAC system operation on radon levels to determine the conditions under which HVAC systems can be used to control radon levels. Data loggers are installed in selected schools to continuously monitor parameters such as radon, differential pressure, HVAC system operation (e.g., amount of outdoor air supplied), opening/closing of classroom-to-corridor doors, and weather. Initial results indicate that HVAC system control of radon levels is school (and sometimes room) specific.

The following subsections briefly discuss some results from a sample of RMB school research projects. The details of these projects, along with other RMB school research projects, will eventually be included in an EPA report.

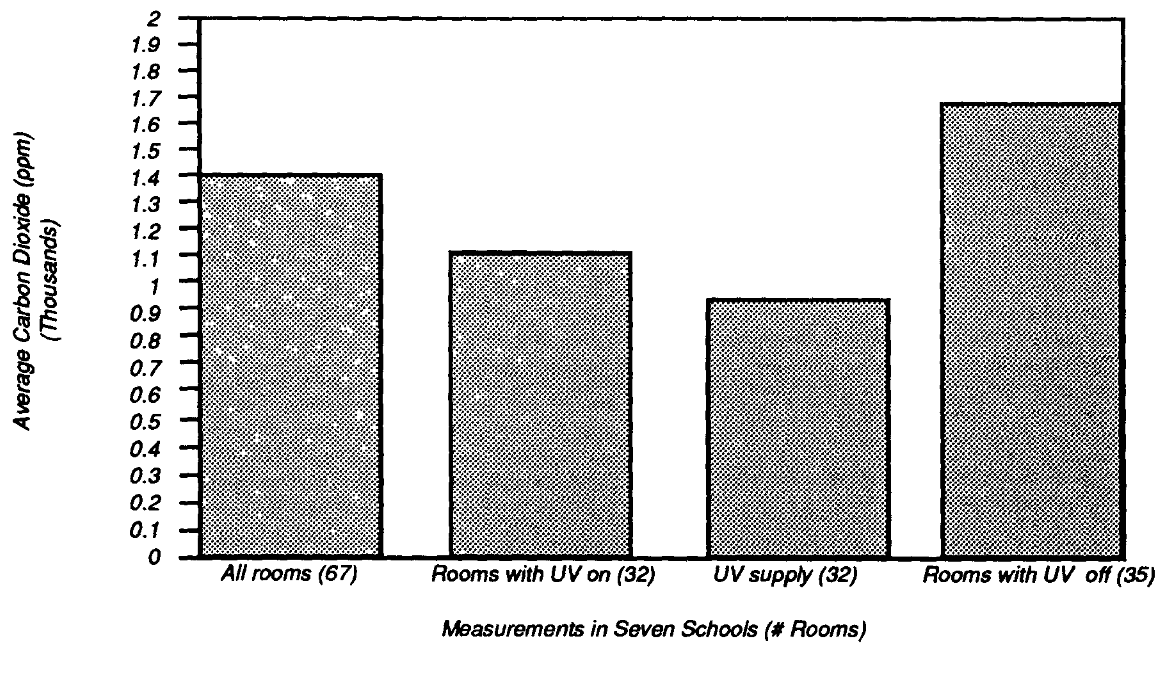

Figure 1. Average Carbon Dioxide Measurements in 67 Classrooms

Research on Central HVAC Systems

During the winter of 1990-1991, a data logger was installed in a Colorado school to continuously monitor radon, differential pressure, temperature, and the status of the outdoor air damper for the school's central HVAC system. The HVAC system supply ducts are located under the slab, with the corridor serving as the return air plenum. From the hallway, the return air is ducted into a subslab return-air tunnel that pulls the air back to the single-fan air handler. Radon levels in the school ranged from 6 to 13 pCi/L.

Results indicate that the position of the HVAC system outdoor air damper has a significant influence on radon levels in the building. With the damper closed, radon levels in the school were elevated for two reasons: (a) the fan was creating a large negative pressure in the return air tunnel, increasing radon levels in the tunnel, and (b) since minimal outdoor air was entering the HVAC system, the radon collected in the return air tunnel was distributed throughout the building with minimal dilution.

With the outdoor air damper opened to 100%, the pressure differential was reduced, radon levels were diluted, and average radon concentrations in the building were less than 1 pCi/L. It appears that radon levels are reduced even when the outdoor air damper is only partially open. Radon levels rise rapidly when the damper is closed, indicating that mitigation in this school will require continual monitoring of the outdoor air damper to ensure that it is open while the building is occupied. This project was conducted with the assistance of the Western Regional Radon Training Center in Fort Collins, Colorado.

Comparison of Three Mitigation Techniques in Same Building

Research in a Maine school, originally studied as part of EPA's Office of Radiation Programs School Evaluation Program, was initiated in the winter of 1990-1991. Because the design and construction of each of the three wings of the school are different and the radon source strength is relatively uniform, the school provides an excellent opportunity to compare different mitigation techniques within the same building.

Three mitigation techniques were evaluated—ASD, unit ventilator pressurization/dilution, and heat recovery ventilation (HRV)—independently in each of the three wings during the winter of 1990-91. Preliminary data indicate that average radon levels in the ASD wing are below 4 pCi/L, with most rooms below 2 pCi/L. The HRV has also reduced radon levels to below 2 pCi/L in the one room where it is installed. However, the unit ventilators have thus far proven ineffective in consistently reducing radon levels to below 4 pCi/L. As a result, an ASD system will be installed in this wing for monitoring during the winter of 1991-92.

Long-term Effectiveness of ASD Systems

Radon levels were measured in February 1991 in two Tennessee schools that were mitigated by RMB in 1989. Measurements made during the first winter after the systems were installed (1989-90) indicated that some ASD system modifications were needed. Following these modifications, measurements made this past winter (1990-91) were all below 4 pCi/L in the mitigated areas of the buildings. (Premitigation levels had averaged 30 and 40 pCi/L in the two schools.) RMB will continue to follow the long-term effectiveness of the ASD systems installed in these two schools.

Crawl Space Mitigation

Submembrane depressurization (SMD), crawl space depressurization, crawl space pressurization, and natural ventilation of the crawl space were compared in a Tennessee school. SMD performed most effectively, reducing radon levels from 9.7 pCi/L in the class rooms above the crawl space to below 0.5 pCi/L in a matter of hours.

Crawl space depressurization worked as well as SMD in reducing class room radon levels (to 0.6 pCi/L), but increased the crawl space levels by at least a factor of two during depressurization. Natural ventilation failed to reduce class room levels to below 4 pCi/L and crawl space pressurization was found to be even less effective than natural ventilation.

The results from crawl space depressurization demonstrate that depressurization may be a cost effective alternative to SMD in buildings where unused crawl spaces can be easily isolated and depressurized. However, its applicability may be limited in buildings where there are utilities in the crawl space, leaky wooden floors above the crawl space, or any other doors or openings where radon can move from the space to occupied rooms. (For more information on crawl space schools see "A Comparison of Radon Mitigation Options for Crawl Space School Buildings," a reprint from the 1991 International Symposium on Radon and Radon Reduction Technology.)

New Research Projects in Existing Schools

Radon diagnostics were conducted in four Ohio schools during the spring of 1991. Data loggers were installed in two of the schools to determine if the HVAC systems can be used to control radon levels and, if they can, how the HVAC systems should be operated. One of the schools has a two fan central HVAC system with the return air located in a subslab tunnel. The other school has fan coil units located in a subslab tunnel, and outdoor air can be supplied to the fan coils in the tunnel.

Radon diagnostics were also conducted in eight South Dakota schools during the summer of 1991. One of the schools with unit ventilators was selected for continuous monitoring with a data logger since it consistently measured the highest radon levels. The opening of the unit ventilator dampers will be controlled to determine the units' ability to reduce radon levels in this cold climate. Parameters that will be monitored include: radon levels, differential pressure, opening/closing of the classroom-to-corridor door, and weather. In the long-term, school officials plan to install an ASD system, and the two techniques (ASD and HVAC system control) will be compared.

Profile of School Building Characteristics

To gain a better understanding of the physical characteristics of schools throughout the U.S. and to help guide future school research, RMB is conducting a profile of school building characteristics using a subsample of approximately 100 schools from ORP's National School Radon Survey. Detailed structural and HVAC system characteristics are being collected, and results should provide approximate percentages of various school building characteristics in the U.S. The results of the profile will also be compared with the RMB research schools in order to identify any correlations between the research schools and the random sample.

Correction of Table in March 1991 Update

Please note that the "Time Door Closed" columns were reversed in the table in the March 1991 *Update*. Below is the corrected table.

Table 1. Average Radon Levels In Washington School During One Week

	Normal Operation			*Test Operation*			
	Average	*Radon*	*Time Door Closed*	*Average*	*Radon*	*Time Door Closed*	*Subslab Radon Sniff, 8/90*
Location	*pCi/L*	*(max)*	*(%)*	*pCi/L*	*(max)*	*(%)*	*pCi/L*
Room 139	*2.6*	*(27)*	*76*	*1.2*	*(17)*	*97*	*400*
Room 140	*5.3*	*(29)*	*74*	*3.2*	*(7)*	*92*	*500*
Room 141	*4.8*	*(32)*	*75*	*2.1*	*(25)*	*88*	*700*
Average	*4.2*	*(29)*	*75*	*2.2*	*(16)*	*92*	*533*

Note that the classroom-to-hall doors had to be closed for the unit ventilators to reduce average radon levels to below 4 pCi/L, although radon spikes (as high as 25 pCi/L) still occurred.

Research Notes

- 1991 Innovative Radon Mitigation Design Competition—RMB is providing funding to the following participants in the Innovative Design Competition sponsored by EPA's Office of Radiation Programs and the Association of Energy Engineers (AEE).

  (a) Pacific Northwest Laboratories (PNL)—to study subslab sealing techniques. Subslab sealing is proposed as a novel new approach to radon prevention and passive mitigation that is applicable to both new and existing buildings. PNL will conduct 2-D modeling to facilitate experimental design and will construct a bench-scale experimental system to test various sealants including epoxies, polyesters, polyurethanes, and phenolics.

  (b) Intermountain Radon Service—to evaluate a solar fresh air ventilation system for radon reduction in schools. Two solar air collectors/heaters will be constructed and installed in a western U.S. school with elevated radon levels. RMB will instrument the school for radon and differential pressure monitoring. Studies will focus on evaluating the solar collectors' effectiveness at providing preheated outdoor air for school ventilation and pressurization systems.

- New Mexico Mitigation Field Testing—Tracer gas measurements in six slab-on-grade houses suggest that about 50% (30-60%) of subslab depressurization exhaust gas is air drawn from inside the house. This is consistent with results reported by other researchers. Fan power measurements show that the 90-watt mitigation fans, operated at full power, are typically drawing 60-65 watts. This will reduce EPA's operating cost estimates which assumed conservatively that fans were operating at 90 watts.

- ASD Exhaust Calculations—Model calculations have been conducted to determine whether the installation of large numbers of ASD systems in a community might result in a significant raising of the ambient radon level in the area. Calculations show that for soil permeabilities below 2 x 10^{-11} m^2 (note that soil permeabilities are normally presented only in SI units) the increase in the total radon emission rate is not significant (less than 1%). Even for permeabilities as large as 5 x 10^{-10} m^2, the total increase in radon emission rate from a mitigation system and its sphere of influence would probably not exceed 5%. The increase in total emission rate is small because the increase in emissions is generally compensated for by a decrease in the rate of escape from the soil surface.

- Blockwall Research—Air entering buildings through concrete block walls can contain radon, moisture, biological agents, and other contaminants that threaten the health of the occupants and the structure itself.

RMB studies of commercially available concrete blocks have demonstrated a variation of over a factor of 50 in block air permeabilities ranging from 0.63 to 35 standard liters per minute/meter^2 at 0.012 inch WC (at 3 pascals). Additional studies have shown that block wall air infiltration rates can be dramatically reduced by applying surface coatings (see December 1990 Update).

Since the application of block coating may not always be practical and some coatings may deteriorate over time, losing their effectiveness, mitigators/designers may wish to select blocks with lower air permeabilities as part of a prevention strategy.

AEERL has developed an inexpensive test procedure to assist in determining the relative air permeabilities of cement blocks. Details will be provided in a subsequent *Radon Mitigation Update*.

Recap of 1991 International Symposium on Radon and Radon Reduction Technology

The 1991 International Symposium on Radon and Radon Reduction Technology, "A New Decade of Progress," was held April 2-5, 1991, in Philadelphia, Pennsylvania. The Symposium's technical presentations and discussions were well received and provided an excellent opportunity for the scientific and commercial communities to meet and exchange research findings and ideas.

Over 400 people representing 15 countries attended this year's Symposium, which was sponsored by AEERL, EPA's Office of Radiation Programs (Radon Division), and the Conference of Radiation Control Program Directors (CRCPD), Inc. Among those in attendance were radiation control program directors of 33 states.

In all, 119 papers relating to state and federal government policies, health effects, radon surveys, measurement methods, and mitigation strategies were presented during the week. Included among them was a Swedish paper that reported a 70% increase in the risk of cancer among those subjects who lived in houses with more than 4 pCi/L of radon.

A number of presenters added continued support/evidence for the use of ASD for effective radon mitigation. Papers also addressed pressurization and ventilation of buildings using HVAC systems to prevent radon entry, finding it important for indoor air quality purposes, though sometimes a less reliable and less effective method for radon control.

Several presentations encouraged treatment of buildings as systems, incorporating an approach which integrates radon mitigation, energy conservation, and indoor air quality issues.

A total of 16 oral and poster presentations covering radon measurement methods, radon mitigation methods, radon entry dynamics, radon prevention in new construction, and radon in schools were delivered by RMB Project Officers and contractors. A brief description of each paper was presented in the March 1991 *Update*.

Peer reviewed proceedings, available from the National Technical Information Service (NTIS) in late 1991, are not available from any other source at this time.

1992 International Symposium

Announcement and Call for Papers

The 1992 International Symposium on Radon and Radon Reduction Technology will be held September 22-25, 1992, at the Sheraton Park Place Hotel in Minneapolis, Minnesota. [(800) 542-5566]

Call for Papers—Abstracts should convey in 150 words or less the essence of the intended paper, clearly indicating the contribution it will make. Papers should provide study results. However, theoretical discussion of concepts and mechanisms will also be considered.

Abstracts will be accepted through November 30, 1991, and should be submitted to:

Abstracts
c/o Timothy M. Dyess
U.S. Environmental Protection Agency
AEERL, MD-54
Research Triangle Park, NC 27711

Symposium Registration—To obtain a registration form, detach and return the information card on the last page of this *Update*.

Update of RMB Publications

All publications with NTIS numbers are available (prepaid) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (phone 703/487-4650).

Reports:

Follow-Up Durability Measurements and Mitigation Performance Improvement Tests in 38 Eastern Pennsylvania Houses Having Indoor Radon Reduction Systems. D. B. Henschel (project officer), EPA-600/8-91-010 (NTIS PB91-171389), March 1991.

Correlation of Florida Soil-Gas Permeabilities with Grain Size, Moisture, and Porosity. D. Sanchez (project officer), EPA-600/8-91-039 (NTIS PB91-211904), June 1991.

Feasibility and Approach for Mapping Radon Potentials in Florida. D. Sanchez (project officer), EPA-600/8-91-046 (NTIS PB91-217372), July 1991.

An Assessment of Soil-Gas Measurement Technologies. D. Sanchez (project officer), EPA-600/8-91-050 (NTIS PB91-219568), July 1991.

Parametric Analysis of the Installation and Operating Costs of Active Soil Depressurization Systems for Residential Radon Mitigation. B. Henschel, EPA-600/8-91-200, October 1991.

Papers:

Cost and Effectiveness of Radon Resistant Features in New School Buildings. A.B. Craig, K.W. Leovic, and D.W. Saum. Presented at the American Society of Heating, Ventilating and Air-Conditioning Engineers (ASHRAE) IAQ'91, Washington, DC, September 1991.

Design of New Schools and Other Large Buildings Which Are Radon Resistant and Easy to Mitigate. A.B. Craig, K.W. Leovic, and D.B. Harris. Presented at the Fifth International Symposium on the Natural Radiation Environment, Salzburg, Austria, September 1991.

Modeling the Influence of Active Subslab Depressurization (ASD) Systems on Airflows in Subslab Aggregate Beds. R. B. Mosley, Presented at the Fifth International Symposium on the Natural Radiation Environment, Salzburg, Austria, September 1991.

Cost Analysis of Soil Depressurization Techniques for Indoor Radon Reduction, Indoor Air, September 1991.

Symposia Publications:

PROCEEDINGS: THE 1990 INTERNATIONAL SYMPOSIUM ON RADON AND RADON REDUCTION TECHNOLOGY

Volume 1: Symposium Oral Papers (Sessions I - IV)
EPA-600/9-91-026a (NTIS PB91-234443), July 1991.

Volume 2: Symposium Oral Papers (Sessions V - IX)
EPA-600/9-91-026b (NTIS PB91-234450), July 1991.

Volume 3: Symposium Poster Papers
EPA-600/9-91-026c (NTIS PB91-234468), July 1991.

Manual Updates:

"Radon Resistant Construction Techniques for New Residential Construction (Technical Guidance)"; M. C. Osborne (project officer), EPA-625/2-91-032, February 1991.

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RMB manuals covering the five topics listed below are being updated and should be available in the near future:

- Radon Reduction for Detached Houses (addresses soil depressurization only)
- Durability of Performance of a Home Radon Reduction System—Subslab Depressurization Systems, Assessment Protocols
- Handbook on Sub-Slab Depressurization for Low Permeability Fill Material Design and Installation of a Home Radon Reduction System
- Radon Reduction Techniques in Schools (includes more technical details and results from recent school research)
- Radon Prevention in the Design and Construction of Schools and Other Large Buildings

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