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IN NONRESIDENTIAL BUILDINGS*

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ABSTRACT

To date, the U.S. Environmental Protection Agency has not published guidance for radon testing, diagnostics, or mitigation within large, nonresidential buildings. Current research indicates that large buildings may contain construction features or mechanical systems that could inhibit the installation or operation of a mitigation system. Health and safety issues such as asbestos and fire codes may further interfere with the installation process. Studies also show that elevated radon can be restricted to a particular area or room within a building and not be uniformly distributed. A four-step, sequential protocol has been developed to address these issues and facilitate large building radon mitigation.

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INTRODUCTION

In recognition of the public health hazard presented by indoor radon, the U.S. Congress passed, and the President signed into law, the Indoor Radon Abatement Act of 1988 (IRAA).⁽¹⁾ IRAA declares the national goal to be "that the air within buildings in the United States should be as free of radon as the ambient air outside the buildings." In addition, the law stipulates that the head of each federal agency that manages a building will design and implement a study to assess the extent of radon contamination in buildings within its jurisdiction and submit the data to the U.S. Environmental Protection Agency (USEPA).

Three years after the enactment of IRAA, the USEPA presented a compilation of radon data collected by various federal agencies surveys (1988 to 1990) at the 1991 Health Physics Conference in Washington D.C.⁽²⁾ The combined federal data sets indicated that 5 to 7% of all federal buildings had at least one reading above 148 Bq m⁻³. If one assumes that these data are truly representative of the one million-plus buildings owned or occupied by the United States government, then perhaps as many as 50,000 to 70,000 buildings require some corrective action. If the published USEPA residential guidelines are followed, all of these buildings will need to be mitigated no later than 1994.⁽³⁾ Unfortunately, the USEPA has yet to provide written guidance or protocol for the control of elevated radon in occupational buildings.

OVERVIEW OF NONRESIDENTIAL RADON MITIGATION

In 1989, the USEPA published the first nonresidential radon mitigation guidebook, Radon Reduction Techniques in Schools (EPA/520/1-89-020). The interim document outlined potential residential radon reduction methods that would be applicable to mitigation in schools, primarily subslab depressurization. However, as stated in the document, USEPA experience in mitigation of schools was very limited at that time. Mitigators essentially were instructed to approach the mitigation of a school as they would a large house. Since the release of the schools mitigation document, additional research involving the use of traditional residential techniques have been performed.^(4,5) These and other studies have indicated that existing mitigation technology can likely succeed in controlling nonresidential radon exposure. Although mitigation progress has been made, very little work has been performed to assist in the selection of the best type of mitigation system for the building.

PROPOSED RADON MITIGATION DIAGNOSTICS FOR LARGE BUILDINGS

In residential buildings, understanding the root cause of how the radon enters the house is not really required to perform a successful mitigation. The reasons being room-to-room radon distribution is fairly uniform and residential buildings are generally very simple in construction: a single foundation, a monolithic slab, and a single mechanical system. In large buildings, sizable room-to-room variations in radon concentration are common as is complicated construction: multiple foundations, slabs, and mechanical systems.^(6,7) In addition, research has indicated that large buildings may contain construction features or mechanical systems that would inhibit the installation or operation of a residential-type mitigation system.⁽⁶⁾ Examples are return air ducts or supply ducts that are routed through the slab. These mechanical components can cause sufficient subslab perturbation to overpower traditional subslab depressurization systems. Also, highly segmented slabs disrupt subslab depressurization fields.⁽⁶⁾ These structural and mechanical complications may potentially discount the "large house" approach.

Other important issues for consideration during mitigation design are health, safety, and local building code requirements. For example, the best method for mitigation of a building might be subslab depressurization, but the presence of asbestos in building material might prevent the installation of the PVC intake and exhaust piping. Local fire codes are a factor as well. To prevent the release of toxic fumes in the event of a fire, codes within certain areas of the country forbid PVC pipe penetrating into occupied areas or through fire walls. Also, roof penetrations for radon exhaust may invalidate the contractor's warranty. All of these factors and more must be considered during the mitigation design.

An alternate diagnostic approach is to model a large building as a collection of small independent structures or units grouped tightly together. The first step of the diagnostics is to perform a short-term radon test (2 to 5 days) of all ground contact rooms, stairwells, pipe chases and other interfloor conduits. With the aid of a building floor plan, the building radon data pattern should be classified as one of the following types: (1) random (no distinct pattern); (2) clustered (grouped together in an certain area of the building); (3) linear (results are in a row); and (4) uniform (all data are about the same).

The second step is to divide the building into diagnostic zones. A diagnostic zone is an area within a building with a common foundation, mechanical system, and slab. Identification of these different zones is accomplished by reviewing the building plans and identifying all foundation footers, slab pours, and mechanical supply and return ducts. All common enclosed footers, slab expansion joints, masonry walls, fire walls, and separate mechanical systems should be grouped along with the short-term radon data into a defined zone. Mitigation diagnostics are then performed within each of the identified zones, and a mitigation design is developed for each zone. During the diagnostics, all interzonal communications, such as subslab field extensions or interzonal mixing of different tracer gases must be noted. If two zones communicate, then it may be advantageous to combine them into a single zone for corrective action. After completion of the diagnostics, a composite mitigation design is developed for the building as a whole. It is important to note that mitigation of a single zone within a building is an option as well.

OTHER CONSIDERATIONS IN NONRESIDENTIAL RADON MITIGATION

By definition, radon mitigation consists of the measures taken to reduce human exposure to elevated radon. As stated previously, elevated radon within large buildings can be confined to certain areas of a building. If these areas are occupied on a regular basis then mitigation should be considered. But, before corrective action is taken, another option should be considered. The key part of the risk associated with radon exposure is that a person must be exposed to be considered at risk. Obviously, if no exposure occurs, no human health risk exists. Thus, by restricting or removing a worker from exposure, a more cost-effective mitigation may result. For example, by limiting or controlling access to a room (i.e., locking the door), or relocating occupants to safer areas within the building, the human health risks are eliminated and de facto mitigation occurs.

Initial installation costs of a radon mitigation system are not the only consideration; future costs, such as the energy penalty and system upkeep, are other factors. In private residences, the cost of operating and maintaining most mitigation systems has been estimated at less than \$500/year in most areas of the United States. In large buildings, however, this cost could run as high as tens-of-thousands of dollars per year if mitigation entailed the use of unconditioned air for increased building ventilation. Because of the potential installation and lifetime operation costs involved, radon mitigation of large buildings can be a major investment. Matching the right system to a building is essential to control both current and future costs.

When dealing with radon in large buildings, the temptation exists to adjust and/or modify the existing mechanical system to increase the building ventilation rate. However, this type of corrective action must be performed with considerable caution. In order for this approach to be successful, the existing system must be redesigned to condition the extra volume of outside air. In cases where the system is not able to handle the increased air uptake, an overall decrease in the building comfort index will result. Examples of the problems that may result are drastic elevation of building humidity, temperature variability problems (i.e., too hot or too cold), higher molds and spore counts (i.e., building flu), and substantially increased energy consumption. If mitigation is to be performed by this method, a qualified mechanical engineer needs to be consulted before action is taken.

CONCLUSION

As stated previously, the USEPA has not, to date, published or provided any guidelines for large building testing, diagnostics, or mitigation. In lieu of this, the following four-phase mitigation protocol is proposed:

Phase I: Prediagnostic. Perform a short-term radon test of all ground contact areas, stairwells, pipe chases, elevator shafts, and interfloor conduits. Review the building construction plans for features that could enhance radon entry. Conduct a visual inspection of the building ground contact areas. Collect information on individual room usage and occupancy for each area. Identify potential radon mitigation diagnostic zones.

Phase II: Active Diagnostics. Based on the information collected in Phase I, perform active radon mitigation diagnostics. Examples of active diagnostics are: building shell leakage, shell air exchange rate, subslab permeability, subslab depressurization field extensions, and mechanical system balance determination. With input from Phase I, design the mitigation system for the building.

Phase III: Mitigation. Install the radon mitigation system.

Phase IV: Postmitigation. Perform postmitigation radon testing. Operate and maintain mitigation system.

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