BUILDING RADON-RESISTANT HOMES IN THE U.S.: STRATEGY FOR THE DISSEMINATION OF THE EPA *MODEL STANDARDS FOR CONTROL OF RADON IN NEW RESIDENTIAL BUILDINGS*

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ABSTRACT

In March, 1994 EPA published Model Standards for radon-resistant new construction in homes. Pursuant to that publication, the Radon Division of EPA has developed an innovative strategy for transferring the Model Standards to the home building community, the building code enforcement community and the general public.

The strategy is based on three goals: 1) voluntary adoption of the Model Standards by home builders into their construction practices; 2) adoption of the techniques by State and local jurisdictions into their building codes; and 3) raising consumer awareness/demand for radon-resistant construction. This strategy includes a partnership with the National Association of Home builders, a unique public/private relationship; use of a multi-media campaign aimed at home builders; and creation of "community roundtables on radon," which bring together local building department officials, local home builders, politicians, health officials and activists to discuss a local solution for radon-resistant construction.

State radon control programs, EPA regional offices and over eight cooperative partner non-profit organizations are involved in implementing the strategy.

The strategy also has an evaluation component.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administration review policies and approved for presentation and publication.

BACKGROUND

Development of the EPA *Model Standards*

As EPA officials and the U.S. Congress became aware of the risk from indoor radon, several steps were taken to mitigate this risk in the U.S. EPA initiated its Radon Action Program, located in EPA's Office of Radiation Programs (now called the Office of Radiation and Indoor Air). In addition, the *Indoor Radon Abatement Act*[1] (IRAA) was passed by Congress in 1988, which gave authority to EPA to conduct research into effective methods of mitigating indoor radon levels and disseminate this technology. IRAA specifically stated the need for national standards for radon-resistant construction of new homes. Per IRAA, EPA was to work with the building industry, model building code groups, researchers and others to develop these standards.

As work with existing homes in the 1980s validated sub-slab depressurization as an effective mitigation technique, momentum built for applying the same technology in new homes. The National Association of Home Builders' (NAHB) Research Center and EPA created a New House Evaluation Program (New-HEP) to study the most effective techniques for radon reduction in new homes, based on sub-slab depressurization. In 1987, EPA and the NAHB Research Center jointly published "Radon Reduction in New Construction - an Interim Guide." In 1988,

suction points or larger fans. In part, this general procedure seems to have evolved out of EPA research and anecdotal evidence which supports it as both cost-effective and responsible. However, it also reflects the absence of diagnostic tools to identify radon sources and to distinguish actual sources from incidental concentrations of radon. The diagnostic tools necessary for the remediation methods being used today are not merely the tools to measure subslab radon concentrations, or relative radon concentrations beneath the slab, in crawl space, and in different interior locations, but the analytical tools to interpret these data and clearly identify the relative source strengths.

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1. Radon Reduction Techniques for Detached Houses: Technical Guidance, EPA, EPA/625/5-86/019, June, 1986
   The eight methods listed in the first technical guidance manual were: natural and forced air ventialtion; forced air ventilation with heat recovery; active avoidance of house depressurization; sealing major radon sources; sealing radon entry routes; drain tile soil ventilation; active ventilation of hollow block basement walls; ventilation of subslab.

2 Radon Diagnostics Workshop, Princeton, NJ, April 13-14, 1987

3. "Guaranteed Radon Remediation Through Simplified Diagnostics", D. Saum and M. Messing, 1987

4. Radon Reduction Techniques for Detached Houses: Technical Guidance (second edition), EPA, EPA/625/5-87/019, January, 1988

5. Radon Mitigation Standards, EPA 402-R-93-078, October, 1993 (Revised April, 1994)

6. Radon Reduction Techniques for Detached Houses: Technical Guidance (Third Edition) for Active Soil Depressurization Systems, EPA, EPA/625/R-93/011, October, 1993

EPA published "Radon-Resistant Residential New Construction." In 1991, EPA's Office of Research and Development published "Radon-Resistant Construction Techniques for New Residential Construction." These documents were technical in nature, but were not "standards."

In 1989, a work group was set up to develop EPA model standards on new construction. Forty-five participants were involved, including the National Institute of Standards and Technology, the National Institute of Building Sciences, national model code organization representatives, indoor air specialists, scientists, engineers, and EPA personnel.

The Model Standards and Techniques for Control of Radon in New Residential Buildings were published on April 12, 1993 for public comment in the Federal Register after an exhaustive consensus process. They were approved by the U.S. Office of management and Budget (OMB) on January 5, 1994 and were released by EPA on March 21, 1994 *(EPA 402-R-94-009)*.

In 1992, the American Society of Testing and Materials (ASTM) published a Standard Guide (E 1465-92 "Guide for Radon Control Options for the Design and Construction of New Low Rise Residential Buildings") that included techniques very similar to those in the draft EPA Model Standards. The only difference was that techniques applying to reducing stack effect were included in an Appendix instead of in the body of the document.

The EPA Model Standards contain specifications for two types of radon control systems: the passive and the active. The systems are applicable to basement, slab-on-grade, crawlspace or combination foundations for detached residences. The passive system relies on physical barriers to radon entry combined with a passive vent stack to the roof which depressurized the sub-slab area or sub-membrane area. This keeps radon entry points low. In addition, the positively pressurized living space resists radon entry. The active system adds a mechanical fan to more actively depressurize the sub-slab/sub-membrane area. This is the same technology utilized in most existing home mitigations, and described in EPA's Radon Mitigation Standards[2] (RMS). In addition to reducing radon entry in new homes, the passive techniques add to energy savings for the occupants and moisture control, according to the Cost Benefit Analysis[3] for the Model Standards. The Model Standards recommend a passive system in Zone 1 on the EPA Map of Radon Zones[4] (see more detailed explanation of EPA Map of Radon Zones below). Of course, State and local jurisdictions in any Zone may implement the Standards to meet their unique needs.

The Model Standards were written to be flexible to meet the needs of a variety of constituents. There were five goals for the Model Standards to meet:

1) REDUCE RADON ENTRY: The primary goal of the Model Standards is to reduce the level of radon in homes.

2) FACILITATE SYSTEM ACTIVATION: In cases where the indoor radon level still exceeds the recommended action level of 4 pCi/L, a passive system can easily be converted to an active system with the installation of a fan.

3) UTILIZE EXISTING CONSTRUCTION PRACTICES: None of the techniques in the Model Standards present new or unfamiliar construction methods.

4) EMPLOY PROVEN TECHNOLOGY: The sub-slab depressurization approach in the Model Standards has proved successful in lowering indoor radon levels in both existing and new homes.

5) PROVIDE MAXIMUM FLEXIBILITY: the Model Standards provide State and local jurisdictions with the option of modifying the technical requirements to meet local construction practices or other local needs.

Another implicit goal was to have the total cost of installing the techniques not be an undue burden to builders. The cost was estimated, using MEANS data, at $350 - $500 for labor and materials in the Cost Benefit Analysis for the Model Standards.

Once EPA released the Model Standards, implementation in Zone 1 was seen as an opportunity to obtain targeted risk reduction in the U.S. Per the Cost Benefit Analysis, 225 lives would be saved over the first five years of implementation. A strategy was needed that would utilize the benefits of the Model Standards, meet building industry needs and be affordable.

A STRATEGY FOR TECHNOLOGY TRANSFER OF THE EPA MODEL STANDARDS

Overview: A Voluntary Approach to Risk Reduction

The EPA's radon program relies on a non-mandatory approach to risk reduction because of a belief in its long-term effectiveness, and the lack of an enforcing mechanism, such as federal legislation. The EPA has targeted three audiences for its voluntary approach to radon-resistant new construction: builders of new homes, buyers of new homes and local and State officials in charge of developing and enforcing building codes. A team was formed within EPA's Radon Action Program to work on this initiative. The team developed the following mission: "achieve measurable reduction in radon risk by: 1) promoting adoption of radon-resistant construction techniques in national, State and local building codes; 2) encouraging voluntary application of the techniques by home builders; and 3) creating consumer demand for radon-resistant new homes". The EPA goal is to increase the cumulative number of homes from an estimated 500,000 homes in 1995 constructed with radon-resistant features to one million homes in the year 2000. In addition, the goal is for fifty percent of homes in Zone 1 to be built incorporating radon-resistant techniques by the year 2000.

Targeting Resources: Passive Systems in Areas of High Radon Potential

In order to target the highest risk areas for radon potential in the country, the EPA Map of Radon Zones was developed by the EPA and the United States Geological Survey (USGS). The map designates each county in the U.S. as having low, moderate or high radon potential. This designation was based on five factors: radon measurement data, soil permeability, geology, aerial radiometric data and house foundation type. This map is an integral part of the implementation of the Model Standards and EPA recommends application of passive radon control systems in Zone 1 areas in the U.S. Although elevated indoor radon levels may be found in all three zones, use of the Model Standards in Zone 1 will reduce the greatest risks first.

Targeted Audiences:

Builders:

EPA has been working with NAHB since the 1980s to find radon control technologies which reduce radon risk for home occupants but are inexpensive for builders. In 1992/3 NAHB and EPA agreed upon implementation of the passive system in Zone 1 areas, as defined by the EPA map or local information on radon potential.

The relationship between NAHB and EPA is somewhat unique in that the two parties have found common ground and, through compromise, are advancing a common agenda. NAHB works with its own membership on education about radon-resistant new home construction and has joined EPA in many activities. These include producing a 12-minute video on radon-resistant construction techniques, several joint speaking engagements and introducing a joint proposal for a code change to the Council of American Building Officials' (CABO) "One and Two Family Dwelling Code." In addition, EPA works with builders directly, apart from working with NAHB. This involves educating builders through training courses, a media campaign with a public relations firm specializing in the housing industry, exhibiting at builders' trade shows, and other activities. In addition, EPA is working to educate architects about radon-resistant construction methods so that they will incorporate these methods into their home designs. EPA developed a set of architectural renderings which show the passive and active system installation in basement and crawl-space dwellings. These drawings are available to architects through the American Institute of Architects (AIA), various publications, exhibits at relevant trade shows, electronically through the Internet, and other channels.

Building Code Officials:

An integral part of EPA's strategy is to promote adoption of the techniques in the Model Standards into State and local building codes. In addition, the Division is actively working with other parties to propose the inclusion of the techniques into the four national model codes: Building Officials' Conference of America (BOCA), Southern Building Code Congress International (SBCCI), International Conference of Building Officials (ICBO) and CABO.

There are approximately 44,000 building code jurisdictions in the U.S. Most of these jurisdictions have a building code official who oversees the development and enforcement of a code for construction within that jurisdiction. The majority of the jurisdictions rely on one of the three regional codes (ICBO, BOCA or SBCCI) or the more nationally used CABO code for a model, which they then amend to meet local needs. Some of the local jurisdictions have more authority than the State and some have less. EPA has targeted building code officials at the State and/or local level in Zone 1 areas to receive education about the health risks of radon exposure and the benefits of radon-resistant new construction to residents in their jurisdiction. The hope is that when these officials update their codes, they will include requirements for radon-resistant construction. This is a long-term solution to institutionalizing risk reduction.

To educate and promote radon-resistant new construction with these code officials, EPA formed an alliance with the National Conference of States on Building Codes and Standards (NCSBCS), a non-profit organization whose mission is public safety through building codes. EPA has accomplished a number of activities with NCSBCS to influence building code officials. These activities include: developing a ten-minute videotape on the benefits of radon-resistant new construction, exhibiting and speaking at code officials' gatherings, promoting the Model Standards in various newsletters and other activities. Recently, NCSBCS, along with the State of Alabama Radon Program, submitted a code change proposal on radon-resistant techniques to the Southern Building Code Congress International (SBCCI). This proposal will be voted on by the SBCCI membership in October, 1995.

EPA has also piloted a new method of seeking community consensus in building code adoption in several locales, called "community Roundtables." Sponsored by local leaders, such as public health officials, local Home Builders Association officers, or others, members of the community who might be effected by a change in the building code are brought together. The local and/or State building code officials attend, as well, which is pivotal to the outcome of the event. The participants spend the day together learning about risks from radon, new construction techniques and related issues. They try to come to consensus on whether the building code should be changed, and if so, how. This type of community participation keeps all parties informed, involved and invested in the process of community health protection.

Finally, as discussed above, EPA is working to change all national model building codes to include radon-resistant features. Since the change proposal to the CABO "One and Two Family Dwelling Code" was accepted in October, 1994, EPA and NAHB have worked together to promote local adoption and acceptance of this new code change. The radon-resistant techniques are contained in an optional Appendix. Building code officials must indicate that the Appendix is applicable because of high radon potential in their jurisdiction. This is similar to geographical seismic or wind-load requirements. Officials, in whose jurisdictions CABO is used, have been targeted for a special EPA/NCSBCS joint mailing after the new 1995 CABO "One and Two Family Dwelling Code" book is released. Approximately 200 code officials in high radon potential areas with a high number of housing starts will receive packets. NCSBCS will be available to respond to inquiries for more information and/or training.

Home Buyers:

The final audience that EPA has targeted are buyers of newly constructed homes. Over one million homes are built each year; in many cases, buyers can influence design decisions. Besides picking kitchen cabinets, carpeting or other features, some new home buyers can request that radon-resistant features be installed in their new home as it is being built. The goal is to alert new home buyers of this possibility. As there is no one way to get to these buyers, EPA is using a variety of approaches. These include use of the Internet, use of a media service which offers camera-ready articles to real estate sections of newspapers across the country, exhibiting at home

shows, distributing information at homebuyers workshops and educating buyer/brokers. EPA believes that informed home buyers are important in stimulating the interest of builders incorporating radon-resistant features in their construction practices.

Public/Private Partnerships:

The EPA has involved EPA Regions, State radon control programs, and its many cooperative partners in the above strategy. As these organizations strive for radon risk reduction, they have seen that institutionalizing risk reduction through building code adoption or builders voluntarily implementing the Standards is long-lasting and cost effective. Examples of activities by these organizations follow:

1) a local city health official in East Moline, Illinois began a program which lowered building permit fees for any builder who installed a passive radon control system in a new home;

2) an environmental citizens group in Ohio made a presentation to the city council to add radon-resistant methods to the local building code;

3) an American Lung Association local affiliate worked with Habitat for Humanity to build a low-cost new home with a passive radon system;

4) several State radon control programs have contacted their State building code official to work on adoption of radon-resistant techniques in the State code.

NEXT STEPS

The EPA is committed to conducting research to further evaluate the effectiveness of the techniques required in the Model Standards. EPA and the NAHB Research Center are continuing a study involving over 75 homes of varying locations and foundation types. It is scheduled for completion in fiscal year 1996.

The EPA is continuing to develop partnerships with outside public health and safety organizations, local governments, local home builders' associations and many other interested parties to meet the goals of the strategy as outlined above.

As EPA's Radon Action Program evolves and matures, more emphasis is being placed on institutionalizing reduction in risk from indoor radon. Radon-resistant new construction of homes will continue to be a goal into the next century because of the tremendous risk reduction benefits to the general population.

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REFERENCES

1. U.S. Congress, *Indoor Radon Abatement Act*, Toxic Substances Control Act, Section 304, 1988.

2. U.S. Environmental Protection Agency, *Radon Mitigation Standards*, EPA 402-R-93-078, 1993.

3. ICF Inc., *Analysis of Options for EPA's Model Standards for Controlling Radon in New Homes*, 1992.

4. U.S. Environmental Protection Agency, *EPA Map of Radon Zones*, EPA-R-93-071, 1994.