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The Legal Implications of Residential Radon Contamination: The First Decade

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THE LEGAL IMPLICATIONS OF RESIDENTIAL RADON CONTAMINATION: THE FIRST DECADE

ROBERT D. KING*

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In December 1984, Stanley Watras, a resident of Boyertown, Pennsylvania, and employee of the Limerick Nuclear Power Plant, set off radiation detection devices as he arrived for work one morning.¹ Investigators, unable to find the source of the radiation, eventually discovered traces of radioactive radon on Watras' clothing. Ultimately, the investigation centered upon Watras' home² which was found to have radon levels over a thousand times greater than the United States Environmental Protection Agency's ("EPA") recommended guideline.³

Although the dangers of exposure to radon were known as early as the 1950s and 1960s from studies that revealed a greater incidence of lung cancer among uranium miners,⁴ it was not until the Watras case that the danger of naturally occurring residential radon contamination became widely known.⁵ The Watras case instantly focused national attention on the potentially lethal nature of naturally occurring radon gas.⁶ Attorneys specializing in real estate matters began to examine the legal issues surrounding the impending litigation over the presence of the

1. V. Elaine Smay, *Radon Exclusive*, POPULAR SCI., Nov. 1985, at 76-77.

2. The radon level in the Watras home was 100 times that allowed in uranium mines. *Id.* at 77. The radiation exposure was equivalent to smoking 135 packs of cigarettes per day. Michelle Galen, *Lawyers Grapple With The Radon Issue: Litigation Surge Likely*, NAT'L L.J., July 21, 1986, at 1.

3. See Anne Rickard Jackowitz, *Radon's Radioactive Ramifications: How Federal and State Governments Should Address the Problem*, 16 B.C. ENVTL AFF. L. REV. 329, 330 (1988). The EPA suggested upper limit of acceptable radon contamination is four picoCuries per liter or 0.02 working levels. *Id.* Although radon measurements are often expressed in either picoCuries per liter ("pCi/l") or working levels ("WL"), most commentators, including those in the media, adopted the picoCuries per liter measurement in making references to residential radon. That measurement standard became particularly prevalent in the real estate profession. Consequently, most lay persons became familiar with EPA's suggested standard of a safe indoor radon level when expressed as four picoCuries per liter ("4 pCi/l") rather than .02 working levels (".02 WL"). For uniformity, therefore, this article will discuss radon issues using the more commonly used picoCuries per liter measurement. See U.S. ENVTL. PROTECTION AGENCY & U.S. DEP'T HEALTH AND HUMAN SERVICES, PUB. NO. OPA-86-004, A CITIZEN'S GUIDE TO RADON: WHAT IT IS AND WHAT TO DO ABOUT IT (1986) [hereinafter A CITIZEN'S GUIDE]. The Curie is the standard measurement for radioactivity. This standard is too large for the radiation discussed in radon cases. The usual unit utilized in radon cases, the picoCurie, is equal to one-millionth of a Curie. See Jackowitz, *supra* note 3, at 330 n.6.

4. Jackowitz, *supra* note 3, at 329.

5. *Id.* at 329.

6. See Galen, *supra* note 2, at 1.

naturally occurring gas.⁷ Moreover, federal and state agencies began ambitious efforts to determine just how widespread a problem the residential radon situation actually was.⁸ Many commentators noted that there would undoubtedly be a "surge of radon-related litigation in the context of real estate transactions."⁹ Some suggested that "[t]his surge definitely has begun."¹⁰ Other commentators noted that radon is responsible for as many as 20,000 lung cancer deaths annually in the United States¹¹ and that "radon levels are the radiation equivalent of having a Three Mile Island accident ... occur in the neighborhood every week."¹² Furthermore, federal environmental and health officials warned the American public that contamination of homes across the nation by cancer-causing radon has emerged as the nation's most serious air

7. *Id.* at 10; see Rorie Sherman, *Radon and Real Estate: Potentially Costly Mixture*, N.J. L.J., Nov. 27, 1986, at 1 (1986).

8. Galen, *supra* note 2. See, e.g., Deborah A. Bannworth, Note, *Radon In New Jersey: Is It Time For Mandatory Testing?*, 15 SETON HALL LEGIS. J. 171, 171-73 (1991); David Dearing, Comment, *Radon Litigation: An Overview of Homeowners' Potential Causes of Action*, 20 CUMB. L. REV. 825, 827 (1990); Rita M. Nichols, Note, *Construction Contractors Confront the Indoor Radon Hazard: Homeowners' Private Causes of Action and a Federal Response with the Indoor Radon Abatement Bill*, 37 WASH. U.J. URB. & CONTEMP. L. 135, 161-67 (1990); Kevin L. Shepherd & Kevin A. Gaynor, *Radon: A Growing Menace in Real Estate Transactions*, 3 PROB. & PROP. 6, 8 (May/June 1989); see generally Jackowitz, *supra* note 3; Janet I. Moore, *The Radon Review: The Federal and State Governments' Responses To Indoor Radon Contamination*, 7 TEMP. ENVTL. L. & TECH. J. 39 (1988).

9. Galen, *supra* note 2, at 1.

10. Dearing, *supra* note 8, at 827. See also Frank B. Cross & Paula C. Murray, *Liability For Toxic Radon Gas In Residential Home Sales*, 66 N.C. L. REV. 687, 688 (1988). Most commentators, however, have noted that there are few lawsuits involving naturally occurring residential radon. See, e.g., Leonard Levin, *Consumerism and Land Sales*, 15 PEPP. L. REV. 131, 136 (1988); Jeanne Prussman, *The Radon Riddle: Landlord Liability For A Natural Hazard*, 18 B.C. ENVTL. AFF. L. REV. 715, 716 (1991); Donald A. Waltz, Comment, *Radon Gas: Ramifications for Real Estate Transactions in Pennsylvania*, 91 DICK. L. REV. 1113, 1114 (1987); Stephen F. Conaway, *Grappling with Silent Invaders of the Home: Legal Remedies for Radon Gas Contamination*, 5 TEMP. ENVTL. L. & TECH. J. 36, 38 (1986); Paul A. Locke, *Promoting Radon Testing, Disclosure, and Remediation: Protecting Public Health through the Home Mortgage Market*, 20 Env'tl. L. Rep. (Env'tl. L. Inst.) 10475, 10476-77 (Nov. 1990).

11. See, e.g., Cross & Murray, *supra* note 10, at 687; Galen, *supra* note 2, at 8.

12. Cross & Murray, *supra* note 10, at 688 (quoting Nero, *The Indoor Radon Story*, TECH. REV., Jan. 1986, at 28).

pollution problem.¹³ Claiming that radon causes thousands of deaths each year from lung cancer, federal officials issued a national health advisory warning that "millions of homes have elevated radon levels" and that "[r]adon-induced lung cancer is one of today's most serious public health issues."¹⁴ Not surprisingly, such dire pronouncements¹⁵ resulted in virtually hysterical reactions among worried homeowners who believed that they no longer could take refuge in their homes as safe havens against the myriad dangers of the outside world.¹⁶

As the dust started to settle, however, the skeptics and naysayers

13. Mark Jaffe & Matthew Purdy, *Radon Warning Issued: U.S. Says Homes Should Be Tested*, PHILA. INQUIRER, Sept. 13, 1988, at 1-A.

14. *Id.*

15. *Id.* In 1988 Dr. Vernon J. Houk, assistant surgeon general of the United States Public Health Service, said that residential radon "exceeds by 10 times the threat posed by outdoor air pollution." Houk further declared that, "Radon exposure raises the risk of lung cancer for a nonsmoker to that of a smoker. I would not buy a home, I would not move into a home, without knowing what the radon content is in it." *Id.* Moreover, at that same time, Lee M. Thomas, the Administrator of EPA noted that radon was "a national problem" and that "[w]e have found a broad level of elevated radon in homes across the country. There are states where 40 to 60 percent of the homes have a problem." *Id.* The federal officials warned that since the potential for radon contamination is so widespread, the only people who are not advised to test their homes are those living in apartments above the second floor of a building. *Id.*

16. The day following the federal warnings that millions of homes have dangerously elevated levels of radon, worried homeowners swamped federal and state environmental agencies with telephone calls. Steve Stecklow & Mark Jaffe, *Radon Alert Worries Homeowners in Area*, PHILA. INQUIRER, Sept. 14, 1988, at 1-A. Moreover, retail outlets selling home radon testing kits in states such as Pennsylvania, where radon levels were said to be particularly high, quickly sold out on the testing devices. *Id.* Homeowners who eventually did discover a radon problem were apprehensive about acknowledging this fact for fear that their property would become stigmatized and, consequently, lose its market value. Gene Austin, *Air Fright: Radon Becomes a Real Estate Problem*, PHILA. INQUIRER, Feb. 19, 1989, at 1-H. In 1989, further adding to the radon hysteria, EPA announced that new evidence showed that radon is present in high levels in classrooms across the United States and urged all school systems to test for the radioactive gas and take remedial action if required. Philip Shabecoff, *New Data On Radon Prompt Call To Test All School Buildings*, N.Y. TIMES, Apr. 21, 1989, at A1. Researchers at Britain's National Radiation Protection Board announced that natural radon was Americans' and Britons' greatest radiation threat. The researchers claimed that radon was a greater menace than medical x-rays and nuclear reactors. *Radon Dangers*, PHILA. INQUIRER, March 17, 1989, at 2-D. See also R. Randy Lee, *The Impact of Radon on Real Estate Transactions*, N.Y. L.J., Sept. 19, 1990, at 33; Jackowitz, *supra* note 3, at 336; Moore, *supra* note 8, at 39.

began to cast doubts on whether ample scientific data existed to support the warnings about residential radon.¹⁷ EPA, meanwhile, maintained its position that residential radon was a serious health threat.¹⁸ The agency

17. See, e.g., Leonard A. Cole, *Radon Scare - Where's The Proof?*, N.Y. TIMES, Oct. 6, 1988, at A31 ("No relationship between illness and radon in homes has ever been established in a scientific study. A presumed relationship exists only because of earlier experiences of miners, particularly uranium miners."); Lee, *supra* note 16, at 33 ("Using EPA's figures, radon is the second leading cause, next to smoking, of the more than 120,000 annual lung cancer deaths in the United States. But one study has since indicated that of the lung cancer deaths attributed to radon, only about 500 were nonsmokers, suggesting that much more research is needed on radon's true health effects."); Eric Morgenthauer, *For A Healthy Glow Some Old Folks Try A Dose of Radon*, WALL ST. J., Oct. 12, 1990, at A1 ("Most of these people suffer from ailments of one sort or another They have journeyed to this remote part of the country ... because there is something in the air of a handful of commercially operated 'health' mines ... that they think will help them: Radon gas. The same stuff that federal health authorities say can turn your house into a lethal weapon At a time when the very mention of radioactivity is enough to clear out a neighborhood, a radon-gas 'health' mine would seem to be an anachronism."); Paul Nussbaum, *Radon Gains Respect In Mont. 'Health Mines'*, PHILA. INQUIRER, Feb. 12, 1989, at 1-A ("In this pocket of Montana's old mining country, a cluster of played-out diggings ... are enjoying second lives as 'health mines,' drawing thousands of visitors searching for relief from arthritis, diabetes, asthma and cancer. And the mystery curative is the same agent that the Environmental Protection Agency considers the nation's top environmental cancer danger: radon."); Malcolm W. Browne, *Scientist Says Low Radon Levels May Be Harmless*, N.Y. TIMES, Sept. 28, 1988, at B7 ("The physicist, Dr. Bernard L. Cohen of the University of Pittsburgh, said the level of radon that is hazardous has not been determined. ... But he cited data suggesting that the Government is being overly cautious in urging renovation of millions of houses to reduce radon dangers."); *Radon Danger Estimate Lowered*, NEWSDAY (N.Y.), Feb. 2, 1991, at 9 ("A study issued by the National Research Council said that earlier estimates of the risk of lung cancer in homes [with radon] may have overstated the danger by 20 to 30 percent."); *U.S. Overestimates Peril of Radon in Homes, New Study Says*, N.Y. TIMES, March 29, 1991, at B6 ("A new study suggests that Americans are exposed to only about a third as much radon inside their homes as monitoring devices indicate, and that many have probably spent money needlessly to get rid of the gas."); *Radon: Cancer Killer?*, POPULAR SCI., May 1989, at 8 ("In counties where lung cancer in women would have been expected to be up 25 percent from the [elevated] radon levels, the incidence of cancer were actually down 30 percent.").

18. EPA responded to the National Academy of Sciences report that the estimates of the risk of lung cancer caused by residential radon may have overstated the danger by 20 to 30% by announcing that it would probably reduce its estimates of the amount of lung cancer caused by radon gas in homes. Warren E. Leary, *U.S. Study Finds A Reduced Cancer Danger From Radon In Homes*, N.Y. TIMES, Feb. 2, 1991, at A10.

did not, however, assume an active part in pursuing legislation mandating the testing for and remediation of residential radon.¹⁹ Rather, the federal government assumed and has maintained an advisory role, leaving the states and local governments to attend to the specifics of how to handle, if at all, the problems associated with the pollution.²⁰

The surge in case law forecasted by some commentators²¹ never materialized during the decade since Stanley Watras' predicament made radon a household word, notwithstanding the fact that numerous articles suggested many legal approaches to recovery of damages for homeowners who found dangerous levels of radon in their homes.²² Moreover, public interest in the radon problem took a precipitous decline

"An environmental agency official said the new estimate of deaths from lung cancer caused by radon would probably be 16,000 a year, down from 21,000." *Id.* See *Clearing The Air*, APPLE SEEDS: A PUBLICATION FOR U.S. HEALTHCARE MEMBERS, Spring/Summer 1992, at 28 [hereinafter *Clearing the Air*]. The EPA now estimates that 14% of lung cancer deaths that occur each year (143,000 in 1991) are attributable to radon. *Id.* at 29.

19. See Mark Jaffe, *Radon: An Enemy of a Different Stripe*, PHILA. INQUIRER, Sept. 18, 1988, at 1-C. EPA officials did not believe that a massive federal program was necessary or desirable. "'With radon we are dealing with a different problem than the agency has traditionally dealt with,' said Margo Oge, director of EPA's radon program. 'Radon occurs naturally. It is not a regulatory problem,' she said. 'We can't regulate the earth or homeowners.' The radon problem will have to be dealt with, EPA and state officials agree, house by house." *Id.*

20. *Id.* The federal government sees its role as a catalyst, not a principal mover in the resolution of the radon problem. EPA "will develop data about radon dangers, target high risk areas, provide information to the public and regulate the industry that tests and cleans up radon." *Id.* See also Locke, *supra* note 10, at 10,476; Jackowitz, *supra* note 3, at 337-44; Moore, *supra* note 8, at 47-49; see *infra* notes 21-233 and accompanying text.

21. See, e.g., Galen, *supra* note 2, at 1; Cross & Murray, *supra* note 10, at 688; Dearing, *supra* note 8, at 827.

22. See, e.g., Nichols, *supra* note 8; Shepherd & Gaynor, *supra* note 8, at 8-9; Levin, *supra* note 10, at 136; Carolyn M. Shuko, *Radon Gas: Contractor Liability for an Indoor Health Hazard*, 37 DEF. L.J. 361, 369-388 (1988); Cross & Murray, *supra* note 10, at 702-24; Sheldon Winicour, Note, *Clearing The Air On Radon Testing: The Duty Of Real Estate Brokers To Protect Prospective Homebuyers*, 15 FORD. URB. L.J. 767, 773-95 (1987); Dearing, *supra* note 8, at 830-46; Waltz, *supra* note 10, at 1118-55; Mary Rose Kornreich, *Dealing with the Invisible Trap of Radon Liability*, PRAC. REAL EST. LAW, Sept. 1987, at 17, 23-30 (1987); Kevin L. Shepherd, *Drafting Radon Contingency Clauses*, PRAC. REAL EST. LAW, Jan. 1990, at 43, 44-50 (1990); Conaway, *supra* note 10, at 38-48; FRANK B. CROSS, LEGAL RESPONSES TO INDOOR AIR POLLUTION 133-52 (1990).

as the ten year anniversary of the discovery of the radon dilemma approached, despite the fact that EPA periodically reaffirmed its position on the dangers of residential radon.²³

At the same time, the public interest and concern seemed to be focused on the newest "danger of the month," such as power lines that emit electromagnetic fields, or EMFs, and computer terminal radiation, among others.²⁴

This Article examines the status of the residential radon problem after its first decade since discovery as a "widespread national problem"²⁵ and "one of today's most serious public health issues."²⁶ Section I of this Article examines the source and extent of the radon problem. Section II examines the legislative and judicial responses to residential radon during the past ten years. Included in this section is a discussion of the probable legal theories under which litigation would likely proceed in actions involving the sale of residential real estate and an analysis of the reasons why the anticipated surge of litigation involving radon has not yet materialized. Section III looks to the residential radon problem in the years ahead with a discussion of recommendations for legislative initiatives as well as private efforts to foster testing for and remediation of radon contamination.

I. THE RADON PROBLEM: WHAT IS IT?

Radon is a colorless, odorless, tasteless, radioactive gas emitted from naturally decaying uranium found in the earth's crust.²⁷ As one

23. Locke, *supra* note 10, at 10,475-76. The author notes, "[D]espite efforts to educate homeowners and others about radon's dangers and how to cope with them, Americans' response so far has been spotty." *Id.* at 10,475. Moreover, the author states, "Despite these efforts to inform the public ... only about two percent of the nation's homeowners have acted to identify or correct radon problems." *Id.* at 10,476.

24. See, e.g., *Tungsten-Halogen Bulbs May Pose a Hazard*, N.Y. TIMES, July 30, 1991, at C4 (concerning ultraviolet radiation); Karen Auge, *Owners Find Their Homes On the Line*, PHILA. INQUIRER, Jan. 2, 1992, at 4-BC (concerning electromagnetic fields (EMFs) caused by power lines); Ronald E. Roel, *Low-Level Radiation Becomes A High-Level Concern*, NEWSDAY (N.Y.), March 25, 1990, at 70 (concerning radiation emissions from computer terminals); *On Healthy Indoor Air, and Avoiding Suits*, N.Y. TIMES, May 15, 1992, at B20 (concerning "sick buildings" caused by lack of ventilation and unsatisfactory heating and air conditioning design).

25. Prussman, *supra* note 10, at 715.

26. Jaffe & Purdy, *supra* note 13, at A1.

27. See generally A CITIZEN'S GUIDE, *supra* note 3.

commentator explained:

Three different isotopes of uranium are present in the earth's crust: uranium-238, -235, and -234. Radon-222 (radon gas) is produced midway through the decay cycle of uranium-238. Although it is an inert gas that does not react chemically with other elements or compounds, it undergoes radioactive decay and produces "radon progeny" or "radon daughters." Unlike radon, these radon progeny (polonium, bismuth, lead-214, and lead-210) are electrically charged and chemically active. They can attach themselves to air particles and when inhaled become lodged in the lung. Trapped inside the lung in close proximity to sterile lung tissue, radon progeny continue to decay, giving off radiation that can weaken, chemically alter, or damage the lung.²⁸

Uranium is commonly found in rocks such as granite, shale and limestone.²⁹ Radon may also be found in soils which have been contaminated with certain types of industrial wastes.³⁰ After being released into the air as a gas during the breakdown of uranium, radon can be found in the atmosphere and in enclosed spaces.³¹ Radon released into the outside air is virtually harmless because it is diluted to such low concentrations.³² Indoor radon, on the other hand, because it is trapped, can accumulate to dangerously high levels.³³ The problem is exacerbated in structures built since the energy-conscious 1970s and 1980s when energy efficiency in homebuilding was universally touted by builders as a selling point. While helping to conserve energy and lower

28. Locke, *supra* note 10, at 10,475 n.2. The radiation given off during the decay process may affect DNA molecules in a manner which reorganizes its molecular structure and changes the cell's genetic coding. If the cell still remains capable of reproducing, it may become abnormal or cancerous. Shuko, *supra* note 22, at 363.

29. Shuko, *supra* note 22, at 362-63.

30. A CITIZEN'S GUIDE, *supra* note 3, at 1.

31. *Id.*

32. *Id.*

33. *Id.* Indoor radon levels are typically five to ten times higher than outdoor levels. However, depending upon the concentration of radon in the soil surrounding a structure as well as the construction of the structure, radon levels can be several thousand times higher than the outdoor level. Jackowitz, *supra* note 3, at 331 n.15.

energy costs, such efforts at airtight construction reduced ventilation which dilutes radon concentrations.³⁴ Although the principal method in which radon gains access to structures is through seepage from surrounding soil,³⁵ radon may also enter structures from building materials, such as bricks or stone, and from well water.³⁶

A. *Residential Radon: Its Discovery and Health Risks*

Although the dangers of residential radon did not become a matter of public concern until publicized pursuant to the Watras case,³⁷ health concerns have been associated with uranium and radium mining since the 1500s.³⁸ The premature deaths of such miners due to respiratory illness were linked to malignant lung tumors almost three hundred years later.³⁹ Because the miners excavated other minerals at the same time they excavated uranium, no definite link to uranium could be established.⁴⁰

Uranium mining began in the United States during the 1940s. In 1972, a study by the National Academy of Sciences Committee on Biological Effects of Ionizing Radiation found that the incidence of cancer among American workers was directly proportional to their exposure to radon gas.⁴¹ As uranium mining continues today,⁴² one

34. Jackowitz, *supra* note 3, at 331.

35. *Id.* at 332. Because radon is a gas, it can travel through small spaces in soil and rock and seep into homes through dirt floors, cracks in concrete floors and walls, floor drains, sump pump holes, joints or small cracks or pores in hollow-block walls. A CITIZEN'S GUIDE, *supra* note 3, at 4.

36. A CITIZEN'S GUIDE, *supra* note 3, at 4. When homes have some brick or stone construction, radon may be released from these building materials into the home. Moreover, radon may enter the water in private wells and be released into the air in the home when the water is used. Large community water supplies do not typically pose this problem since the radon would likely be released into the outside air before the water reaches the home. *Id.* See also U.S. ENVTL. PROTECTION AGENCY, PUB. NO. OPA-87-011, REMOVAL OF RADON FROM HOUSEHOLD WATER, (1987) [hereinafter REMOVAL OF RADON FROM HOUSEHOLD WATER].

37. See *supra* notes 1-3 and accompanying text.

38. Shuko, *supra* note 22, at 364.

39. *Id.*

40. *Id.*

41. *Id.* at 364-65.

42. States where uranium mining still exists include New Mexico, Arizona, Utah and Colorado. *Id.* at 364 n.26.

commentator noted:

This continued exposure to uranium and its radon byproducts, as well as the increased awareness of radon's carcinogenic effects, have led American miners to bring negligence suits against mining companies. These suits have alleged failures to maintain a healthy work environment. Miners have also sued the Environmental Protection Agency ..., challenging its standards for the disposal of uranium mill tailings.⁴³

These negligence suits are among the few precedents available to courts when confronted with plaintiffs' claims of naturally occurring residential radon-induced injury.

The Stanley Watras case, however, galvanized the issue of naturally occurring radon gas in the residential environment. In December 1984, Stanley Watras set off a radiation detection device as he reported for work.⁴⁴ Watras triggered the alarm while approximately three feet away from a radiation detection device at the Limerick Nuclear Power Plant where he was employed as an engineer.⁴⁵ After it was determined that Watras was not picking up radiation at the power plant, Watras and his wife decided to test their split level home located in Boyertown, Pennsylvania.⁴⁶ They discovered that their home was contaminated with an excess amount of radon gas. The home registered a reading of 4400 picoCuries per liter of air ("pCi/l"), more than one

43. *Id.* at 365 (footnotes omitted); *see, e.g.,* Begay v. Kear-McGee Corp., 499 F. Supp. 1317, 1317-25 (D. Ariz. 1980) (alleging that exposure to radon while working in defendant's mine caused decedents to contract cancer). The uranium mill tailings cases involve radioactive waste materials of the uranium milling process. During the 1950s to mid 1960s builders in Grand Junction, Colorado, used tailings as landfill. During the late 1960s, it was discovered that homes and other structures built upon the tailings fill had significant concentrations of radon gas. *See* Shuko, *supra* note 22, at 365 n.31; *see also* Brafford v. Susquehanna Corp., 586 F. Supp. 14 (D. Colo. 1984); American Mining Congress v. Thomas, 772 F.2d 617 (10th Cir. 1985); T & E Industries v. Safety Light Corp., 587 A.2d 1249 (N.J. 1991).

44. Jackowitz, *supra* note 3, at 329.

45. Shuko, *supra* note 22, at 367.

46. Galen, *supra* note 2, at 1.

thousand times the EPA's suggested maximum of 4 pCi/l.⁴⁷ The radon levels in the home were said to be the equivalent of smoking 135 packs of cigarettes per day or being exposed to 455,000 chest x-rays per year.⁴⁸

What made the Watras case so noteworthy and newsworthy was the distressing fact that the extremely high radon levels in the home were the result of an entirely natural phenomenon. There were no toxic waste dumps or other man-made activities at play except for the energy efficient construction of a relatively airtight house which diminished drafts and other avenues for radon-diluting ventilation. As Stanley Watras stated, "Man didn't put [radon] in the ground; who are we going to sue, God?"⁴⁹

As noted earlier, the original sources of naturally occurring residential radon are the uranium and radium in the earth's crust.⁵⁰ Virtually every geographic area contains some amount of these elements.⁵¹ Consequently, radon gas is emitted from the earth's crust throughout the world. There are, however, varying concentrations of these elements in the earth's crust. Thus, higher radon gas levels are found in areas where there is a greater concentration of uranium soils.⁵² In the United States, the highest concentrations of uranium soils have been found in the Reading Prong area of eastern Pennsylvania, western New Jersey, Florida, most of New England, the eastern slope of the Appalachians, the Georgia and Carolina coasts and in scattered areas in Wisconsin, Minnesota and west of the Rocky Mountains.⁵³ Even within these high concentration areas, it is not uncommon for one house to have high levels of indoor radon and for an adjacent property to have a negligible level.⁵⁴ Furthermore, although indoor radon levels are clearly

47. Jackowitz, *supra* note 3, at 330; *see also supra* note 3 and accompanying text. The government's upper limit of 4 pCi/l is by no means considered to be a totally safe radon level. "By the government's own admission, people living in homes contaminated at a level of 4 picoCuries face the same risk of lung cancer as they would from smoking a half-pack of cigarettes a day or from receiving 200 chest x-rays a year." Matthew Purdy, *Guideline On Radon Misleading*, PHILA. INQUIRER, Oct. 24, 1988, at 1-A.

48. Jackowitz, *supra* note 3, at 330.

49. Galen, *supra* note 2, at 1.

50. *See supra* notes 27-36 and accompanying text.

51. *See* CROSS, *supra* note 22, at 6.

52. *Id.*

53. *Id.*

54. *Id.*

related to the soil concentrations in the particular area, it does not follow, a priori, that areas of relatively low uranium soil concentration are free from the residential radon hazard. As one commentator noted, "Soil gas flow and other factors also matter. For example, the Spokane River Valley has only average soil radium content, but many homes in the valley have unusually high indoor radon concentrations."⁵⁵

Radon gas enters houses and builds to high concentrations in a variety of ways. Typically, the gas seeps through cracks in foundations and tiny pores or cracks in hollow-block walls, as well as through openings specifically made for water, sewage or gas pipes.⁵⁶ Even houses with no discernable cracks in solid concrete foundations cannot totally prevent radon gas seepage.⁵⁷ One commentator noted, "It is impossible to construct a building that prevents the entry of radon gas."⁵⁸

Radon gas can also enter private well water and be released into the air when the water is used.⁵⁹ Although viewed as a much less serious source of radon contamination, EPA estimates that radon released from household water use causes from 100 to 1800 lung cancer deaths each year.⁶⁰ Similarly, building materials, such as concrete blocks or

55. *Id.* at 7. In a letter to the editor, William N. Stasiuk, Director, Center for Environmental Health, New York Department of Health, noted that high radon levels can occur anywhere in New York state, even in areas of normal or low concentrations of radium in the soil. Stasiuk explained:

These areas are characterized by gravel deposits in which the ground water is more than 10 feet to 20 feet below the surface. Indoor radon levels become elevated because soil gas moves easily through gravel, and more of it can be pulled into the indoor environment. We urge people who live in such areas to test for radon.

William N. Stasiuk, *Radon In Homes Associated With Gravel Deposits and Soil Gas*, N.Y. TIMES, Jan. 25, 1991, at A28.

56. See CROSS, *supra* note 22, at 7; see also A CITIZEN'S GUIDE, *supra* note 3, at 4.

57. See CROSS, *supra* note 22, at 7.

58. *Id.*

59. A CITIZEN'S GUIDE, *supra* note 3, at 4.

60. See REMOVAL OF RADON FROM HOUSEHOLD WATER, *supra* note 36, at 1. One commentator noted that:

In some locations, however, ... water or natural gas may produce significant amounts of radon exposure. Radon gas may escape from water during showering, washing, drinking, and related activities.

bricks produced from materials containing radioactive elements, may be a source of indoor radon contamination. Although not considered a primary source, building materials may account for three to ten percent of all radon exposure or up to 2000 deaths yearly.⁶¹

Shortly after the discovery of naturally occurring radon in the Watras home, EPA began conducting a nationwide radon-assessment survey.⁶² EPA found that radon may be a problem throughout the United States,⁶³ and in 1988 declared that contamination of homes across the nation by cancer-causing radon was the nation's "most serious" air pollution problem.⁶⁴ Moreover, a joint announcement by the Administrator of EPA and the Assistant Surgeon General of the United States Public Health Service recommended that virtually every home in the nation should be tested for radon gas.⁶⁵ Furthermore, the federal officials warned that millions of homes had elevated levels of radon, that an estimated 20,000 deaths each year were caused by radon, that radon exposure exceeds by ten times the threat posed by outdoor air pollution, that radon gas was second only to cigarette smoking as a cause of lung cancer and that radon exposure raises the risk of lung cancer for a nonsmoker to that of a smoker.⁶⁶ Finally, Dr. Vernon J. Houk,

Radon concentrations in New England well water run into tens of thousands of picocuries per liter (pCi/L) [sic], and radon levels tend to be higher in privately supplied water. The American Medical Association estimated that privately supplied water in the New England and Appalachian regions may account for 35 percent of indoor radon air exposures in these regions. Water wells in Georgia often exceed 2,000 pCi/L of radon. Texas and the Carolinas also have high average levels of radon in groundwater. In the 18 percent of homes using private wells for their water supplies, water may contribute an average of 0.5 pCi/L radon to the indoor air. In more than 1 percent of U.S. homes, well water causes indoor exposures of 1 pCi/L or greater, in addition to whatever indoor level is caused by ground emissions.

CROSS, *supra* note 22, at 10 (footnotes omitted).

61. CROSS, *supra* note 22, at 10.

62. Galen, *supra* note 2, at 8.

63. CROSS, *supra* note 22, at 8.

64. Jaffe & Purdy, *supra* note 13, at 1-A.

65. *Id.*

66. *Id.* Radon is said to be 15 times more dangerous to smokers because they do not exhale it as readily as nonsmokers. *Id.* While exposure to radon is typically linked to lung cancer, and occasionally stomach cancer, a British study also linked exposure to

Assistant Surgeon General of the United States Public Health Service announced that he would not buy or move into a home without knowing the radon level in it.⁶⁷

A building's construction characteristics play a major role in determining whether the building is likely to have a potential radon problem. One commentator summarized the building's role in assessing the likelihood of radon contamination:

Houses with basements, crawl spaces, and sump holes tend to have higher concentrations. ... [T]he number and size of cracks and penetrations of the foundation affect the amount of radon entering a house. One study found that "[r]adon levels in houses where [the slab] is badly cracked seem to be only about 30 % higher than in houses where it is uncracked." This feature of foundations seems less significant, however, than do pressure differentials.

Differences in pressure and temperature between the indoor and outdoor environments may suck high levels of radon into a house, much as a vacuum draws a gas. Differences in temperature cause pressure differentials. Heating a house creates a convection pattern that draws in

radon gas to leukemia in children and adults, brain, spine, bone and skin cancer in children, and kidney and skin cancer in adults. See Edith M. Lederer, *Radon Linked To Variety Of Cancers*, PHILA. INQUIRER, April 29, 1990, at 5-A; Prussman, *supra* note 10, at 721.

67. Jaffe & Purdy, *supra* note 13. The joint announcement of EPA and the U.S. Public Health Service was prompted by a survey of 11,000 homes in seven states that found dangerous levels of radon in almost one-third of the homes. *Id.* EPA estimated, therefore, that as many as eight million homes across the nation may be tainted. Moreover, the federal officials noted that the potential for radon contamination is so widespread that they suggested only people living in apartments above the second floor of a building need not test for radon contamination. *Id.* The survey revealed, for example, that 31% of the homes examined in Pennsylvania had levels of radon above the EPA guideline of 4 pCi/l and that 65% of the homes in North Dakota and 40% of the homes in Minnesota had high radon readings. *Id.* at 6-A. The government's announcement not only triggered a firestorm of concern from worried homeowners, but it also firmly established in the public mind the 4 pCi/l standard as the threshold value for radon remediation. Notwithstanding EPA's own admission that 4 pCi/l is not necessarily a safe level, but rather a technologically attainable level, the 4 pCi/l measurement initially assumed prodigious power in making or breaking real estate sales. *Id.* See Austin, *supra* note 16.

air from its understructure. Wind may also depressurize the interior of a house. This effect is exacerbated by installed equipment, including exhaust fans, fireplaces, and even water heaters. The pressure-differential factor apparently explains a great deal of radon entry in housing.

The rate of radon entry explains only a part of indoor radon exposure. The rate of radon exit has an equally powerful effect on indoor concentrations. Even high entry levels will not produce high concentrations, if the radon quickly exits the house. The exit of radon is largely dependent on the ventilation of a building, typically measured in air changes per hour Buildings with high ventilation levels typically have lower levels of indoor radon and other pollutants.⁶⁸

The energy conservation efforts of the 1970s, particularly in new home construction, have only added to the lack of ventilation. Although the finding is controversial,⁶⁹ the more energy-efficient home actually may present a more serious potential for radon contamination.⁷⁰

In addition to the controversy surrounding the impact of energy-efficient construction on indoor radon levels, an even livelier debate

68. CROSS, *supra* note 22, at 8 (footnotes omitted).

69. *See id.* at 8-9. The controversy surrounding energy conservation methods and indoor radon concentrations seems to be primarily related to the fact that some energy-efficient construction methods may in fact impede the ability of radon gas to enter the structure in the first instance. *See id.* at 9. The general indication, however, is that energy-efficient construction methods more often exacerbate the radon problem than reduce it. *See id.* As one commentator pointed out:

Some [studies] have found that energy-efficient homes have two to five times the indoor radon concentrations. EPA once estimated that the Department of Energy's weatherization program perversely would cause thousands of additional deaths from indoor radon. Other recent studies have found little or no correlation between reduced ventilation rates and increased radon concentration. ... Nevertheless it is a physical certainty that, for any given entry rate, reduced ventilation will increase indoor radon concentrations.

Id. (footnotes omitted).

70. *See id.* at 9. Where radon is present in a building, its concentration will be inversely proportional to the ventilation rate. *Id.* For example, a 50% reduction in ventilation will double the indoor radon concentration. *Id.*

exists about the level of radon exposure that should be deemed a significant health risk. Notwithstanding all of the attention the problem of residential radon contamination has received during the past decade, there appears to be only one certainty among commentators concerning the health risks posed by the naturally occurring gas: A causal relationship exists between exposure to high levels of radon and increased incidence of lung cancer.⁷¹ The controversy, and hence the confusion, concerns the level of radon exposure which poses a significant health risk.⁷² Although it appears well-settled that indoor radon contamination may be a problem throughout the United States, "experts have heatedly debated what should constitute an 'acceptable standard' for indoor radon levels."⁷³ Scientists have not yet been able to determine the lowest level of radon that increases one's risk of developing lung cancer over a period of time.⁷⁴ As one commentator noted, "The task, therefore, is to define the minimum radon level that may cause significant harm to building occupants."⁷⁵

Following the publicity engendered by the Watras case, EPA examined published data concerning radon exposure in the mining industry.⁷⁶ By extrapolating the data relating to the miners, EPA arrived at a recommended maximum average level of indoor radon of 4 pCi/l.⁷⁷ The EPA guideline of 4 pCi/l is considered to be an action level -- a level above which remediation to reduce the amount of indoor radon should be contemplated.⁷⁸ With regard to a 4 pCi/l reading or lower, EPA advised: "Exposures in this range are considered average or slightly above average for residential structures. Although exposures in this range do present some risk of lung cancer, reductions of levels this low may be difficult, and sometimes impossible, to achieve."⁷⁹

71. See Kornreich, *supra* note 22, at 18.

72. See *id.*; Cross & Murray, *supra* note 10, at 696.

73. Shepherd & Gaynor, *supra* note 8, at 7. Any exposure to radiation, such as radon, is considered potentially unhealthy. See Cross & Murray, *supra* note 10, at 696. Consequently, there is no completely safe level of radon exposure. See *id.* This assumption is not presently supported by epidemiological data. See *id.*; Kornreich, *supra* note 22, at 19.

74. See Shelley Bookspan, *Radon: The Risks of a Natural Gas*, 19 REAL EST. L.J. 363, 364 (1991).

75. Cross & Murray, *supra* note 10, at 696.

76. See Bookspan, *supra* note 74, at 364.

77. A CITIZEN'S GUIDE, *supra* note 3, at 7.

78. See *id.*

79. *Id.* at 11.

Because epidemiological data for indoor radon is virtually nonexistent,⁸⁰ the actual risk of lung cancer at or above 4 pCi/l is not known.⁸¹ EPA estimated that out of 1000 persons exposed to a radon level of 200 pCi/l for seventy years, 440 to 770 are expected to die of radon-induced lung cancer.⁸² For comparison purposes, their risk is deemed slightly greater than that of a four pack-per-day cigarette smoker.⁸³ For readings at this level, EPA recommends that homeowners take action within weeks to reduce indoor radon levels.⁸⁴ Similarly, exposure to radon at levels between 20 and 200 pCi/l is considered too far above average and should be remediated within several months.⁸⁵ Out of 1000 persons exposed for seventy years to a reading of 20 pCi/l, 60 to 210 are expected to die of radon-induced lung cancer.⁸⁶ Even exposure at 4 pCi/l is said to pose the risk of lung cancer for between 13 and 50 people for every 1000 exposed at that level to indoor radon over a seventy year period.⁸⁷

EPA estimated that approximately 5000 to 20,000 residential radon-induced lung cancer deaths occur each year.⁸⁸ At the height of the 1988 media blitz concerning the issue of indoor radon, the larger estimate was almost universally used.⁸⁹ As one commentator observed, "Many sources now have broadcast the news that indoor radon exposures

80. See Kornreich, *supra* note 22, at 19. Some studies examining the radon levels in homes of persons dying from lung cancer to levels in homes of those dying from other causes suggest that the estimates of risk proffered by EPA are reasonable. See *id.*; see also Cross & Murray, *supra* note 10, at 696-97 (discussing the reliability of the EPA's indoor radon level guidelines).

81. See Bookspan, *supra* note 75, at 364.

82. A CITIZEN'S GUIDE, *supra* note 3, at 9.

83. *Id.* at 10.

84. *Id.* at 11.

85. *Id.*

86. *Id.* at 10.

87. See Kornreich, *supra* note 22, at 19; A CITIZEN'S GUIDE, *supra* note 3, at 10. EPA estimates are based not only upon a 70 year exposure but also are premised upon a person's spending 75% of their time in the home. See Kornreich, *supra*, note 22, at 19.

88. See A CITIZEN'S GUIDE, *supra* note 3, at 1.

89. See, e.g., *Behind the Door: Pollution is Bad Outside, But Problems Also Lurk Within*, CHICAGO TRIB., Dec. 18, 1988, at D18; *Radon-Cancer Link Examined in Study*, N.Y. TIMES, Nov. 28, 1988, at B2; Sam Hankin, *Codes Changing Slowly to Meet Radon Threat*, Wash. Post, Nov. 12, 1988, at E2.

may be responsible for 20,000 deaths annually."⁹⁰ Moreover, lifestyles are said to impact the risk of radon-induced cancer. For example, smokers and children are believed to be more susceptible and those who sleep or spend considerable time in lower portions of a house, such as basements, are said to be at greater risk.⁹¹

Although EPA made clear that its projections on the health risk of radon were estimates based upon scientific studies of miners exposed to varying levels of radon gas in their work,⁹² and although most commentators evidenced no serious objections to EPA's strong warnings on indoor radon based upon those studies,⁹³ EPA's warning and the panic it created to test for and remedy indoor radon soon came under attack.⁹⁴ Most critics claimed that EPA's guideline of 4 pCi/l as the action level for indoor radon remediation was too stringent and was not supported by actual scientific data. There was also criticism which claimed that EPA's 4 pCi/l action level was misleading the members of the public into a false sense of safety if their homes tested at or near the 4 pCi/l level.⁹⁵

Shortly after EPA's 1988 announcement that indoor radon was the nation's most serious air pollution problem,⁹⁶ an epidemiologist at the National Cancer Institute declared that even if radon were reduced in all homes to EPA's recommended 4 pCi/l level, there would be only a marginal reduction in the health risk posed by indoor radon.⁹⁷

90. Cross & Murray, *supra* note 10, at 696. In 1991, following a report released by the National Academy of Sciences that said earlier estimates of the risk of lung cancer caused by indoor radon may have overstated the danger by 20 to 30%, EPA indicated that it would probably reduce its estimates. *See supra* notes 17-18 and accompanying text.

91. *See* A CITIZEN'S GUIDE, *supra* note 3, at 12; Winicour, *supra* note 22, at 768 n.5.
92. *See* A CITIZEN'S GUIDE, *supra* note 3, at 2.

93. *See, e.g.,* Cross & Murray, *supra* note 10, at 696-97. The authors noted that, "The studies of radon risk have taken identified risk levels [gathered by measuring uranium miners] and extrapolated downward to the radon levels found in the indoor environment. While some uncertainties remain in this risk assessment process, the procedure is regularly employed by expert government agencies and may even understate the true risks of indoor radon." *Id.* (footnotes omitted).

94. *Id.*

95. *See* Cross & Murray, *supra* note 10, at 698.

96. *See supra* notes 63-67 and accompanying text.

97. Purdy, *supra* note 47, at 4-A. EPA has admitted that the 4 pCi/l threshold is not necessarily a safe level of indoor radon: "'The risks at 4 [pCi/l] are not insignificant.' ... 'It's equivalent perhaps to smoking a half a [sic] pack of cigarettes a day. That's

Although EPA attempted to disclaim any efforts on its part to encourage reliance upon its 4 pCi/l threshold as absolutely safe, that standard nonetheless assumed extraordinary powers among homeowners, the real estate industry and professional radon testers.⁹⁸ Some members of Congress expressed similar concerns about the EPA's 4 pCi/l guideline.⁹⁹ Then Congressman James J. Florio (D., N.J.) charged that the EPA's "standard kills people. ... It's almost a semi-fraudulent [sic]

maybe more risk than some people want to accept. We have to dispel the image that 4 [pCi/l] is safe flying.'" *Id.* EPA's position in recommending the 4 pCi/l guideline is based upon pragmatic considerations:

[T]he [4 pCi/l] guideline was set because federal officials believed that radon in most contaminated homes could be reduced to that level fairly easily without frustrating, scaring or bankrupting homeowners [T]echnology makes it difficult and expensive to reduce radon much further in most homes. ... [T]he federal government has essentially told people to stop trying once they reach 4 picocuries, not because it is a safe level, but because it is -- as government officials say -- "doable."

Id.

98. *See id.* The critics of EPA's use of the 4 pCi/l guideline contend that the standard gives a false sense of security to homeowners who test their property and receive reports of radon contamination in the 4 pCi/l range. *See id.*

"If it's below 4 [pCi/l], most people believe they're safe and clear," said Harold Stesis, president of the U.S. Toxic Substance Testing Bureau, a Philadelphia-based company that conducts radon testing nationwide. "If you try to give advice that's not in accordance with the EPA, you're really putting your neck on the line."

Id. Prior to using the 4 pCi/l standard, EPA considered setting no guideline because it was believed that no level of radon was considered safe. *Id.*

However, upon further reflection it was feared that without a guideline, no one would act. *Id.* Unfortunately, the subtleties of EPA's suggested guideline of 4 pCi/l have been lost on the public. One residential radon mitigation contractor noted that the 4 pCi/l level can be crucial when it comes to selling a home: "If the level in your home tests at 4.1 [pCi/l], you might have trouble selling it." Austin, *supra* note 16, at 4-H. Moreover, the contractor noted that the issue of radon testing and remediation has become a real estate problem: "What's happening is that a lot of real estate transactions are being determined by a radon screening, but there are actually no protocols for testing under real estate conditions.'" *Id.* at 1-H.

99. *See Purdy, supra* note 47, at 4-A.

representation. EPA should not be affirmatively misleading people."¹⁰⁰

However, it was the critics who charged that the 4 pCi/l guideline was too stringent and unsupported by scientific data who received the lion's share of the publicity. Following EPA's announcement concerning the dangers of indoor radon, Dr. Bernard L. Cohen, a physicist at the University of Pittsburgh, asserted that the level of radon that is hazardous has not been determined. He cited data suggesting that EPA was being too cautious in urging remediation of millions of houses to reduce radon levels.¹⁰¹ Dr. Cohen based his findings on a review of studies of average radon levels and average lung cancer rates in countries such as the United States, Scandinavia and China. He found that areas with high concentrations of naturally occurring radon tended to have low average rates of lung cancer.¹⁰²

One commentator argued that federal officials were advising the American public about allegedly dangerous radon levels prematurely. As a result, homeowners were testing and remedying homes before epidemiological studies confirmed the need to take such costly measures.¹⁰³ Furthermore, he concluded that even if a correlation

100. *Id.* Florio charged that even radon below 4 pCi/l is unsafe. "The Environmental Protection Agency is not telling people the full story, because it would cost more to do the job right," Florio said ... at a hearing of the National Cancer Advisory Board." Austin, *supra* note 16. Florio also contended that setting a lower guideline would provide the incentive to develop the technology to reach the lower standards. See Purdy, *supra* note 47, at 4-A.

101. See Browne, *supra* note 17.

102. *Id.* Although Federal health officials have estimated that long-term exposure to radon is responsible for 5,000 to 20,000 lung cancer deaths each year, they do concede that most of these deaths occur among people who smoke. *Id.* Smoking greatly increases the risk of radon. *Id.* Dr. Cohen, of the University of Pittsburgh, argued that a threshold value of radon below which there is no health risk exists. *Id.* He noted an area in southeastern Finland where homes have an average radon level of 8 pCi/l, which is eight times as high as the world average and three times the average for Finland as a whole, and yet the lung cancer rate is significantly lower than in other areas of Finland. *Id.* Moreover, he cited another study of a county in Sweden where there is an average indoor radon level of 12 pCi/l, which is the highest yet reported for a large area, but where the lung cancer rate is only 75% as high as Sweden's national average. *Id.*

103. See Cole, *supra* note 17. Cole is critical of EPA's guideline on residential radon since it is based on the studies involving uranium miners:

Radon is a breakdown product of uranium, and miners exposed for years to high levels of it suffered higher rates of lung

between indoor radon and lung cancer could be established, the postponement of remedial action for a few years would have a negligible impact on the health of the residents because the supposed dangers of indoor radon are premised upon many years of exposure.¹⁰⁴

The most serious challenge to EPA's position on the risk of indoor radon based upon the experience of miners came in 1991 when the National Academy of Sciences released a report by its National Research Council. The report found that earlier estimates of the risk of lung cancer caused by indoor radon may have been overstated by twenty to thirty percent.¹⁰⁵ The report "concluded that 'direct extrapolation of risk estimates from the mining to the home environment may

cancer than the general population. But to assume that the radon concentrations affecting miners automatically apply to homeowners disregards important differences between the two environments.

The miners inhaled radon's radioactive particles, which had become attached to swirling dust generated by mining activities. Before ventilation systems were installed, radon concentrations were unremitting and miners were exposed to large amounts daily.

In homes, continuous swirls of dust are absent and radioactive particles are less likely to be inhaled. This is all the more true where people do not smoke. Concentrations of the gas and exposure of individuals may vary dramatically with the time of day, seasons, weather conditions and opening and closing of windows and doors. One or two high readings in the home may signal none of the health consequences of those in a mine.

Id. Cole also notes a study by the New Jersey Department of Health in which an effort to find a correlation between residential radon and lung cancer was unsuccessful. *Id.* 104. *Id.* Other commentators have suggested that the government may be acting prematurely in recommending remediation at lower levels of indoor contamination:

The EPA, however, estimates that from 5,000 to 20,000 lung cancer deaths are caused annually when radon is trapped and builds up to higher levels in buildings. Using EPA's figures, radon is the second leading cause, next to smoking, of the more than 120,000 annual lung cancer deaths in the United States. But one study has since indicated that of the lung cancer deaths attributed to radon, only about 500 were nonsmokers, suggesting that much more research is needed on radon's true health effects.

Lee, *supra* note 16.

105. See Leary, *supra* note 18.

overestimate the numbers of radon-caused lung cancer cases."¹⁰⁶ The report specifically questioned the application of studies on miners breathing radon in mines to homeowners breathing radon indoors: "But if levels of radon exposure are equal in a home and in a mine, ... the lung tissues of miners get a greater dose of radiation than those of people in the home because the miners are breathing more deeply from exertion."¹⁰⁷ In response to the report released by the National Academy of Sciences, EPA said it would probably reduce its estimates of the amount of lung cancer caused by indoor radon.¹⁰⁸

Shortly thereafter, another study questioned EPA's estimate of the risks of indoor radon. A study conducted by Dr. Naomi H. Harley, a radiological expert at New York University Medical Center, found that homeowners are exposed to only a third as much radon inside their homes as monitoring devices indicate.¹⁰⁹ The study was the first to examine how much radon people are actually exposed to rather than how much radon is found in a particular part of the house.¹¹⁰ Again, an EPA spokesperson said the agency may eventually revise their risk estimates.¹¹¹

106. *Id.*

107. *Id.* The study challenged the application of the miners' experience to the home environment due to the fact that there is a higher breathing rate caused by the exertion put forth by the miners. Thus, the report noted, the miners were breathing increased amounts of air and radon. The report did concede, however, that radon-carrying dust particles in the home are smaller than in the mines and can be breathed deeper into the lungs. The report concluded, however, that the impact of rapid breathing in the mines probably outweighed the breathing of smaller particles. *Id.*

108. *Id.* EPA indicated that it requested the study because of concern regarding the relationship between the miners' health experience with radon and the residential population. *Id.* An EPA spokesperson concluded that "[t]he new estimates may give us lower numbers, but it increases our confidence in those numbers" *Id.*

109. See *U.S. Overestimates Peril of Radon in Homes, New Study Says*, *supra* note 17.

110. *Id.* Based upon radon readings in basements, EPA estimated that 20% of the homes in the United States should have some radon remediation. *Id.* Based upon her study, Dr. Harley concluded that approximately seven percent of homes in the United States may need remediation. In Harley's study, household members in 52 households in DuPage County, Illinois, wore personal radon monitors (developed specifically for the study), and radon detectors were placed throughout the house. Participants wore the monitors at all times for approximately three weeks. Dr. Harley found that the stationary radon detectors on the first floor recorded the most accurate radon levels in the house, and that the personal exposure to radon was about 70% of the first floor readings. *Id.*

111. *Id.*

Notwithstanding the onslaught of criticism concerning its estimates and projections on the risk of residential radon, EPA remained firm in its conviction that indoor radon continued to be one of the most serious health threats in the nation. Although the agency admitted it may have "garbled"¹¹² the message on the dangers of radon, it reiterated its firm support in the scientific community for the proposition that indoor radon poses a serious health threat.¹¹³

Although EPA was probably accurate in noting that the scientific community was in general agreement on the risks posed by indoor radon,¹¹⁴ the agency may not have fully realized the impact that the criticism of its estimates had on the public perception of radon as a serious health threat. The hysteria created by its earlier public warnings¹¹⁵ quickly waned.¹¹⁶ Although numerous explanations exist as to why the indoor radon problem has failed to capture fully the public's concern,¹¹⁷ at least part of the responsibility must be borne by EPA in its rush to form a judgment on the radon levels which pose serious health risks.

B. *Curing Residential Radon: Testing and Remediation*

Although the controversy over the level of indoor radon deemed

112. See Mark Jaffe, *Scientists Affirm Threat of Radon*, PHILA. INQUIRER, April 3, 1991, at 3-BR.

113. *Id.*

114. *Id.*; see also Bookspan, *supra* note 74, at 365.

115. See *supra* notes 15-16 and accompanying text.

116. As one commentator noted:

In fact, EPA considers dissemination of public information a high priority and many of EPA's radon-related activities have consisted of circulating information to the public about radon and radon-reduction methods. Despite these efforts to inform the public, however, only about two percent of the nation's homeowners have acted to identify or correct radon problems. This low response is partly due to the difficulties in communicating and mitigating radon risks -- difficulties that block the effectiveness of radon-related public information and awareness campaigns.

Locke, *supra* note 10, at 10,476 (footnotes omitted).

117. *Id.* at 12,476-77. Locke lists nine difficulties in communicating the risks of radon to the public. *Id.*; see *infra* text accompanying note 331.

to pose a health risk contributed to the apparent public apathy which greeted the residential radon issue less than a decade after its discovery, the debate over mechanisms and procedures for testing for the presence of the gas generated even more confusion.

In a pamphlet aimed at educating the public about the dangers of residential radon, EPA discussed two principal, commercially available methods to detect the presence of the odorless, colorless, tasteless gas: the charcoal canister and the alpha track detector.¹¹⁸ The charcoal canister is a device left in the house for a period of three to seven days, after which it is sent to a laboratory for analysis.¹¹⁹ The alpha track detector is exposed to indoor air for at least two to four weeks before it is sent to a laboratory.¹²⁰ Both devices have the benefit of being relatively inexpensive and easy to use.¹²¹ Consequently, citizens employed these devices most frequently to test for indoor radon.¹²² Because the charcoal canister test could be completed in a matter of days, it became the test of choice for most people who needed or wanted to test for radon.¹²³

EPA recommended that short-term screening devices be used in the lowest livable area of the home, such as the basement, as a preliminary test to give the homeowner an idea of the highest radon level in the home.¹²⁴ If the short-term test indicated a radon reading less

118. A CITIZEN'S GUIDE, *supra* note 3.

119. *See id.*; *see also* Nichols, *supra* note 8, at 142.

120. A CITIZEN'S GUIDE, *supra* note 3, at 5; *see also* Nichols, *supra* note 8, at 142. As one commentator noted with regard to these testing devices:

Their primary advantages are that they are simple; they are relatively inexpensive; and they provide averaged measurements over a period of time. The ability to provide the averaged data is particularly significant because radon levels often vary significantly from one day to another and with the seasons.

Prussman, *supra* note 10, at 723 (footnotes omitted).

121. Prussman, *supra* note 10, at 723. The charcoal canister device typically costs from \$10 to \$25, and the alpha track detector costs from \$20 to \$50. A CITIZEN'S GUIDE, *supra* note 3, at 5; Nichols, *supra* note 8, at 142.

122. Other testing devices are available, but not generally to the lay person. *See* A CITIZEN'S GUIDE, *supra* note 3, at 5; Shepherd, *supra* note 22, at 48.

123. *See* Shepherd, *supra* note 22, at 48.

124. *See* A CITIZEN'S GUIDE, *supra* note 3, at 6.

than 4 pCi/l, follow-up measurements were "probably not required."¹²⁵ When measurements were between 4 pCi/l and 20 pCi/l, EPA recommended that citizens pursue follow-up measurements.¹²⁶ If short-term measurements revealed radon readings above the 20 pCi/l level, EPA urged homeowners to conduct follow-up tests on a more expeditious basis.¹²⁷ EPA further recommended remediation to prevent indoor radon contamination if follow-up tests, usually tests of much longer duration,¹²⁸ confirmed these initial radon levels.¹²⁹ When the short-term tests revealed high radon levels, such as 20 pCi/l or above, a strong probability existed that the follow-up test would indicate at least a measurable radon reading. Therefore, a strong probability also existed that the property had sufficient radon contamination to warrant remediation.¹³⁰ The preliminary readings around the 4 pCi/l range, however, caused most of the confusion and misinformation.

Although the short-term testing devices, such as the charcoal canister, were said to be only preliminary devices to give the homeowner an idea of the highest radon reading in the home,¹³¹ this precursory apparatus instead became, in many instances, the final authority on the property's radon status.¹³² This occurrence became particularly true in

125. *Id.* at 7.

126. *Id.*

127. *Id.*

128. *See also* Bannworth, *supra* note 8, at 177-78.

129. A CITIZEN'S GUIDE, *supra* note 3, at 8, 11, 13.

130. Some short-term testing devices were found to give results which were off by 25% or more. *See* George Lobsenz, *Some Home Radon-test Kits Are Inaccurate, Group Says*, PHILA. INQUIRER, Jan. 5, 1989 (Magazine), at 1-D. A test reading of 20 pCi/l or more, even if overstated by 50%, would still yield a radon level considered dangerous by the EPA. *See* A CITIZEN'S GUIDE, *supra* note 3, at 11.

131. *See* A CITIZEN'S GUIDE, *supra* note 3, at 6-7.

132. Commentators have noted that radon tests have become crucial to the success of many residential real estate transactions and that the 4 pCi/l test result has assumed too much significance in the determination of whether or not a sale will succeed. William Brodhead, employer of radon-mitigation crews in Montgomery County, Pennsylvania, stated, "'It's really a real estate problem.' ... 'What's happening is that a lot of real estate transactions are being determined by a radon screening, but there are actually no protocols for testing under real estate conditions.'" Austin, *supra* note 16.

Mitchell Finkelstein, President of the Montgomery County Board of Realtors, said,

"People are getting misinformation and a lot of hype." ... "There has been very little done in uniformity of testing or in interpretation or the

the real estate setting where buyers insisted upon a radon test of the subject property prior to sale. In such transactions, time constraints often militated against the use of the more accurate, yet more time consuming, radon detection devices.¹³³

Once the charcoal canister device became routinely utilized as the first step in monitoring for indoor radon, its shortcomings started to become apparent.¹³⁴ Because indoor radon levels are a function of many variables, such as the season of the year and the type of weather,¹³⁵ test results, particularly those around the 4 pCi/l range,

validity of the radon scare. It's a situation of the government trying to do something and screwing it up. EPA hasn't really taken good leadership." ... "Still, some sales have fallen through because of radon." ... "It leaves the real estate industry in a very unsteady and uncomfortable situation."

Id. at 4-H. Brodhead added, "If the level in your home tests at 4.1 [pCi/l], you might have trouble selling it." *Id.*

133. One commentator noted that, "Despite all the disclaimers by the federal government, the [4 pCi/l] guideline has become virtual gospel among homeowners, the real estate industry and professional radon testers, as a safety standard." Purdy, *supra* note 47.

134. See Lobsenz, *supra* note 130. The EPA noted one of the most common shortcomings of the short-term radon-measuring devices when it stated that,

the screening measurement is not a reliable measure of the *average* radon level to which you and your family are exposed. Since radon levels can vary greatly from season to season as well as from room to room, the screening measurement only serves to indicate the *potential* for a radon problem.

A CITIZEN'S GUIDE, *supra* note 3, at 7 (emphasis in original); see also *infra* text accompanying note 140.

135. See Rae Tyson & Tracy Walner, *Nationwide Radon Test Urged*, USA TODAY, Oct. 19, 1989, at 8A. EPA recommended that all windows and doors should be closed during the testing period in order to keep the radon level relatively constant throughout the testing period. The agency, therefore, suggested that the test be done in the cool months of the year. *Id.* at 6. One commentator recommended the cooler months, preferably winter, to conduct the charcoal canister test because, "The increased difference in indoor/outdoor air pressure creates an environment in which more radon is likely to enter the home. Test results are therefore more reliable (and usually higher)." *Clearing The Air*, *supra* note 18, at 30. Other variables which are said to affect indoor radon readings include rainfall, soil type, vegetation, climate, and construction quality. See Marc Schogol, *Radon Testing*, PHILA. INQUIRER, March 20, 1991, at 1-D; see also *infra* note 125 and accompanying text.

were often unreliable indications of the property's true radon levels.¹³⁶ Moreover, once the variables which affect indoor radon readings were further identified, reports conflicted as to when it was best to test for radon in order to assure a more accurate result.¹³⁷ The short-term

136. Lobsenz, *supra* note 130.

137. While EPA encouraged short-term testing in the cooler months, *see* A CITIZENS' GUIDE, *supra* note 3, at 6, later studies cast doubt on EPA's advice. One study found:

Levels of radon gas in the soil may be as much as 10 times higher in the summer than in the winter, when most testing for the cancer-causing gas is done....

Experts say the unusually high seasonal variation raises questions about the reliability of radon tests in homes and buildings. The tests are normally conducted in the winter when indoor levels are believed to be highest.

"Since the radon in houses is derived from soil gas, you could have relatively high radon concentrations in the summer, when people least expect it and are least likely to test for it," said Arthur W. Rose, a geochemistry professor who conducted a study of radon levels in central Pennsylvania.

Indoor radon levels are thought to be higher in the winter because windows and doors are kept closed, reducing ventilation that would otherwise dissipate radon gas and prevent its accumulation to dangerous levels.

....
"If they have the house sealed in the summer because of air-conditioning, the rates in the house might be even higher than in the winter," Dr. Rose said.

....
"[T]he study's findings reinforce the belief of many scientists that one-time or short-term measurements of radon levels in the home may be misleading," said William J. Fisk, an environmental scientist at the Lawrence Berkeley Laboratory in California.

....
Although Dr. Rose is unsure of the reason for the seasonal variation, he said it may be caused by the dryness of the soil in the summer, which allows the gas to travel more easily.

Higher Radon Levels In Summer Cast Doubt On Reliability of Tests, N.Y. TIMES, May 23, 1989, at C4.

Other studies suggested similar doubts about the reliability of the short-term radon testing devices:

Rain can sharply increase the level of indoor radon, according to one

monitoring devices, such as the charcoal canister, often detected unrepresentative peaks or valleys of radon concentration.¹³⁸ Depending

study. A group of researchers from George Mason University in Fairfax, Va., found that moisture can be the biggest determinant of the radon level in a house. The moisture traps radon in the soil, so the radioactive gas accumulates below the house. When the moisture evaporates, the soil releases the gas in heavy concentrations. The higher the saturation of moisture in the ground, the heavier the subsequent emission of radon. Douglas Mose, one of the researchers, says the findings cast doubt on the validity of federal and state guidelines for taking radon measurements. He says the guidelines advise homeowners and potential home buyers who want to check radon levels in the summer to close the windows of the house beforehand. The assumption is that radon levels are higher in winter than in summer, when windows are often open.

But the readings may also be skewed by the level of precipitation, Mr. Mose says. To be meaningful, he says, the measurements should be taken in times of relatively normal weather.

Amal Kumar Naj, *Rain Stops the Radon -- But Only Temporarily*, WALL ST. J., Aug. 29, 1990, at B1.

Other commentators also suggested that EPA's guidelines for testing might need revision:

Forget those government recommendations for testing your home for radon in the winter. The theory was that tightly sealed doors and windows were likely to trap the radioactive gas and produce the highest readings. But experts have found that many factors -- such as rainfall, soil type, vegetation, climate and construction quality -- can cause high indoor radon readings. So "what you really want to do is test your house two times a year, or quarterly," advises Daniel J. Greeman, Pennsylvania State University geologist.

Schogol, *supra* note 135.

138. Following EPA's 1988 announcement claiming indoor radon as the nation's most serious air pollution problem, and the subsequent criticism leveled against the popular charcoal canister testing device, some advertisements for alternative testing devices stressed the need for continuous monitoring for the most accurate radon readings. One such advertisement noted:

It is estimated that the average radon level changes as much as 60% from season to season, while a simple change in the barometric pressure can change the level of concentration to at least five times the average level.

upon the test result, the homeowner was often led to a false sense of fear or a false sense of security. In addition to the confusion concerning the proper way to utilize the charcoal canister, many of the laboratories selling the canisters came under criticism for poor quality control procedures which lead to erroneous test results.¹³⁹ The consumer group Public Citizen urged EPA to ask Congress for authorization to establish a certification program for testing laboratories or mandatory standards for test kits.¹⁴⁰ Notwithstanding Public Citizen's claim that three of the nation's seven largest-selling EPA-approved home radon testing kits did not provide reliable measurements of radon, EPA declined to seek congressional authority to certify testing laboratories.¹⁴¹ The unreliability of the short-term charcoal canister test

....
Long term monitoring of your environment ... will give you the average level of radon. The typical charcoal canister will only give the highs and lows from a one or two week period.

Radon Monitoring, Survivor 2...Short and Long Term Protection For Your Home (Advertisement), POPULAR SCI., May 1989, at 69.

139. In late 1988 a Pennsylvania state legislator called for an investigation into the radon-testing industry. State Senator Michael A. O'Pake, who had earlier sponsored a law requiring certification for radon firms operating in Pennsylvania, cited a study by the *Patriot-News* in Harrisburg that found that wide variations in charcoal-test results can occur, even when several tests are placed in the same room at the same time. *A Review Sought On Radon Tests*, PHILA. INQUIRER, Dec. 1, 1988, at B-14. The *Patriot-News* study involved 16 charcoal radon tests produced by eight companies certified by the state to do radon testing. The tests were conducted at the same time and location in a house near Harrisburg known to have high levels of radon. The test results issued by the testing companies differed by as much as 133 %. Senator O'Pake noted, "I am troubled by the fact that properly certified testing firms came up with widely varied results in the newspaper study" *Id.* "Homeowners are using charcoal testing kits to make decisions which affect the health of their families" *Id.* "They need accurate readings. Homeowners cannot be expected to take the need for testing for radon seriously when tests yield such a wide variation in readings." *Id.*

140. See *Radon-Testing Labs Under Question*, NEWSDAY, Jan. 5, 1989, at 49.

141. The Ralph Nader-founded Public Citizen consumer group claimed that three of the seven top-selling radon test kits representing 70% or more of the market, and approved by the EPA, showed levels of radon as being much higher or not nearly as high as was actually the case. William Giese, *Your Home, Radon-Testing Problems*, CHANGING TIMES, April 1989, at 28-29. As one commentator stated:

EPA approval theoretically means the tests should measure within an accuracy of 25%. But the approval process wasn't careful enough:

kits not only resulted in misguided notions of security on the part of many homeowners concerning indoor radon contamination, but also contributed to improper decisions on costly remediation, particularly in real estate sales where time constraints precluded further lengthy, yet more accurate, testing.¹⁴² Consequently, this unreliability also furthered the growing distrust and sense of apathy on the part of the public with regard to the radon issue.¹⁴³

Although correcting a residential radon problem did not engender the controversy which attended the issues of radon health risks and testing, choosing among the various methods of radon remediation did present some difficult choices for the homeowner. Because radon levels can vary from house to house, each diagnosis and cure needs to be accomplished on a case by case basis.¹⁴⁴

EPA's guidelines suggested specific time periods within which

The ... [Public Citizen] tests show that three devices were off by more than 25% at least once.

Faced with the findings, EPA officials now concede that the agency muffed its product-testing responsibilities. "the radon-measuring program was not a perfect program," says former EPA spokesman Chris Rice. "The EPA should clean up its act."

Id. at 29; see also Lobsenz, *supra* note 130; *Radon-Testing Labs*, *supra* note 140.

142. Many buyers, sellers and real estate professionals do not understand or take the time to learn how a radon test should be conducted, the difference between short term and long term tests, the difference between a screening measurement and follow-up measurements, what the test results mean and what remedial construction techniques, if any, should be worked into a home to correct a problem. Frequently, sellers and buyers incur costs for improper tests and unnecessary construction expenses, as well as attorneys' fees to review and redraft sales and lease contracts that address the perceived risks.

Lee, *supra* note 16.

143. *A Review Sought On Radon Tests*, *supra* note 139, at 14-B. One commentator noted that, notwithstanding EPA's efforts to disseminate information to the public about radon and radon-reduction methods, only about two percent of the nation's homeowners have acted to identify or correct radon problems. See Locke, *supra* note 10, at 10,476.

144. See Moore, *supra* note 8, at 41.

remediation should take place.¹⁴⁵ Obviously, the higher the preliminary test readings, the more urgent the need for remedial action. When preliminary and follow-up tests consistently revealed indoor radon levels greater than 4 pCi/l, the general assumption was that some efforts should be made to reduce the indoor radon to as low a level as possible and practical.¹⁴⁶ However, reducing the indoor level to below 4 pCi/l was the goal.¹⁴⁷

To assist homeowners in understanding their options in reducing high levels of indoor radon, EPA published a pamphlet outlining the methodology, cost, effectiveness, limitations and procedures for ten approaches to reducing indoor radon levels.¹⁴⁸ Most of the methods suggested involved either some form of ventilation, sealing of entry points, or pressurization.¹⁴⁹ The effectiveness of each approach depended upon the particular building's characteristics.¹⁵⁰ Fortunately,

145. EPA recommended that for preliminary radon test results greater than 200 pCi/l, follow-up measurements should be performed as soon as possible. A CITIZEN'S GUIDE, *supra* note 3, at 7. Detectors used in the follow-up tests should not be exposed for more than a week. If follow-up tests yield the same high readings, PA recommended taking immediate steps to reduce the level. *Id.* When initial test readings fell in the 20 pCi/l to 200 pCi/l range, EPA recommended follow-up measurements of no more than three months duration. *Id.* If follow-up measurements confirmed the radon levels of the initial test, EPA recommended remedial action within several months. *Id.* at 11. Where initial test results were in the 4 pCi/l to 20 pCi/l range, EPA recommended follow-up tests of one year duration. *Id.* at 7. Where follow-up measurements were in the upper end of this range, EPA recommended remedial action within a few years. For initial readings less than 4 pCi/l, EPA suggested that follow-up measurements were not required. Moreover EPA noted that, although radon at these levels do pose health risks, reduction of levels this low may be difficult, if not impossible. *Id.* at 11.

146. *Id.* at 7, 11. The 4 pCi/l came to be the benchmark for safety notwithstanding the somewhat weak disclaimers of EPA and the critics, such as former Congressman James Florio from New Jersey, who charged that EPA was spreading an erroneous and perilous sense of security. See Purdy *supra* note 47, at 4-A; see also *supra* notes 94-97 and accompanying text.

147. A CITIZEN'S GUIDE, *supra* note 3, at 11.

148. See U.S. ENVTL. PROTECTION AGENCY, Pub. No. OPA-87-010, RADON REDUCTION METHODS, A HOMEOWNER'S GUIDE (2d ed.) (1987) [hereinafter RADON REDUCTION METHODS].

149. *Id.* EPA also mentions the technique for reducing radon known as "air cleaning" but does not endorse the use of air cleaners because "this technology has not been demonstrated to be effective in reducing the health risks associated with radon." *Id.* at 4. See Cross & Murray, *supra* note 10, at 701-02 for a detailed discussion of air cleaners.

150. See Cross *supra* note 22, at 17.

virtually every structure contaminated with indoor radon is deemed to be remediable.¹⁵¹ The New Jersey Environmental Protection Commissioner, in fact, declared that "virtually any house or building can be cleansed of potentially dangerous indoor levels of [radon] through sophisticated ventilation and sealing techniques."¹⁵² The costs for the various methods suggested ranged from approximately \$100 to \$2500, depending upon the complexity of the technique utilized.¹⁵³ Average costs per home were said to be in the \$1000 range.¹⁵⁴

Because these remediation costs were relatively modest when compared to the health risks suggested by EPA, and because the remediation procedures appeared to make a major impact on reducing radon levels, the stumbling block in the remediation process concerned, once again, the genuineness of the necessity to remedy and the qualifications of the those who performed the remedial work. The genuineness of the necessity to remedy was bound up with the controversy over the level of radon which poses health risks¹⁵⁵ and the testing devices, particularly the short-term testing devices which came under attack so frequently.¹⁵⁶ Even if a homeowner subscribed to EPA's position that an indoor radon reading in the 4 pCi/l to 20 pCi/l range posed substantial health risks¹⁵⁷ and the homeowner were convinced that tests performed on the property were reliable, the decision to spend up to \$2500 to reduce the radon level was apparently not one easily made.¹⁵⁸ Even EPA's advice on the urgency to remedy in this range was lukewarm at best: "We recommend that you take action within a few years, sooner if levels are at the upper end of this range."¹⁵⁹

151. *Id.* (footnote omitted).

152. *Id.* (alteration in original).

153. See RADON REDUCTION METHODS, *supra* note 148, at 4-17. Estimates for remedial work sometimes range as high as \$5000. See Cross & Murray, *supra* note 10, at 701 n.99.

154. See Cross & Murray, *supra* note 10, at 701 n.99.

155. See *supra* notes 103-17 and accompanying text.

156. See *supra* notes 145-54 and accompanying text.

157. See A CITIZEN'S GUIDE, *supra* note 3, at 8-10.

158. One study revealed that of approximately 41% of households estimated to have indoor radon levels in excess of 4 pCi/l, less than one percent undertook mitigation procedures despite an awareness campaign and the availability of reduced-price testing kits made to the sample households within the study group. See Locke, *supra* note 10, at 10,478.

159. A CITIZEN'S GUIDE, *supra* note 3, at 11.

Although the concern with the qualifications of those who perform radon mitigation services was somewhat assuaged for some homeowners whose state government had certification programs for radon measurement and mitigation,¹⁶⁰ many homeowners were left to heed EPA's advice:

We cannot overemphasize the importance of carefully selecting a contractor and reviewing any proposal for radon reduction work at your house. Asking for business references and checking with your local Better Business Bureau or Chamber of Commerce will help you ensure that a contractor is reputable. Many states will provide lists of contractors doing radon mitigation work, and some states have certification programs for radon measurement and mitigation.¹⁶¹

Moreover, EPA's dramatic 1988 announcement about the dangers of residential radon¹⁶² sparked a surge in businesses dealing with the issue of indoor radon.¹⁶³ Obviously, in the absence of governmental controls in many states, the field was wide open for fraud and scams.¹⁶⁴ In addition, EPA's announcement created a panic for some homeowners in those geographic areas where radon is more likely to

160. See RADON REDUCTION METHODS, *supra* note 148, at 1; see also Bannworth, *supra* note 8, at 178 n.76 (explaining New Jersey's approach to certifying radon mitigation firms).

161. RADON REDUCTION METHODS, *supra* note 148, at 1.

162. See *supra* notes 68-71 and accompanying text.

163. See Jonathan P. Hicks, *U.S. Report Helps Radon-Test Companies*, N.Y. TIMES, Sept. 19, 1988, at D1.

164. A publication of the American Association of Retired Persons warned of one such scam:

Take steps to protect yourself. While there are hundreds of ruses going around, many are variations on a theme. Be aware of the most common: The radon test scheme. An individual claiming to be a "radon inspector" proposes to hang small sacks around your home that will test for radiation. After the sacks "detect" the alleged radiation, the inspector calls in a colleague who, for a fee, offers to "purge" your property of the unwanted radon. The operation is likely a scam.

occur. Homeowners were concerned that obvious evidence of remediation of their homes would stigmatize the property and have a deleterious impact on property value.¹⁶⁵ Consequently, many homeowners chose not to remedy indoor radon unless they were required to do so pursuant to the contractual terms of an agreement for the sale of their home.¹⁶⁶

The confusion surrounding the radon issue was often grounded upon the vagaries of the levels of exposure deemed to pose health risks as well as the reliability of the testing and remediation processes. However, EPA's risk estimates for developing lung cancer from indoor radon were premised on a person spending seventy-five percent of her time at home and being exposed in the home for roughly seventy years. These presumptions did little to inspire the homeowner to take remedial action. Even EPA cautioned that,

[t]he risk estimates ... are based on the assumption that you will be exposed to the radon level found in your home for roughly 70 years. As you evaluate your potential risk, therefore, you might consider the total amount of time you expect to live in your home.¹⁶⁷

Clearly, the American public was not prepared to invest in a cause, though seemingly worthy, with so many uncertainties.

165. As one commentator noted with regard to a radon mitigation company:

The radon-mitigation crews employed by William Brodhead work in unmarked trucks, so neighbors aren't aware of what the workers are doing when the trucks are parked outside a client's home It's really a real estate problem What's happening is that a lot of real estate transactions are being determined by a radon screening but there are actually no protocols for testing under real estate conditions.

Austin, *supra* note 16.

166. See Locke, *supra* note 10, at 10,479 ("Presented in the home sale context, both the home seller's and home buyer's apathy about radon's hazards can be transformed into self-protective action, thereby eliminating most of the problems associated with communicating radon risk and encouraging remediation.").

167. A CITIZEN'S GUIDE, *supra* note 3, at 12.

II. THE RADON PROBLEM AND THE LAW

The ten years since the dramatic discovery of high levels of naturally occurring indoor radon in the Watras house have witnessed the development of a confusing, sometimes contradictory, public policy at the federal government level sporadic attention at the state government level, and the virtual lack of intervention by the courts. Because the American public continues to display a lack of interest in the issue of indoor radon after ten years of publicity about the significant health hazards which attend long-term exposure to the gas, the federal government, through both legislative and administrative efforts, has had to shoulder the lion's share of responsibility. Federal public policy on naturally occurring indoor radon primarily has taken the form of research gathering, testing and the dissemination of information to the public.¹⁶⁸ As one commentator noted:

Given the magnitude of the cancer risk from indoor radon, which apparently exceeds all outdoor pollutants combined, one might expect government control action. To date, however, government has done relatively little. There is virtually no direct regulation of the indoor radon problem, and little other government action. Most disturbingly, indoor radon appears to have a very low priority with government health and safety agencies, despite protestations to the contrary. In addition, "the legislative and regulatory framework for radon has been characterized by ambiguity and controversy about whether particular agencies have the responsibility and authority to address the problem."¹⁶⁹

168. See Jaffe, *supra* note 19, at 1-C.

169. CROSS, *supra* note 22, at 77 (quoting SHELDON KRIMSKY & ALONZO PLOUGH, ENVIRONMENTAL HAZARDS: COMMUNICATING RISKS AS A SOCIAL PROCESS 142 (1988)) (footnote omitted).

A. *Radon and Public Policy*

1. *Federal Responses to Radon Contamination*

In early 1985, following the December 1984 discovery of extremely high levels of naturally occurring radon in the Watras house, EPA recognized that indoor radon may be a widespread phenomenon.¹⁷⁰ Consequently, in September 1985, EPA established the Radon Action Program, which focused on discovering the extent of the indoor radon dilemma, reducing exposure to radon in existing homes and preventing radon from entering new construction.¹⁷¹ Pursuant to the Radon Action Program, EPA developed the State Radon Survey Program to assist states in conducting statewide radon surveys.¹⁷² In addition, EPA developed and demonstrated cost-effective mitigation methods to reduce levels of indoor radon in existing homes as well as in new construction.¹⁷³ Under the Radon Action Program, EPA also sought to provide the states with the technical assistance necessary to become self-sufficient in managing the radon problem.¹⁷⁴ Moreover, EPA published several brochures on radon in an effort to inform the public of the dangers related to the indoor gas, the methods for testing for radon and the techniques for reducing indoor radon levels.¹⁷⁵ Finally, the

170. *Id.* By 1980, the General Accounting Office, a research branch of Congress, had gathered a considerable amount of evidence regarding the hazard posed by indoor radon. Even then, it was estimated that indoor radon could be responsible for as many as 20,000 deaths annually. *Id.* at 77-78.

171. *See* Jackowitz, *supra* note 3, at 337.

172. *Id.* at 338.

173. *Id.* at 339.

174. *Id.* EPA's aim was to give technical advice to the states instead of performing the task for the states. *Id.* EPA also implemented the Radon Proficiency Measurement program to assist the development of private industry involved in radon measurement. *Id.* at 340.

175. *See, e.g.,* A CITIZEN'S GUIDE, *supra* note 3; RADON REDUCTION METHODS, *supra* note 148. A CITIZEN'S GUIDE became for many the source of the accepted position on numerous issues related to radon which were in reality not well-settled. For example, EPA's recommendation with regard to the 4 pCi/l as the action level at which a homeowner should consider remediation of the home for indoor radon was a controversial one. *See supra* text accompanying notes 75-103. Moreover, EPA's recommendation for testing using a short-term charcoal canister testing device placed in the lowest livable area of the home became accepted protocol for testing. Notwithstanding much controversy surrounding the accuracy of such short-term tests. *See supra* text accompanying notes 115-39; *see also infra* text accompanying notes

Radon Action Program coordinated various federal agencies that were similarly interested in the problems associated with indoor radon, such as the United States Department of Energy and the United States Department of Housing and Urban Development¹⁷⁶

Congress' first and most significant response to the indoor radon problem came with the passage of the Radon Gas and Indoor Air Quality Research Act of 1986 ("The Research Act").¹⁷⁷ Although The Research Act increased the level of attention given to the indoor radon problem, the statute's primary thrust was to authorize further research on the issue of indoor radon.¹⁷⁸ In fact, Congress quite specifically provided that The Research Act not be "construed to authorize the Administrator to carry out any regulatory program or any activity other than research, development, and related reporting, information dissemination, and coordination activities specified in this title."¹⁷⁹

Perhaps the most significant statement made by Congress concerning the indoor radon dilemma has been in the Indoor Radon Abatement Act of 1988 ("The Abatement Act").¹⁸⁰ Among the law's major provisions are: the establishment of a national goal of reducing indoor radon concentrations significantly below the heretofore routinely accepted 4 pCi/l guideline¹⁸¹ and the authorization of up to \$10 million for grants to state radon programs,¹⁸² \$1.5 million for the study of radon in schools,¹⁸³ \$1.5 million for regulating radon testing and

192-206. Ultimately, the controversy which many of EPA's recommendations engendered resulted in fostering the apathy with which the radon issue was greeted during the late 1980s and beyond. See Locke *supra* note 10, at 10,476. EPA acknowledged the public apathy at the time it released its revised edition of A CITIZEN'S GUIDE in 1992. See U.S. ENVTL. PROTECTION AGENCY, PUB. NO. 400-R-92-011, TECHNICAL SUPPORT DOCUMENT FOR THE 1992 CITIZEN'S GUIDE TO RADON 6-1 (1992) [hereinafter TECHNICAL SUPPORT DOCUMENT]; see also *infra* note 183.

176. Jackowitz, *supra* note 3, at 340 (detailing discussion of the coordination efforts among various federal agencies concerning radon issues).

177. Radon Gas and Indoor Air Quality Research Act of 1986, Pub. L. No. 99-499, 100 Stat. 1758 (1986), reprinted in 42 U.S.C. § 7401 note (1988).

178. See CROSS, *supra* note 22, at 82.

179. The Research Act § 404, reprinted in 42 U.S.C. § 7401 note (1988); see Moore, *supra* note 8, at 44-47 (discussing in detail The Research Act).

180. Pub. L. No. 100-551, 102 Stat. 2755 (codified as amended at 15 U.S.C. §§ 2661-2671 (1988 & Supp. II 1992); see also Nichols, *supra* note 8, at 161.

181. See The Abatement Act § 301, 15 U.S.C. § 2661.

182. *Id.* § 306(j), 15 U.S.C. § 2666(j).

183. *Id.* § 307, 15 U.S.C. § 2667.

mitigation firms,¹⁸⁴ \$1 million for regional training centers at universities¹⁸⁵ and \$3 million for technical assistance in radon testing and mitigation.¹⁸⁶ The Abatement Act also authorized federal agencies to study their own buildings for radon contamination¹⁸⁷ and allowed EPA to develop and promote model construction standards to avoid excessive indoor radon.¹⁸⁸ The House Committee on Energy and Commerce emphasized that the development of model construction standards and the goal of reducing indoor radon levels below the 4 pCi/l guideline do "not ... create a legal cause of action for any building occupant, building purchaser, or member of the public against building owners, real estate professionals, lenders, or builders."¹⁸⁹

One commentator likened The Abatement Act to its predecessors:

[T]his bill does more to recognize the problem than to solve it. The Radon Abatement Act provides no regulatory authority to protect building occupants and the amounts of money authorized for indoor radon research and control are insignificant. Congress failed to

184. *Id.* § 305(e), 15 U.S.C. 2665(e).

185. *Id.* § 308, 15 U.S.C. § 2668.

186. *Id.* § 305, 15 U.S.C. § 2665.

187. *Id.* § 309, 15 U.S.C. § 2669.

188. *Id.* § 304, 15 U.S.C. § 2664.

189. Nichols, *supra* note 8, at 162 (quoting H.R. REP. NO. 1047, 102d Cong., 2d Sess 11, reprinted in 1988 U.S.C.C.A.N. at 3617). One commentator noted with regard to the model construction standards:

These standards or guidelines could become mandatory for all new home construction or existing homes upon transfer by either state or local legislative and regulatory actions. Also, because of the potential liability faced by builders and sellers of homes, attorneys often counsel these clients to incorporate radon construction techniques into all their homes. The problem with all of this is that if construction standards are incorporated into every new home, we create a situation where we will "fix" 100 percent of new housing when, according to even EPA figures, only 10 percent of homes nationwide have a radon problem. The other 90 percent of new home buyers will then incur expenses to address a nonexistent health risk. Misinformation about this natural substance and liability fears are driving us toward an irrational fear.

appropriate funds for many of the programs contained in the law.¹⁹⁰

Through The Abatement Act, however, Congress did recognize that EPA had, primarily through its publication of A CITIZEN'S GUIDE, oversimplified the testing procedures for radon as well as the risks associated with various radon levels, particularly the 4 pCi/l guideline.¹⁹¹ Thus, Congress explicitly directed EPA to rewrite A CITIZEN'S GUIDE.¹⁹² Clearly, Congress recognized that the public was laboring under major misconceptions regarding the radon dilemma, most of which were fostered by EPA through A CITIZEN'S GUIDE.¹⁹³

In May 1992, EPA issued the second edition of A CITIZEN'S GUIDE ("CITIZEN'S GUIDE, 2D ED.").¹⁹⁴ At the time CITIZEN'S GUIDE, 2D ED., was issued, EPA acknowledged that the first version served as the core policy statement, the primary public information brochure and the federal government's principal guidance document on indoor radon.¹⁹⁵ However, at the time of the second edition, EPA sought to distance itself from the shortcomings of the original brochure by explaining that it was based upon limited experience with homes whose indoor radon problems resulted from uranium mill tailings¹⁹⁶ and that research in these homes revealed that most could be mitigated consistently to an average indoor radon level of 4 pCi/l.¹⁹⁷ Consequently, "EPA established 4 pCi/l as the action level at which people should fix their homes."¹⁹⁸ Moreover, EPA explained that its

190. CROSS, *supra* note 22, at 83.

191. Nichols, *supra* note 8, at 163-66. In requiring that EPA revise A CITIZEN'S GUIDE, Congress was concerned that the short-term radon test results may not be accurate. *Id.* at 163 n.168. Congress was also concerned that many homeowners misinterpreted EPA's action level of 4 pCi/l as suggesting that there is little or no health risks at that level. *Id.* at 164 nn.173 & 178.

192. The Abatement Act § 303(a), 15 U.S.C. § 2663(a).

193. Former Congressman James J. Florio (D., N.J.) charged EPA with making a virtually fraudulent representation with its 4 pCi/l action level. Florio maintained that the 4 pCi/l standard kills people. See Purdy, *supra* note 47, at 4-A.

194. U.S. ENVTL. PROTECTION AGENCY ET AL., PUB. NOS. ANR-464, 402-K92-001, A CITIZEN'S GUIDE TO RADON: THE GUIDE TO PROTECTING YOURSELF AND YOUR FAMILY FROM RADON (2d ed. 1992) [hereinafter CITIZEN'S GUIDE, 2D ED.].

195. See TECHNICAL SUPPORT DOCUMENT, *supra* note 175, at 1-1.

196. See *id.*

197. *Id.*

198. *Id.*

earlier testing protocols, which suggested short-term tests, such as the charcoal canister,¹⁹⁹ to establish a worst-case radon level, were based upon very limited information on the relationship between short-term and annual radon concentrations.²⁰⁰

EPA's stand on both the 4 pCi/l action level and the protocol for short-term testing led not only to the unfounded establishment of the 4 pCi/l as the threshold value between safe and unsafe indoor radon levels, but also caused short-term testing using the controversial charcoal canister to become, in many instances, the single determinant of whether or not a property needed radon remediation.²⁰¹ Furthermore, while EPA suggested that A CITIZEN'S GUIDE was prepared in a manner geared to avoid public panic,²⁰² EPA's subsequent announcement in 1988 on the dangers of radon²⁰³ did little to avoid an initial overreaction by the public. Of even greater concern was that the public began to rely on the recommendations of A CITIZEN'S GUIDE,²⁰⁴ many of which EPA later came to disavow.²⁰⁵ While EPA recognized in 1992 that the public perceived the issue of indoor radon with apathy,²⁰⁶ it was not, as EPA suggested, the "factual and informative"²⁰⁷ tone of A CITIZEN'S GUIDE

199. See *supra* notes 126-45 and accompanying text.

200. See TECHNICAL SUPPORT DOCUMENT, *supra* note 175, at 1-1, 3-1.

201. During congressional hearings on The Abatement Act, concern was expressed that many people have misinterpreted EPA's designated action level of 4 pCi/l as meaning that there is little or no health risk at that level. Moreover, there was concern that instantaneous or short-term radon test results may not indicate reliable long-term radon levels and that homeowners may, in reliance upon inaccurate test results, not pursue radon mitigation. See Nichols, *supra* note 8, at 135, 163 n.168, 164 n.173. Where radon was a concern in a real estate transaction, the reliance upon the 4 pCi/l action level was often perfunctory:

"If it's below 4 [pCi/l], most people believe they're safe and clear," said Harold Stesis, president of the U.S. Toxic Substance Testing Bureau, a Philadelphia-based company that conducts radon testing nationwide. "If you try to give advice that's not in accordance with the EPA, you're really putting your neck on the line."

Purdy, *supra* note 47, at 4-A.

202. See TECHNICAL REPORT DOCUMENT, *supra* note 175, at 6-1.

203. See *supra* note 64 and accompanying text.

204. See Purdy, *supra* note 47, at 4-A.

205. See TECHNICAL SUPPORT DOCUMENT, *supra* note 175, at 1-1, 1-2, 3-1, 3-2.

206. *Id.* at 6-1.

207. *Id.*

which caused the torpid response. Rather, it was A CITIZEN'S GUIDE's oversimplification of the indoor radon issue,²⁰⁸ coupled with its recommendations which were unsupported by appropriate scientific studies²⁰⁹ and the subsequent controversy over many of its suggestions²¹⁰ that provided much of the rationale for the public's eventual failure to respond to the residential radon issue.

The absence of any other significant radon legislation demonstrates that the federal government chose to remain a catalyst on the issue of naturally occurring indoor radon, and not be the principal agent of change. Notwithstanding the reaffirmation of the dangers of residential radon in its CITIZEN'S GUIDE, 2D ED., the federal government, through EPA, seemed content with developing data about radon dangers, targeting high risk areas, providing information to the public²¹¹ and regulating the industries that test and mitigate.²¹² Furthermore, as one commentator noted: "So long as Congress denies explicit regulatory authority to EPA and other agencies, there can be no comprehensive, effective federal program of radon control. The provision of regulatory authority appears highly unlikely, as legislators are concerned about the costs regulation might impose on the construction industry and homeowners."²¹³

208. See *supra* notes 88-120 and accompanying text.

209. See *supra* notes 187-90 and accompanying text.

210. See *supra* notes 88-102, 125-132 and accompanying text. See generally LEONARD A. COLE, ELEMENT OF RISK: THE POLITICS OF RADON (1993) (challenging EPA's recommendation that every house in the United States should be tested for radon).

211. When it became clear that the public was not responding to the governmental warnings about radon, EPA enlisted the services of the Advertising Council. See Purdy, *Officials Renew Call For Radon Testing*, PHILA. INQUIRER, Oct. 19, 1989, at 3-A.

212. See Jaffe, *supra* note 19.

213. CROSS, *supra* note 22, at 84. While the federal government's decision not to regulate the radon problem has been controversial, some commentators have noted that Congress has not granted EPA authority to regulate in this field. *Id.* at 78. Although statutes such as the Clean Air Act, which gives EPA the authority to regulate air pollutants entering the "ambient air," have been suggested as authority for regulating indoor radon, EPA has interpreted this authority as limited to outdoor air. *Id.* at 79; see generally Clean Air Act Amendments of 1990, 42 U.S.C. §§ 7401-7642 (1988 & Supp. III 1991); see also Moore, *supra* note 8, at 42-44 (discussing the application of the Clean Air Act and the Consumer Product Safety Act, 15 U.S.C. §§ 2051-2083 (1988 & Supp. II 1990), to the indoor radon problem).

2. *States Responses to Radon Contamination*

The federal public policy on indoor radon made clear that the federal government was not prepared to assume regulatory functions. Most of the federal public policy merely provided for assistance to the states in developing radon programs. Consequently, much of the real effort to deal with the residential radon issue has taken place at the state level.

Radon rich soils are not found equally throughout the United States.²¹⁴ Thus, state initiatives to deal with indoor radon vary from state to state. The states where radon levels have been found to be highest have established the most sophisticated state programs to deal with the issue.²¹⁵ The states of New Jersey, Florida, Maine, Pennsylvania and New York, where radon surveys have confirmed high radon levels, are among those that have made the greatest efforts to deal with the issue.²¹⁶ Although each of these states has instituted its own specific approach to treat the radon dilemma, the programs nonetheless share some common elements.²¹⁷ These states have, to one extent or another, engaged in surveying for radon levels, setting standards for testing and remediation, establishing loan programs for remediation, disseminating information to the public and formulating recommendations for reducing radon in new construction.²¹⁸ Also, each of the states with an operational program has established laboratories to analyze the results of the tests.²¹⁹

New York, New Jersey and Pennsylvania account for eighty-eight percent of all state radon funding.²²⁰ Pennsylvania used some of its funding to offer free radon testing devices to the public²²¹ whereas New Jersey conducted epidemiologic studies to examine the link between radon and cancer.²²² Thus, the states vary somewhat as to what specific programs they fund.

Perhaps the most significant common traits among the states with

214. See *supra* notes 52-57 and accompanying text.

215. See Moore, *supra* note 8, at 50-59.

216. See Jackowitz, *supra* note 3, at 349.

217. See Moore, *supra* note 8, at 51.

218. See *id.*

219. See Jackowitz, *supra* note 3, at 351.

220. See *id.* at 350.

221. See, e.g., Moore, *supra* note 8, at 52.

222. Jackowitz, *supra* note 3, at 352; see Moore, *supra* note 8, at 52.

advanced radon programs, however, have been their efforts to increase public awareness about the health risks associated with indoor radon²²³ and their efforts to protect consumers from unscrupulous testing and remediation contractors.²²⁴

The majority of states have acknowledged that the radon problem could pose a health risk for their citizens, but have not gotten beyond rudimentary organizational efforts to establish a radon program.²²⁵ Often, these states were not sure whether radon is actually a significant health risk to their citizenry.²²⁶ Some states with developing programs typically had initiated or completed surveys to determine the extent of the radon problem in the state.²²⁷

A small number of states have virtually ignored the radon issue. "These states have not yet perceived that they have a radon problem and thus do not have plans to develop a program until future evidence reveals the need for such a program."²²⁸ In these states public awareness of radon remains minimal.²²⁹

Because federal public policy concerning the radon issue assumes that the radon problem is primarily a matter of local concern,²³⁰ federal legislation and EPA efforts have not gone much beyond information gathering and public education.²³¹ This has left the states with the responsibility of determining how to deal with the issue. Except for those relatively few states where radon has been shown to be a significant indoor pollutant, the states have remained quite passive in

223. See Jackowitz, *supra* note 3, at 353. The states with operational programs have made frequent use of EPA-published brochures, A CITIZEN'S GUIDE and RADON REDUCTION METHODS, in educating their citizens about the dangers of indoor radon. *Id.*

224. See Moore, *supra* note 8, at 53-54. New Jersey took the lead in protecting its citizens from unqualified radon contractors by enacting legislation which requires the state's Department of Environmental Protection to establish a program for certification of radon testers. *Id.*; see N.J. STAT. ANN. § 26:2D-70, -71.

225. See Jackowitz, *supra* note 3, at 345-47. EPA categorizes the states into four levels: Level I (states with informational programs); Level II (states with formative programs); Level III (states with developing programs); and Level IV (states with operational programs). *Id.* at 345-54.

226. *Id.* at 345.

227. *Id.* at 347.

228. *Id.* at 345.

229. *Id.*

230. *Id.* at 344.

231. See *supra* notes 160-202 and accompanying text.

their response to the radon dilemma.²³² Even those states with operational radon programs have generally not acted to regulate the radon problem through mandatory testing and remediation.²³³ Because both federal and state public policy on radon primarily stressed information-gathering, research and public education, many commentators believed that the courts would eventually define the responsibilities of homeowners with regard to the indoor radon issue.

B. *Radon and the Courts*

Shortly after the discovery of extremely high levels of naturally occurring radon in the Watras house,²³⁴ many commentators began to speculate about the surge of litigation which they predicted was imminent.²³⁵ Some commentators even suggested that a litigation surge involving naturally occurring indoor radon had begun,²³⁶ notwithstanding the virtual lack of such lawsuits filed at the time these proclamations were made.²³⁷ In preparation, numerous commentators reviewed and analyzed the legal theories upon which lawsuits would be

232. See CROSS, *supra* note 22, at 87. Among the states with operational radon programs, New Jersey took an early lead. Through legislative enactment it gave its Department of Environmental Protection authority to survey the state to determine the extent of radon contamination, established a certification program for radon testers and mitigation firms, provided for a public information and education program, required disclosure of radon test results to prospective buyers, when radon tests had already been performed, and provided for the adoption of radon-resistant construction standards with regard to new home and school construction. See N.J. STAT. ANN. §§ 26:2D-59-80, 52:27D-123a to -123e (West 1987 & Supp. 1993).

233. See generally Bannworth, *supra* note 8, at 181 n.103.

234. See *supra* notes 46-49 and accompanying text.

235. Galen, *supra* note 2, at 1.

236. See *supra* note 10 and accompanying text.

237. See, e.g., Bannworth, *supra* note 8, 181 n.103 (1991) (reporting that, as of the writing of the note, there were no reported decisions in New Jersey arising out of issues related to naturally occurring radon). In early 1991, however, a New Jersey court ruled on a breach of contract case involving a purchaser's refusal to perform the purchase contract on a home which had a radon reading of 2.9 pCi/l pursuant to a three-day test. The court found the purchaser's refusal to perform the purchase contract due to a radon level of 2.9 pCi/l was objectively unreasonable and did not justify the breach. Wong v. Mercado, 590 A.2d 723 (N.J. Super. Ct. Law Div. 1991).

brought.²³⁸

The onslaught of radon-based litigation, however, has not materialized. Although the radon finding at the Watras house was a watershed -- a discovery that should have dramatically changed the fact that Americans view their homes as safe and secure havens from the ills of the outside world -- the radon issue instead is all but ignored by the public just ten years after its discovery. While there are numerous reasons to explain the public's apathy,²³⁹ the failure of the anticipated litigation explosion to date is certainly a positive result. Commentators who analyzed the anticipated lawsuits, however, have provided a resource of analyses concerning the indoor radon issue which will prove beneficial should the litigation surge become a reality.

As the public policy related to naturally occurring indoor radon contamination is primarily research and education oriented, rather than regulatory, the anticipated bases for recovery are common law theories. Most commentators predicted that litigation would most likely arise in the context of the sale of real property. They listed probable defendants to include homeowners, builders, real estate agents, developers, surveyors, architects, engineers, landlords, radon testers and remediation contractors, carpenters, plumbers, suppliers of fill, manufacturers of concrete slabs, private house inspectors, ventilation contractors, utilities that encourage weatherization, and repair persons.²⁴⁰

Although the theories of recovery suggested by commentators are many and varied, there has been a decided convergence of opinion on the efficacy of two bases for recovery: (1) the implied warranty of habitability and (2) strict liability.²⁴¹ Other theories of recovery

238. See, e.g., Shuko, *supra* note 22, at 369-88; Cross & Murray, *supra* note 10, at 702-24; Dearing, *supra* note 8, at 830-46. The uranium mill tailing cases, which involve radon contamination resulting from the uranium milling process, are among the few cases involving radon contamination. The precedential value of these cases is limited since the radon contamination in homes built on top of the mill tailings is not considered to be naturally occurring. See *supra* notes 38-43 and accompanying text.

239. See *infra* note 314 and accompanying text.

240. See, e.g., Sherman, *supra* note 7; Shepherd & Gaynor, *supra* note 8, at 8; Shuko, *supra* note 22, at 369.

241. Although commentators routinely noted that no clear-cut liability yet exists under any established common law theory, some have suggested that: "In some respects, strict liability offers the most promise for homeowners exposed to excessive indoor radon levels." Cross & Murray, *supra* note 10, at 703. The greater weight of opinion, however, apparently found the implied warranty of habitability to provide the strongest basis for recovery. See, e.g., Shuko, *supra* note 22, at 369 ("[O]nly the implied

suggested include negligence,²⁴² fraud²⁴³ and violation of the constitutional right to privacy.²⁴⁴

1. *Implied Warranty of Habitability*

The implied warranty of workmanlike construction and habitability holds that the builder-vendor of a home impliedly warrants that the home is built in a workmanlike manner and is reasonably fit for the purpose for which it is sold.²⁴⁵ Homeowners who discover indoor radon could argue, therefore, that the radon contamination renders the home unfit for human habitation. The implied warranty theory makes litigation easier for the homeowner because it does not require that the homeowner show fault on the part of the seller.²⁴⁶

The warranty, however, does not blindly make the builder liable for any and all defects in the house.²⁴⁷ A reasonableness test is applied to the level of workmanship and the duration of the warranty.²⁴⁸ Where radon contamination can be linked to faulty construction, such as cracks in foundations which give radon gas an easy entry, the application of the warranty to a homeowner's lawsuit seems clear.²⁴⁹ Unlike negligence, the lack of foreseeability of a radon problem does not bar the

warranty of habitability may provide a legally adequate means of relief for the aggrieved party."); Dearing, *supra* note 8 ("[T]he implied warranty approach will probably prove to be the most effective cause of action in the area of radon gas litigation."); Conaway, *supra* note 10, at 46 ("The policy considerations and purposes of the implied warranty of habitability appear to make its extension to the radon pollution context appropriate.").

242. See, e.g., Conaway, *supra* note 10, at 38-43.

243. See, e.g., Cross & Murray, *supra* note 10, at 722-24.

244. See Bannworth, *supra* note 8, at 184-86. The author raises constitutional right to privacy issues with regard to laws which require state certified radon testers and mitigators to supply names, addresses and radon test results to government agencies. *Id.* See, e.g., N.J. STAT. ANN. § 26:2D-74 (West 1987).

245. See Waltz, *supra* note 10, at 1119; Schipper v. Levitt & Sons, 207 A.2d 314, 327 (N.J. 1965) (stating that a real estate developer warrants that the home he sells is "built in a workmanlike manner and is suitable for habitation").

246. See Waltz, *supra* note 10, at 1119.

247. *Id.* at 1121.

248. *Id.*

249. *Id.* at 1123-25; see also Nobel v. Marvin E. Kanze, No. 83-05253 (Montgomery Co., PA, C.C.P. Civ. Div. filed April 13, 1983) (cited in Galen, *supra* note 2, at 8) (suing a component's supplier for breach of implied warranty because an air conditioning-heating device caused homeowner to have a radon problem).

use of the warranty by the homeowner.²⁵⁰ As one commentator noted: "If given the present knowledge of the radon problem, a reasonable builder did not use certain building methods or materials when constructing a home in a radon prone area, it may be seen as a breach of workmanlike construction."²⁵¹

Most jurisdictions recognize some form of the implied warranty of habitability; however, the level of workmanship which the builder is held to warrant is not consistent among the jurisdictions.²⁵² While some courts hold that the warranty guarantees that the home will have no defects that substantially impair the enjoyment of the home, other courts apply the warranty only when the home is virtually uninhabitable.²⁵³ Other potential limitations to the warranty's use and effectiveness include: the requirement for a timely notice from the buyer to the builder-vendor notifying him of the defect, an opportunity for the builder-vendor to correct the defect and contract disclaimers of the warranty which are clearly and conspicuously stated.²⁵⁴ Moreover, because the implied warranty of habitability is essentially contract-based in origin,²⁵⁵ its application may require a showing of privity of contract.²⁵⁶ These limitations have prompted some to suggest that strict liability offers the most promise for the homeowner with an indoor radon problem because strict liability appears to offer most of the benefits of the implied warranty without many of the drawbacks.²⁵⁷

250. See Waltz, *supra* note 10, at 1124. Implied warranty theory is derived from products liability cases where there is no requirement of foreseeability of the harm to impose liability on the seller. *Id.* at 1126.

251. *Id.* at 1127. Faulty construction may not be the only exposure to liability faced by the builder. Some cases involving residential real estate have extended implied warranties to site location as well. See, e.g., *Degnan v. Executive Homes*, 696 P.2d 431 (Mont. 1985) (bringing action for breach of implied warranty of habitability when ground instability caused structural damage to the houses).

252. See Cross & Murray, *supra* note 10, at 716.

253. *Id.* at 716-17.

254. *Id.* at 716-18.

255. *Id.* at 715.

256. *Id.* at 717. Although privity is still the majority rule, there is a growing trend to abandon or limit the privity requirement in implied warranty cases. *Id.*

257. *Id.* at 703.

2. *Strict Liability*

Like the implied warranty of habitability, the strict liability theory is attractive because the plaintiff need not prove fault on the part of the seller.²⁵⁸ Although the tort concept of strict liability has been applied in many contexts, it is most notably utilized in the products liability context.²⁵⁹ However, the use of a strict liability rationale to hold a builder-vendor liable for damages caused by a house is not without precedent. In the 1965 landmark decision *Schipper v. Levitt & Sons*,²⁶⁰ the New Jersey Supreme Court found the developer of mass produced houses strictly liable for injuries sustained by a child who suffered burns as a result of a defective water heater. The court in *Schipper* also held that a builder impliedly warrants that the house he sells is "built in a workmanlike manner and is suitable for habitation."²⁶¹ Since the court's decision in *Schipper*, many courts have adopted the same reasoning to hold developers liable for real property defects on either a strict liability in tort theory²⁶² or contract-based implied warranty of habitability rationale.²⁶³

The court in *Schipper* premised its decision on a number of policy considerations including the unequal bargaining position of the homeowner in relation to the builder, the reliance by the homeowner on the builder's expertise, deep pocket considerations and risk spreading, and the buyer's relative inability to protect herself.²⁶⁴ In order to recover under a strict liability theory, the plaintiff must establish that the

258. See Dearing, *supra* note 8, at 830.

259. See Cross & Murray, *supra* note 10, at 703. In certain instances a home may be found to be a product. *Id.* See, e.g., *Schipper v. Levitt & Sons*, 207 A.2d 314 (N.J. 1965); *Waggoner v. Midwestern Dev.*, 154 N.W.2d 803 (S.D. 1967); *Wayne v. Tennessee Valley Authority*, 730 F.2d 392 (5th Cir. 1984), *cert. denied*, 469 U.S. 1159 (1985).

260. 207 A.2d 314 (N.J. 1965).

261. *Id.* at 327 (quoting *Carpenter V. Donohoe*, 388 P.2d 399, 402 (Colo. 1964)).

262. See, e.g., *Patitucci V. Drelich*, 379 A.2d 297 (N.J. Super. Ct. Law Div. 1977); *Gay v. Cornwall*, 494 P.2d 1371 (Wash. Ct. App. 1972); *Kriegler v. Eichler Homes*, 74 Cal. Rptr. 749 (Cal. Ct. App. 1969).

263. See, e.g., *Rutledge v. Dodenhoff*, 175 S.E.2d 792 (S.C. 1970); *Gable v. Silver*, 258 So.2d 11 (Fla. Dist. Ct. App. 1972). The court in *Schipper* referred to the theories of strict liability and implied warranty interchangeably in its analysis. *Schipper*, 207 A.2d at 325; Raymond A. Pagliari, Comment, *Strict Tort Liability To The Builder Vendor Of Homes: Schipper And Beyond?*, 10 OHIO N.U. L. REV. 103, 106 (1983).

264. *Schipper*, 207 A.2d at 325-26.

product (in the radon context, a home) was in a defective condition unreasonably dangerous to the user.²⁶⁵ The defective condition of the product may be established by: (1) a flaw in the product that was present at the time it was sold by the defendant; (2) a failure by the manufacturer to warn adequately of a risk or hazard related to product design; or (3) a defective design of the product.²⁶⁶

While noting that the application of strict liability theory to the homeowners' suit against the builder-vendor for indoor radon contamination seems logical, some commentators observed that the application would, nonetheless, face certain obstacles. As one commentator noted:

The perfect [indoor radon] case for strict liability under prevailing principles would be one where: (1) the builder-vendor was engaged in mass production sales; (2) radon entered the house primarily through cracks in a faultily constructed basement; (3) the sale took place recently; and (4) indoor radon levels substantially exceeded applicable standards.²⁶⁷

The above suggested best-case scenario is premised upon the following. First, the facts of *Schipper* dealt with a builder engaged in the mass production of houses. It is not clear that the court's policy justifications would or should apply to small or custom builders.²⁶⁸ Second, the plaintiff's injury in *Schipper* was caused by a defective product (a water heater) and not simply a naturally occurring phenomenon such as radon. It is possible for a house to become contaminated with radon using state-of-the-art construction without any design or manufacturing defect.²⁶⁹ Third, the indoor radon hazard is a relatively recent discovery. It was not until the finding of high levels of indoor radon in late 1984 at the Watras house that EPA and the media began to publicize the possibility of dangerous levels of naturally

265. RESTATEMENT (SECOND) OF TORTS § 402A (1965).

266. PROSSER AND KEETON ON THE LAW OF TORTS § 99 (1)-(3) (5th ed. 1984) [hereinafter PROSSER & KEETON].

267. See Cross & Murray, *supra* note 10, at 714. For a detailed analysis supporting the commentators' suggested perfect case for the application of strict liability to a radon lawsuit, see *id.* at 708-15.

268. *Id.* at 706-08.

269. *Id.* at 711-14.

occurring radon accumulating indoors.²⁷⁰ Finally, the levels at which indoor radon poses substantial health risks is clearly not a well-settled issue. Obviously, the higher the radon level in the home, the greater the consensus in the scientific community that a dangerous health condition exists.²⁷¹

While suits based upon breach of the implied warranty of habitability or strict liability were suggested as providing the best chance for recovery by homeowners suing for radon-induced damages, suits based upon negligence and fraud were also seen as viable in particular circumstances.

3. *Negligence*

Most commentators suggested that a lawsuit against the builder, architect or real estate broker²⁷² for indoor radon contamination grounded upon a common law negligence theory might be viable.²⁷³ However, few thought that this approach superior to the warranty of habitability or strict liability avenues.²⁷⁴ The negligence theory with regard to a builder, for example, requires that the homeowner prove by a preponderance of the evidence that: (1) the defendant owed a duty to the homeowner to use reasonable care in building the residence; (2) the defendant breached the duty; and (3) the homeowner was injured and

270. See *id.* at 711; see *supra* notes 62-67 and accompanying text.

271. See *supra* text accompanying notes 71-107.

272. See Waltz, *supra* note 10, at 1144-46 for a detailed discussion of potential liability of real estate brokers with regard to the radon issue.

273. See, e.g., Cross & Murray, *supra* note 10, at 719-22; Shuko, *supra* note 22, at 370-76; Conaway, *supra* note 10, at 38-43.

274. See, e.g., Cross & Murray, *supra* note 10, at 719-22; Shuko, *supra* note 22, at 370-76. One commentator noted:

Many difficulties arise in proving an existing duty on the part of the contractor or architect, a breach of this duty, and causation. Therefore, although probably more viable than strict product liability, a negligence theory is often not the best remedy to pursue in the event of radon contamination in the home. However, as the industry becomes more aware of the radon hazard, this theory will become more appropriate because the duties of builders will become more clearly defined.

suffered damages as a proximate result of the breach.²⁷⁵

With regard to the first element, the law of negligence imposes a duty of care upon the builder if a reasonable person similarly situated would have anticipated that harm or injury was likely to occur.²⁷⁶ Thus, the builder in the negligence action potentially will be liable if the defendant knew or should have known that the home was constructed in a manner permitting radon contamination. Clearly, the state of knowledge with regard to the radon hazard will be relevant to this determination.²⁷⁷

If the plaintiff can establish a duty, the plaintiff will then have to prove that the builder breached the duty by not exercising the care and skill of an ordinary builder under like circumstances.²⁷⁸ The plaintiff might argue not only that deficiencies existed in construction, but also might contend that the location of the construction in a radon prone area breached the duty of care.²⁷⁹

Although the plaintiff's ability to bear the burden of proving the first two elements of the negligence claim will be challenging, proving that the breached duty proximately caused injury or damages to the plaintiff may be the most difficult. With regard to the radon issue, there remains much to learn about the degree and duration of exposure which causes injury, if injury is caused at all.²⁸⁰ Most commentators agreed that, until more is learned about the dangers of indoor radon, a negligence-based lawsuit "is not the best option available to the homeowner injured as a result of radon contamination."²⁸¹

4. *Fraud*

Common law fraud or deceit actions require the plaintiff to establish five elements: (1) a false representation of a material fact by

275. PROSSER & KEETON, *supra* note 266, § 30.

276. RESTATEMENT (SECOND) OF TORTS, *supra* note 265, §§ 289, 298.

277. See *supra* text accompanying notes 74-110 (discussing the state of knowledge).

278. See, e.g., *Brafford v. Susquehanna Corp.*, 586 F. Supp. 14 (D. Colo. 1984). For a discussion of the "reasonable person" standard, see PROSSER & KEETON, *supra* note 266, § 32.

279. See *Cross & Murray*, *supra* note 10, at 720.

280. See *supra* text accompanying notes 74-111; *Cross & Murray*, *supra* note 10, at 724-35 (detailing the health-related damages that may be associated with a radon claim).

281. *Cross & Murray*, *supra* note 10, at 721.

the defendant; (2) knowledge or belief by the defendant that the representation was false (or lack of sufficient information upon which to base such a statement); (3) intent to induce the plaintiff to rely on the false representation; (4) justifiable reliance on the representation by the plaintiff; and (5) damage to the plaintiff as a result of reliance.²⁸² Clearly, the builder, seller and real estate broker who are aware of a radon condition in the home are under a duty to disclose this information to the potential buyer.²⁸³

As in all suits for fraud, one of the most difficult burdens for the plaintiff, however, is proving knowledge on the part of the defendant. Proving that the defendant knew of the degree of radon contamination may be particularly difficult.²⁸⁴ Consequently, the court may hold the defendant liable for negligent misrepresentation, which relieves the plaintiff from having to prove that the defendant made the misrepresentation with the intent to deceive or with knowledge of the statement's falsity.²⁸⁵ Even a statement made with an honest belief in its truthfulness can, nonetheless, be the basis for a claim of negligent misrepresentation.²⁸⁶ Thus, if any defendant makes a statement concerning radon, that defendant can be held accountable for its truthfulness.²⁸⁷ In cases in which the defendants have uttered no statements about radon, proving fraud may depend on whether the silence of the defendants can be viewed as a false representation.²⁸⁸ Generally, with regard to real estate sales, silence as to latent defects of which the defendant has actual knowledge or which are reasonably discoverable by the defendant will constitute fraud.²⁸⁹

Knowledge of the possibility of indoor radon contamination has

282. PROSSER & KEETON, *supra* note 266, § 105, at 728.

283. *See, e.g.,* Lingsch v. Savage, 29 Cal. Rptr. 201, 204-05 (1963) (where seller knows facts materially affecting the value or desirability of the property and the facts are only accessible to him, and where the facts are not known to or within the reach of the buyer, the seller is under a duty to disclose); Reed v. King, 193 Cal. Rptr. 130, 131-33 (1983) (seller knew that home was the site of multiple murder and was under a duty to disclose that fact to the buyer).

284. *See* Cross & Murray, *supra* note 10, at 722.

285. *Id.*

286. *Id.*

287. *Id.*

288. *Id.* at 723.

289. *Id.*; *see generally* PROSSER & KEETON, *supra* note 266, § 106, at 736-40 (discussing duty to disclose).

only come about recently.²⁹⁰ For sales of homes which occurred more than a decade ago, one could not expect disclosure of a yet unknown defect. However, with regard to real estate sales since the information explosion following the discovery at the Watras house, one commentator noted: "At a minimum, as knowledge of radon and its effects on residential real estate grows, the builder, seller, and real estate broker of homes in radon-prone areas must be expected both to determine if a radon problem exists and to disclose that problem to potential purchasers."²⁹¹

5. *Violation of Constitutional Right to Privacy*

Finally, some commentators suggest that the courts may become involved in the determination of constitutional privacy issues with regard to radon testing and mitigation efforts. More specifically, states, particularly those which are establishing or have established operational programs with regard to radon,²⁹² have the need to assess the extent of radon contamination within their borders. For example, New Jersey, as part of its data gathering activities, statutorily requires that certified radon testers and mitigators disclose certain facts regarding work they perform to specified state agencies. In particular, such contractors must disclose the names of the owners of the real estate at which they perform work, the address at which the work was done and the results of any tests.²⁹³ Although the statute does not provide for such information to be made a matter of public record,²⁹⁴ it is not clear from the law whether interested persons can request and receive such information.²⁹⁵ The concern among property owners is that the release of such information to the public would have a deleterious impact on the property's market value.²⁹⁶ Moreover, the fear that such disclosure to interested persons might be ordered by the court could dissuade homeowners from testing.

290. See *supra* notes 47-52 and accompanying text.

291. Cross & Murray, *supra* note 10, at 723.

292. See *supra* notes 214-29 and accompanying text.

293. N.J. STAT. ANN. § 26:2D-74 (West 1987).

294. *Id.* § 26:2D-78.

295. See Bannworth, *supra* note 8, at 185.

296. Cf. N.J. STAT. ANN. 26:2D-73. New Jersey requires that in the case of a prospective sale of a property which has been tested for radon, the seller must provide the buyer, at the time the contract of sale is entered into, with the results of the test and evidence of any subsequent mitigation. *Id.*

6. *Measure of Damages*

Commentators also speculated about the measure of damages which plaintiffs would be able to successfully establish.²⁹⁷ Clearly, plaintiffs would seek health-related damages, property-related damages or both.²⁹⁸ Due to the considerable degree of speculation which remained concerning the health risks associated with the indoor radon problem²⁹⁹ as well as the long latency period of up to thirty years before manifestation of radon-induced lung cancer,³⁰⁰ health-related damages were viewed as much more tenuous than those related to the property.³⁰¹

Although numerous commentators responded to the discovery of indoor radon with discussions of the legal issues which they anticipated to be the basis of the predicted litigation explosion,³⁰² and although that explosion did not materialize during radon's first decade as one of the nation's most serious public health issues,³⁰³ the commentators' analyses helped to bring into focus not only the issues which would likely arise during the course of litigation, but also the issues which remain disturbingly unknown about the naturally occurring phenomenon. Before the public will take seriously the alleged health risks associated with indoor radon and evidence their concern through the redress of grievances in the court room, and even more importantly, through the testing and mitigation of radon in their homes, more concrete scientific evidence of indoor radon's dangers must be developed.

C. *Radon and the Public*

The failure of the forecasted litigation surge involving indoor radon during the last ten years is perhaps the only positive aspect of an otherwise confusing, tumultuous decade in which the American public tried to come to terms with the odorless, colorless, tasteless, otherwise

297. See Cross & Murray, *supra* note 10, at 724.

298. *Id.* at 724-38.

299. See *supra* notes 74-111 and accompanying text.

300. See Cross & Murray, *supra* note 10, at 724 n.259.

301. *Id.* at 735.

302. See Sherman, *supra* note 7 ("Radon, the naturally occurring gas seeping up into New Jersey's houses, can explode into litigation for almost anyone connected to real estate, environmental law specialists warn.").

303. See *supra* note 67 and accompanying text.

invisible killer said to lurk within our most intimate environs: our homes. The lack of cases filed with the courts during the last ten years can surely be attributed to apathy,³⁰⁴ particularly during the later years of the decade. Notwithstanding the apparent apathetic response of the public to the radon issue, it may be too simplistic to attribute the failure of the radon issue to swamp our courtrooms merely to apathy. Other factors clearly played a role.

As commentators began to forecast a litigation explosion, and federal and state agencies began to engage in greater efforts to educate the public with regard to radon, legal analysts and practitioners examined ways to protect clients from being successfully sued over radon issues. Because most commentators anticipated that potential litigation over radon would likely occur pursuant to the sale or transfer of an interest in real estate,³⁰⁵ analysts examined both disclaimers and inspection clauses as means of avoiding liability.³⁰⁶ Commentators typically dismissed the reliance upon generalized contract disclaimers or the "buyer takes as is" type of clause, suggesting that such clauses are often found to be against public policy.³⁰⁷ They did suggest, however, that disclaimers that specifically reference radon and that are conspicuous and clearly stated, would likely protect the seller.³⁰⁸

More frequently recommended, and evidently more successfully employed,³⁰⁹ were the radon contingency clauses which are found in contracts for the sale of real estate.³¹⁰ In a typical radon contingency clause the parties establish a standard, typically 4 pCi/l,³¹¹ above which the seller agrees to take remedial action or potentially lose the sale.³¹² For example, pursuant to the radon contingency clause, a test for radon is made before the settlement on the property. If the test determines that

304. See TECHNICAL SUPPORT DOCUMENT, *supra* note 175, at 6-1.

305. See, e.g., Sherman, *supra* note 7, at 1; Prussman, *supra* note 10, at 717.

306. See, e.g., Waltz, *supra* note 10, at 1146-51; David Brooks, *Radon Clauses Enter House Contracts*, N.J. L.J., Mar. 10, 1988, at 25.

307. See Waltz, *supra* note 10, at 1147-51. *But see* Cross & Murray, *supra* note 10, at 718.

308. *Id.*

309. See Brooks, *supra* note 306.

310. See Shepherd & Gaynor, *supra* note 8, at 9.

311. "Contract clauses are generally tied to the identical federal and state guidelines of 4 picocuries per liter, a reading above that level often forces the seller to get rid of the gas, or allows the buyer out of the deal." Brooks, *supra* note 306, at 27.

312. See Shepherd & Gaynor, *supra* note 8, at 9.

the radon level exceeds a predetermined level and if the estimated remedial costs are less than a predetermined amount, the clause obligates the seller to perform the work.³¹³ However, if the estimated remedial costs exceed the predetermined amount, the seller can either credit the buyer with the estimated costs to remedy or notify the buyer of the seller's unwillingness to allow for the credit.³¹⁴ The buyer, of course, may waive the contingency and go ahead with the purchase anyway or may void the contract.³¹⁵

These types of clauses were used with increasing frequency, particularly in areas identified with high radon levels.³¹⁶ The use of the contingency clauses clearly contributed to the failure of the litigation explosion. For many buyers and sellers the radon contingency clause became as standard as the clause for termite infestation and urea formaldehyde insulation.³¹⁷ Furthermore, even when radon was discovered, one commentator noted, "the detection of radon has caused few [real estate] deals to fall through, even though prolonged exposure to high concentrations of the gas is believed to cause cancer."³¹⁸ Also, even though tampering with the radon testing devices by sellers, particularly the short-term devices typically used in real estate transactions,³¹⁹ was recognized as a very real possibility,³²⁰ there are, nonetheless, virtually no reported cases of fraud involving the issue of test tampering.

Although the suggestion that the use of radon contingency clauses in contracts helped to avert a litigation explosion cannot be gainsaid, it too cannot entirely explain the failure of the issue to catch fire. Considering that radon contamination in the home is claimed to cause significant life threatening risks, the fact that there has not been greater evidence of public concern manifested through the form of litigation on the issue is surprising. Many commentators have noted that the latency period of twenty years or more for the development of radon-induced

313. *Id.*

314. *Id.*

315. *Id.*

316. See Shepherd, *supra* note 22, at 45; Brooks, *supra* note 306, at 27.

317. See Brooks, *supra* note 306, at 27.

318. *Id.* at 25.

319. See Shepherd, *supra* note 22, at 48.

320. *Id.* "Some officials believe that between 25 and 40 percent [sic] of all residential real estate radon tests involve tampering." *Id.*

lung cancer³²¹ is an impediment to plaintiffs in recovering health-related damages in radon litigation.³²² However, property-related damages, such as compensation for remediation of radon or diminution in market value, are not a function of the latency period.³²³ Yet very few of these cases have been brought in the last ten years.³²⁴ The obvious lack of public interest in the issue caused commentators to speculate as to the reasons why the radon scare faded so quickly. One commentator noted:

Whatever happened to the radon scare?

Two years ago this month, the Environmental Protection Agency recommended that all homes be tested for the colorless, tasteless gas that is blamed for at least 20,000 lung-cancer deaths each year.

The message created a brief flurry of testing activity among homeowners and then was quickly forgotten.³²⁵

As previously discussed, EPA must assume much of the responsibility for the lack of public interest in the radon issue.³²⁶ EPA's overly simplistic, somewhat arbitrary action level for testing and mitigation led to much criticism and controversy.³²⁷ Even EPA was forced to admit that its initial estimates of radon-induced deaths were probably overblown.³²⁸ At the same time, Congress was ordering EPA to rewrite A CITIZEN'S GUIDE to correct, among other things, the perception that a 4 pCi/l radon level was the threshold between safe and unsafe radon levels.³²⁹ Furthermore, EPA failed to properly educate

321. See Cross & Murray, *supra* note 10, at 724.

322. *E.g., id.* at 724.

323. *Id.* at 735-38.

324. See Jackowitz, *supra* note 3, at 357 & n.192 (citing residential radon cases filed as of 1988). Litigation in this field also involves actions by vendors against purchasers. After a discovery of residential radon contamination, purchasers who default on purchase agreements may be held liable to the vendor for damages. See, e.g., Wong v. Mercado, 590 A.2d 723 (N.J. Super. Ct. Law Div. 1991) (holding purchaser liable because default was based on a radon level of 2.9 pCi/l was objectively unreasonable).

325. Gene Austin, *Has Homeowners' Radon Scare Gone With The Wind?*, PHILA. INQUIRER, Sept. 30, 1990, at 1-L.

326. See *supra* notes 92-100 and accompanying text.

327. See *supra* notes 75-117 and accompanying text.

328. See *supra* notes 101-13 and accompanying text.

329. See *supra* notes 191-93 and accompanying text.

the public about the fact that radon levels can vary from one home to the other. According to one EPA official, "If someone tests in a neighborhood and gets a low reading, everybody says, 'There's no radon here, so why bother.' If someone gets a high reading, the others don't want to hear about it."³³⁰ Obviously, the public was, and remains, simply confused about the dangers of radon.

In the final analysis, however, it does appear that apathy played the most significant role in the failure of the radon issue to move the public. One commentator suggested a compelling argument that the public's apathy is due in part to the characteristics of radon:

1. Radon poses a "life-style" risk -- similar to that posed by smoking cigarettes or drinking alcohol -- and people tend to underestimate, deny, or dismiss life-style risks.
2. The objective probability of getting lung cancer from radon -- between one and five percent if exposure is four picocuries per liter ... -- is too low for people to understand the risk and respond appropriately.
3. Radon -- colorless, odorless, and tasteless -- presents no perceptual reminders to alert people to its presence; its physical characteristics do not trigger self-protective behavior.
4. Because radon poses a natural risk, rather than a risk created by man or technology, there is no "villain" to blame or to make responsible. Moreover, people tend to underestimate, dismiss, or deny natural risks and treat them less seriously than man-made risks.
5. Homeowners' experience with radon generally is benign, many having long lived with it in their homes without negative ramifications.
6. Radon-induced lung cancer has a long latency period and displays no early warning symptoms. Because it takes so long for radon to cause cancer, homeowners do not

330. Austin, *supra* note 325.

perceive it as a serious threat.

7. Exposure to radon does not cause mass death or disaster; deaths occur singly. Also, there is no obvious perceptual link between exposure and death.

8. People, who choose their homes, voluntarily expose themselves to radon (and, before 1986, information about radon to consider when choosing homes was hard to obtain).

9. Radon risk is not the same for everyone; it varies depending on such factors as soil type, house structure, and behavior of home occupants.³³¹

The public's failure to initiate radon-related litigation during the last ten years is a positive note for an already litigious society. However, it also supports the proposition that the public simply does not take the indoor radon threat seriously. The characteristics of radon contamination as well as the bungled message concerning radon from governmental sources both have contributed to the public passiveness with regard to the issue during the past decade. If radon truly is the life-threatening phenomenon as the great weight of scientific evidence suggests, then new approaches to reach the public about the seriousness of the radon problem must be proposed, examined and implemented.

III. THE RADON PROBLEM IN THE FUTURE

Most commentators who have addressed the residential radon problem since 1988 recognized that a passive governmental approach, either on the federal level or state level, would not adequately protect the public.³³² Some commentators suggested that EPA should continue to coordinate information about radon, disseminate that information to the states, research testing and remedial techniques and recommend standards for new construction³³³ These commentators also saw the need for

331. Locke, *supra* note 10, at 10,476-77 (footnotes omitted).

332. See, e.g., Moore, *supra* note 8, at 60-61; Jackowitz, *supra* note 3, at 354-80; Locke, *supra* note 10, at 10,478-82.

333. See Moore, *supra* note 8, at 59-60.

some efforts at regulating the radon problem through legislation.³³⁴

One commentator called for the federal government to draft "legislation mandating states to develop radon programs that will adequately address the problem within the state."³³⁵ The recommended legislation would employ EPA to set standards which the states would achieve by developing their own programs. States, however, would not be required to guarantee that every building met EPA's standard.³³⁶ Essentially, this commentator appears to be suggesting that the federal government should at least insist that every state show some evidence that it takes the radon problem seriously by establishing an operational state radon program.³³⁷

Similarly, other commentators suggested government intervention, but on a much more intrusive level. For example, one commentator suggested that Congress enact legislation authorizing EPA to promulgate regulations requiring the states to comply with its 4 pCi/l guideline.³³⁸ She argued that allowing homeowners to decide for themselves whether to improve their own indoor air quality³³⁹ and providing common law remedies to compensate for injury related to indoor radon contamination³⁴⁰ are both insufficient means to protect the public. To respond to these problems, she called for federal legislation mandating state enforcement of a 4 pCi/l standard.³⁴¹ Coinciding with the federal legislation, the commentator called for mandatory testing legislation at the state level: "A state mandatory testing regulation could require, for instance, that all homeowners within the state test for radon annually."³⁴² Other commentators also supported mandatory testing on the state level.³⁴³ Some appeared to call for mandatory remediation as well: "If seat belts and smoking restrictions are now accepted by the public, the time for mandatory radon testing and remediation, at least for

334. *Id.*; Jackowitz, *supra* note 3, at 354-80; Locke, *supra* note 10, at 10,478-82; Marsha Wolf & Lewis Goldshore, *New Radon Bill Reflects Change In Approach*, N.J. L.J., Nov. 2, 1989, at 9.

335. Moore, *supra* note 8, at 60.

336. *Id.*

337. See generally *supra* notes 220-26 and accompanying text.

338. See Jackowitz, *supra* note 3, at 359.

339. *Id.* at 354-58.

340. See *id.* at 357-58.

341. *Id.* at 359.

342. *Id.* at 370.

343. See, e.g., Bannworth, *supra* note 8, at 192.

public buildings and on sale of private residences, is drawing closer."³⁴⁴

In light of the EPA's dogged adherence to its advisory posture with regard to the radon issue during the last ten years, it seems highly unlikely that the agency would support mandatory testing. It is also important to note that mandatory testing necessarily implies mandatory remediation. That the federal government would insist that a homeowner test to discover a radon problem and yet permit the problem to go unabated at the whim of the owner seems incongruous. The same problem clearly exists at the state level.

Moreover, if the government, either federal or state, is going to mandate testing and remediation, then it must be prepared to shoulder at least some of the expense. Even financial assistance to remediate in the form of low interest loans, tax credits, subsidized remediation service and grants to low income homeowners³⁴⁵ would surely overburden the already financially strapped governmental budgets.

With ten years having passed since the discovery of naturally occurring indoor radon contamination at the Watras house, too many uncertainties remain involving radon risks for federal and state governments to seek to implement mandatory testing in the near future.³⁴⁶ Before the government can entertain any efforts to force people to test it must provide evidence to support the risks at given levels of exposure with definitive scientific studies. Although few would argue against abatement of high levels of indoor radon, the health risk at levels around EPA's 4 pCi/l action level remain too tenuous to insist upon mandatory remediation. The EPA should continue to inform homeowners of its current thinking with regard to the action level and urge citizens to mitigate; but, at this time, mandatory testing and remediation are simply too intrusive,³⁴⁷ difficult to monitor and enforce³⁴⁸ and expensive.³⁴⁹

If the government wishes to address the radon issue in a more regulatory manner, then it should consider a proposal to achieve its goal through a more indirect and less obtrusive manner. One commentator

344. Wolf & Goldshore, *supra* note 334.

345. See Jackowitz, *supra* note 3, at 372.

346. See *supra* notes 75-116 and accompanying text.

347. See Jackowitz, *supra* note 3, at 360 n.207.

348. *Id.* at 370.

349. *Id.*

offered a solution which recognized a pattern of behavior which has occurred during the past ten years with regard to testing and mitigating indoor radon. Because studies have shown that during the last ten years most of the testing for and mitigation of radon have occurred pursuant to the sale of real estate, the commentator proposed a federal law which would tie testing and remediation to the financing of real estate purchases.³⁵⁰ Citing a study that indicated that home buyers are a population which appears to take radon hazards more seriously than others, as evidenced by their perseverance through the testing and mitigation processes,³⁵¹ the commentator proposed a two-part national strategy which ties the testing for radon to the purchase of real estate.³⁵² The commentator specifically suggested (1) that Congress enact legislation which mandates the provision of radon information to the mortgagor for every federally related mortgage loan originated by mortgage granting institutions and (2) that radon test results be included in every federally related mortgage loan purchased, swapped, handled or otherwise acquired by federal or quasi-federal governmental organizations that participate in the secondary mortgage market.³⁵³

The efficacy of providing radon information at the time of the buyer's application for financing³⁵⁴ is grounded on the fact that all parties to the process -- the buyer, the seller and the lending institution -- have an interest in seeing that the home is marketable.³⁵⁵ Unabated radon contamination clearly affects the value of the real estate. Because federally related loans encompass most of the mortgages issued to purchase residential real estate,³⁵⁶ a high likelihood exists that most buyers will be informed of the hazards of indoor radon.³⁵⁷ To ensure, however, that buyers take seriously the warnings about radon contained in the provided radon information, the second part of the proposal

350. See Locke, *supra* note 10, at 10,479-81.

351. *Id.* at 10,478-79.

352. *Id.* at 10,479-81.

353. *Id.*

354. The commentator suggested a law which would require all lenders of federally related mortgage loans to distribute a booklet, prepared or approved by EPA, to potential mortgagors. He suggested further that the booklet could be based on EPA's two most widely disseminated radon pamphlets, A CITIZEN'S GUIDE and RADON REDUCTION METHODS. *Id.* at 10,480.

355. *Id.*

356. *Id.*

357. See *id.* at 10,481.

requires that radon test results be contained in documents which accompany the transaction in the secondary mortgage market.³⁵⁸ Because billions of dollars worth of mortgages are sold each year in the governmental-based secondary mortgage market, most primary lenders would insist upon radon tests of the subject property as a prerequisite to making a loan commitment.³⁵⁹

In support of this proposal, the commentator noted many advantages to using the loan application process for educating the homeowner about the dangers of radon. Principal among the cited advantages are: (1) the proposal recognizes that buyers of real property are inclined to take radon warnings seriously; (2) parties related to the home-buying process, such as real estate agents and mortgage bankers, will have access to radon information and will encourage buyers to take the issue seriously; (3) radon testing and mitigation will become a commonplace prerequisite to selling a home; (4) the program is cost-effective for the federal government due to the fact that there are no costly and burdensome regulatory and enforcement responsibilities; and (5) the program creates uniformity among the states, thus avoiding a piecemeal radon policy.³⁶⁰ The most significant drawback to the proposal is that its scope is limited to the sale of homes. Because only five percent of all homes are sold each year, its attack on the radon problem is slow.³⁶¹

While the proposal utilizing the home mortgage market is far more appealing than the more intrusive mandatory testing and mitigation suggestions, it nonetheless perpetuates a reliance on EPA's guidance regarding the radon levels deemed to be health risks. Without further scientific evidence on the dangers of a 4 pCi/l reading, for example, and without more reliable short-term testing devices,³⁶² the burden of radon tests and mitigation efforts, as well as their attendant expenses, will continue to be placed on parties to the sale of real estate without a clear-cut justification.

As noted previously, the greater weight of scientific authority

358. *Id.* at 10,480-82.

359. *Id.* at 10,481.

360. *See id.* at 10,481-82.

361. *Id.* at 10,482.

362. One commentator noted, "Because time is of the essence in most real estate transactions, few home buyers have the luxury of awaiting the results of a long-term radon test. ... The most popular short-term screening device is the charcoal canister." Shepherd, *supra* note 22, at 48.

supports the concern about the dangers of indoor radon.³⁶³ The public should not ignore the warnings. On the other hand, EPA, while subject to criticism, has changed its position on some important facts related to the radon problem, such as the projected number of deaths caused by radon-induced lung cancer³⁶⁴ and the recommended treatment for a 4 pCi/l radon level.³⁶⁵ Consequently, for the government, either federal or state, to require testing or remediation is not appropriate at this time. If further studies confirm indoor radon hazards with greater detail, then governments should consider the possibility of regulation.

Scientific inquiry is an ongoing process and there appears to be enough scientific evidence to suggest that the public should be apprised of radon. Thus, buyers of real estate, particularly in those areas of the country where radon is known to be a potential indoor hazard, should be informed of the potential dangers of radon as well as the limitations on testing and mitigating which have been gleaned during the course of the last ten years. This can be accomplished primarily through the efforts of sales agents who are already under a duty to inform prospective buyers of a potential radon problem.³⁶⁶ The buyer, however, should also be apprised by the agent of the fact that short-term radon testing devices have not yet been deemed sufficiently reliable to determine the extent of an indoor radon problem and that short-term testing devices are too easily manipulated by eager sellers. The buyer, therefore, should routinely be urged by the real estate professional to take the opportunity to perform a more reliable long-term test upon the transfer of the

363. See Jaffe, *supra* note 112.

364. In A CITIZEN'S GUIDE, EPA states, "Scientists estimate that from about 5,000 to about 20,000 lung cancer deaths a year in the United States may be attributed to radon." A CITIZEN'S GUIDE, *supra* note 3, at 1. In CITIZEN'S GUIDE, 2D ED., EPA notes that, "Radon is estimated to cause about 14,000 deaths per year -- however, this number could range from 7,000 to 30,000 deaths per year." CITIZEN'S GUIDE, 2D ED., *supra* note 194, at 2.

365. In A CITIZEN'S GUIDE, EPA states that if a short-term screening measurement is less than about 4 pCi/l "follow-up measurements are probably not required." A CITIZEN'S GUIDE, *supra* note 3, at 7. In CITIZEN'S GUIDE, 2D ED., EPA states: "A short-term test followed by a second short-term test may be used to decide whether to fix your home. However, the closer the average of your two short-term tests is to 4 pCi/l, the less certain you can be about whether your year-round average is above or below that level. Keep in mind that radon levels below 4 pCi/l still pose some risk. Radon levels can be reduced in most homes to 2 pCi/l or below." CITIZEN'S GUIDE, 2D ED., *supra* note 194, at 14.

366. See Winicour, *supra* note 22, at 791 n.190.

property.

Pursuant to the long-term test, the buyer should be urged to consider requiring that the seller fund an escrow account upon which the buyer could draw to mitigate a radon problem should the long-term test result indicate a radon level of 4 pCi/l or greater. With regard to the escrow account, the buyer should be informed that if at the end of the buyer's first year of occupancy a long-term test has not been performed, or if performed with a test result less than 4 pCi/l, the escrow money will be returned to the seller.³⁶⁷ The real estate agent should address these issues in a writing given to and initialed by the buyer. The seller should also be apprised that the sales agent is bound by law to provide the potential buyer with all relevant information on radon. Of course, because the establishment of the escrow account would remain a matter of contract negotiation, the buyer may waive the right to require the escrow account or the seller may refuse to agree to it.

The escrow account idea is not a perfect solution. However, it does recognize that at the time of the sale of real estate people are most receptive to information about radon.³⁶⁸ Moreover, it is likely to encourage prospective sellers to test and mitigate in order to avoid the possibility of having funds held in escrow for a year. Equally important, because it requires no governmental intervention beyond the research and publication efforts already underway, it is cost effective. Furthermore, it places the duty to inform of the potential radon hazard in the geographic location on those who would or should know best about its likelihood: real estate agents. The law is now clear that real estate brokers must inform potential customers about the condition of homes and that brokers may be held liable for failing to inform buyers about known defects that could injure persons or property or about factors that materially affect the value of property.³⁶⁹ As one commentator noted: "The real estate broker, who has greater knowledge about homes than do owners or buyers and is hired to increase the efficiency of the real estate transaction, appears to be best situated to ensure that prospective buyers are provided with information."³⁷⁰

367. This escrow account proposal has been favorably suggested by a number of commentators. See, e.g., Jackowitz, *supra* note 3, at 376-77; Sherman, *supra* note 7, at 24.

368. See Locke, *supra* note 10, at 10,478.

369. See Note, *Imposing Tort Liability On Real Estate Brokers Selling Defective Housing*, 99 HARV. L. REV. 1861, 1862-65 (1986).

370. *Id.* at 1867-68 (footnotes omitted).

Although the escrow account suggestion labors under the same shortcomings as the mortgage-based regulatory scheme³⁷¹ to the extent that it is limited to the sales of homes³⁷² and is a slow process for correction of a potentially large indoor radon contamination problem,³⁷³ it is perhaps the best alternative for handling the problem as we enter the second decade of dealing with the indoor pollutant. It recognizes that radon is most likely a serious health threat and at the same time informs the homeowner of the limitations that still exist with regard to our understanding of the hazards. The homeowner, whether buyer or seller, is not required to correct a condition which is still under investigation by the scientific community, yet is afforded the opportunity to receive the most current thinking of the scientific community with regard to the issue as set forth in governmental publications. Furthermore, although the escrow account option encourages the homeowner to test and remedy, it nonetheless retains a freedom to act on the part of buyers and sellers which respects their right to interpret information about a risk that is still uncertain.

IV. CONCLUSION

Since the discovery of high levels of naturally occurring indoor radon at the Watras house in Boyertown, Pennsylvania, in December 1984, the American public has been bombarded with a variety of allegations about the effects of the indoor gas. After a study by EPA, the federal agency announced in 1988 that indoor radon from naturally occurring sources was the nation's most serious air pollution problem. EPA claimed that indoor radon was responsible for 20,000 deaths each year and urged every homeowner to test for radon. Following EPA's announcement, worried homeowners sought out testing devices and began to engage contractors to correct indoor radon problems. While EPA suggested that radon test results above 4 pCi/l were dangerously high and needed to be reduced, this action level came to be regarded as the threshold point between safe and unsafe household levels of radon.

As the 4 pCi/l value became firmly entrenched in the minds of the

371. See *supra* notes 364-65 and accompanying text.

372. See Locke, *supra* note 10, at 10,482 (tying radon testing to real estate sales is limiting because "it does not address other dwelling units, such as apartment rental units or schools and public buildings").

373. *Id.*

public, most typically through real estate transactions, critics emerged challenging the data EPA utilized to establish the guideline. Moreover, common radon testing devices came under scrutiny and were often found to be unreliable. In addition, EPA's protocol for testing came under attack as critics charged that radon entry into the home was a function of many variables, some of which EPA apparently had not recognized. While EPA attempted to maintain an advisory posture with regard to indoor radon, some critics in Congress charged that the EPA was not doing enough to educate the public about the dangers. Finally, some charged that EPA had mislead the public with the 4 pCi/l guideline because even that level was unsafe.

Just two years after the federal government's stern warning about the dangers of indoor radon, the public all but ignored the issue. EPA's credibility with regard to the radon issue was damaged. Its efforts to inform the public without creating a panic resulted instead in complete apathy. Forecasted explosions in litigation concerning radon issues never materialized and calls for comprehensive regulatory policy went unheeded. Since the discovery of dangerously high levels of radon at the Watras house ten years ago, the radon issue today appears virtually dead.

Although the scientific community generally agrees with the federal government about the dangers of indoor radon, the necessity for further research substantiating the health hazards of indoor radon remains. Consequently, EPA and other governmental bodies must not yet seek regulatory control over the homeowners' response to the problem in order to prevent further erosion of the public's concern about the indoor pollutant. There simply are too many unanswered questions remaining with regard to almost all areas of the radon issue.

Rather, EPA should continue its efforts to research the radon phenomenon in order to support more thoroughly and convincingly its position on the health risks. At the same time, EPA should take steps to increase citizen awareness of the radon issue. Because there apparently is sufficient scientific support to warn the public about higher levels of radon and because the public appears most receptive to grappling with radon issues during the sale of real estate, real estate professionals should be the conduit for informing the buying public about the necessity to consider radon issues when purchasing a home. Although such efforts reach only a fraction of the homes that the government estimates are in need of radon mitigation, the government is not yet in the position to advocate a greater intrusion into the homes of the American people.