

## THE DEBATE OVER RADON CONTINUES

**“While the carcinogenicity of radon daughters is established and the hazards of high levels of exposure during mining are well recognized, the risks of exposure to low levels of radon progeny have not as yet been precisely characterized.”**

**L**ung cancer has surpassed breast cancer as the number one cause of cancer death in women, and it is also the most frequent cause of cancer death in men. These figures are not disputed, nor are the number of deaths from lung cancer in 1985—106,000 deaths in smokers and 3800 deaths in non-smokers—as determined by the Surgeon General. The question that remains concerns the lung cancer deaths not caused by smoking.

The Congress, The Environmental Protection Agency and others believe progeny of radon-222—which emanates from the soil and certain building materials and can accumulate in poorly ventilated structures—cause many cases of lung cancer. Others are less certain of radon's role, because there has not been any solid epidemiological data showing a clear association between low levels of radon in the environment and lung cancer risk. However, there is evidence for an increased risk of exposure to radon in smokers; most cases of lung cancer in which radon is a suspected cause occur in smokers.

While the Congress and the Environmental Protection Agency (EPA) continue to support stricter guidelines regulating radon levels in homes, schools, and other buildings, some experts argue that such efforts to minimize radon levels might be premature, misdirected, and perhaps counterproductive.

Jacob I. Fabricant, MD, PhD, professor of radiology at the University of California, Berkeley and senior scientist at Lawrence Berkeley Laboratory, told *Newsline*, “My great concern is that I don't believe there's enough information available to pass regulatory laws to control [radon levels].” Dr. Fabricant, who is chairman of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR), and senior author of the BEIR IV Report, “The Health Effects of Radon and Other Alpha Emitters,” discussed the Committee's findings at a seminar on radon during the American College of Nuclear Physicians (ACNP) Annual Meeting in February. Noting that numerous studies of underground miners exposed to radon in mines have shown they have an increased risk of lung cancer compared to non-exposed populations and that animals exposed to radon also develop lung cancer, he told the seminar attendees, “there is abundant epidemiological and experimental data to establish the carcinogenicity of radon progeny. . . Nevertheless, while the carcinogenicity of radon daughters is established and the hazards of high levels of exposure during mining are well recognized, the risks of exposure to lower levels of radon progeny have not as yet been precisely characterized. . . . It is very difficult to determine the precise risk of exposure to indoor radon progeny in the general

public in the presence of the more proven causative agent, cigarette smoking.” Continued studies are needed, added Dr. Fabricant, to determine the risks of lower levels of exposure in order to address the potential health effects of radon in homes and other buildings and to establish standards for exposure.

### **The EPA's Approach to Radon**

While the EPA continues to study the issue, its approach is one of cautious pessimism; for the sake of prudence the Agency assumes the worst. In April, the EPA released information on radon screening measurements of schools that they had taken over the past winter. The agency surveyed 3000 classrooms (every occupied room from ground floor to basement) in 130 schools in 16 states and found that 54% of the schools sampled had at least one room with a radon level greater than 4 picocuries per liter (pCi/L) of air, the EPA's currently recommended standard. Of the classrooms sampled, 3% had levels over 20pCi/L. The EPA urged all school systems to test for radon and take remedial action if necessary. Although Kirk Maconaughey, chief of the problem assessment branch of the EPA's radon division, told *Newsline*, “this was not a truly random sample, and there is no basis to extrapolate to the nation,” the EPA did not want to withhold these, what they considered surpris-

ingly high, numbers from the public. The Agency recommends that for levels ranging from 4-20pCi/L, the situation should be monitored, for levels from 20-200pCi/L, remedial action should be taken within a few months, and for levels greater than 200pCi/L, action should be taken within a few weeks, according to Mr. Maconaughey.

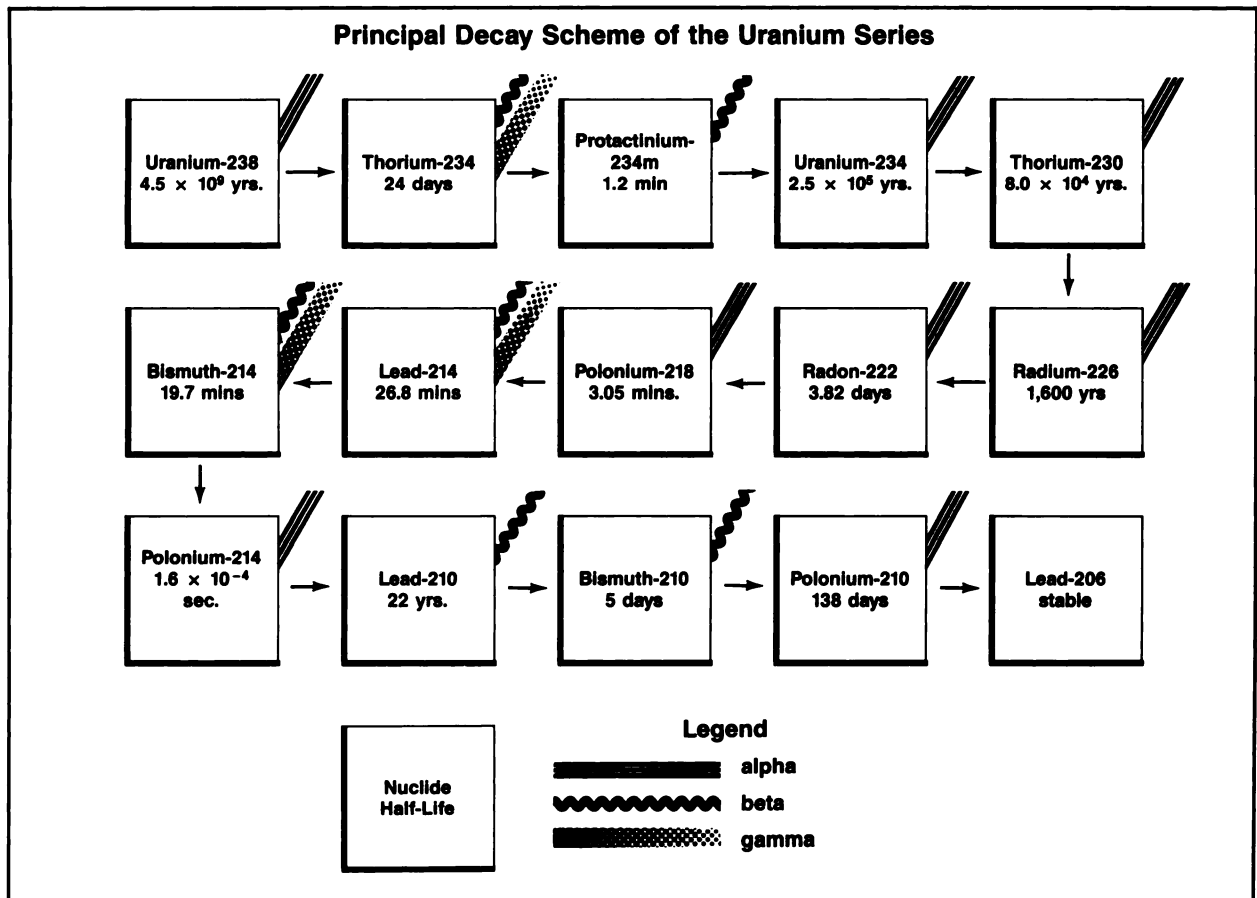
This guidance for schools follows two radon-related government actions this past fall. The EPA issued an advisory in September asserting that radon poses a larger health threat than was previously thought. This advisory was based on monitoring of 23,000 single family homes in 17 states and several Midwest Indian lands during the winters of 1986-1987 and 1987-1988, in which 1/4 of the homes surveyed had levels greater

than 4pCi/L. At that time, the EPA recommended that all homes in the US be surveyed for radon levels. In October, the Indoor Radon Abatement Act, an amendment to the Toxic Substances Control Act, was signed into law by President Reagan. The Act, which calls for a long-term national goal for indoor radon levels to equal ambient concentrations (0.2-0.7 pCi/L), requires that the EPA revise its *Citizen's Guide to Radon*; develop construction standards for controlling radon in new buildings; develop various programs and services to assist states, such as a clearinghouse for radon-related information, training seminars, public information material, and a national radon database; determine the extent of radon in the nation's schools; and fund universities for operating re-

gional radon training centers to provide training to state and local officials and private firms.

Through the Radon Abatement Act the "Congress has said EPA needs to drive the standard down lower," Mr. Maconaughey said, but the remediation technology, primarily subslab depressurization, in which radon-contaminated air is suctioned from below the house to the roof and outside; increasing air pressure within a building to force radon out; and sealing cracks in foundations, "has not advanced to get the levels lower than 4 [pCi/L]. Four was never a health-based standard." That level, according to the EPA, is comparable to the level of radiation one receives from smoking half a pack of cigarettes a day and is associated with 20,000 lung

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cancer deaths per year.

### Criticism of EPA's Approach

Some experts are critical of the EPA's approach to radon and their dosage estimates. William Mills, PhD, senior technical advisor to the Oak Ridge Associated Universities (ORAU) in Washington, D.C., who directs ORAU's science and policy support to the Committee on Inter-agency Radiation Research and Policy Coordination, Office of Science and Technology Policy, told *Newsline* that the EPA's equating of 4pCi/L to half a pack of cigarettes a day and another comparison to 300 chest x-rays is "ludicrous" and said, "I don't think there's any way you can educate the public by releasing numbers like that—it's just comparing apples and oranges."

Contrary to EPA's estimates, Dr. Mills told the seminar attendees, "20,000 Americans are not dying every year from radon exposure, the number is much less than that... 10,000 is probably an upper bound on the risk... screening measurements of state surveys are absolutely poor indicators of radon risk, [the type of measurements done by the EPA, often taken in closed basements during the winter, tend to maximize risk], and yet that's what the media is reporting."

Naomi Harley, PhD, research professor of environmental medicine at New York University Medical Center, speaking at the seminar, said the EPA estimates that the risk of exposure to 200 pCi/L is 75%, if that exposure carried for 70 years. "In light of what you've seen with the miner data, that's simply outrageous, because even the miners at much higher exposure rates have never attained this [or] even [a] 50% value... There has never been lung cancer observed in the US [Colorado miners] cohort below about 250

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working level months (WLM), there just aren't any." [A working level month is a unit of exposure to radon progeny. One WLM is approximately 200pCi/L x 170 hours.] Dr. Harley also noted that data done on Czechoslovakian miners demonstrated that "the radon risk really does return to zero when you get about 35 years away from a given exposure."

Dr. Mills was critical of EPA's risk estimates for children, who the Agency considers much more vulnerable to the gas than adults. "Actual exposure is probably many-fold lower than the measurement values reported by the EPA... They argue that if a child gets exposed... he carries the associated risk throughout his whole lifetime... There is some evidence that the lung may fight off, through some mechanism, the potential for the development of cancer," he said. Dr. Harley, who chaired the National Council on Radiation Protection (NCRP) task force that prepared a report titled, "An Evaluation of the Occupational and Environmental Risk from Radon and Radon Daughters", and who chairs an NCRP committee preparing another report on radon and radon daughters, agreed that the risk estimates for children are probably overstated. Dr. Harley said, "The dose per WLM on the bronchial tree is essentially identical across populations, men, women, children, with the exception of a child about ten

years old, [who does] tend to have a slightly higher dose per unit exposure, per WLM exposure. But this only lasts for a few years and given the fact that lung cancer does not appear until older ages... and the fact that the effect of exposure is reduced with time, then the dose to children probably is not very meaningful."

### Lung Cancer Risk Mainly in Smokers

In the keynote address to the ACNP Annual Meeting, Rosalyn Yalow, PhD, underscored the principle role of smoking in the current epidemic of lung cancer in the US and said that radon is a hazard only when combined with cigarette smoking. Noting that increases in lung cancer incidence closely parallel increases in smoking rates, with about a 20 year lag accounting for the time it takes for solid tumors to appear after exposure to a carcinogen, Dr. Yalow said, "... in the absence of smoking, lung cancer in our country should be 2-3 per 100,000."

According to Dr. Mills, "In order to reach the estimate of the baseline risk of the smoking population exposure would have to have considerable... 30 or 40 working level months a year" [or about 80 pCi/L]. Extending the BEIR IV data, Dr. Fabricant projected the risk of lung cancer in non-smokers to be 1% and in

smokers, about 10%. Dr. Mills pointed out that while the EPA estimates the range of risk of lung cancer from radon progeny in the general population to be 1-4%, they did note it could be as low as .3%.

Using the lung cancer risk estimates put out by the BEIR IV Committee, Dr. Mills said 4000 lung cancers per year are predicted to occur in residents of the estimated four million homes in the US with radon levels above 4pCi/L. Three quarters of those lung cancers would be in US smokers, a population of 50 million, and one quarter would occur in non-smokers, a population of 190 million. Dr. Mills further estimated that 300-400 of the lung cancers in the non-smoking population can be attributed to passive smoke, and he noted that since all the risk estimates are based on extrapolations from data from miners, many of whom, in addition to being heavy smokers, were exposed to high doses of radon progeny, the numbers are "still very hypothetical." Beyond that, he said, "I just don't know if there are any effects in the non-smoking population from 4pCi/L." Dr. Harley said extrapolations from the mining data to estimate the risk of those that are exposed environmentally are valid.

The lung cancer risk estimates for radon daughters derived in the BEIR IV Report were based solely on epidemiological studies of exposed miner populations, said Dr. Fabricant. The Committee analyzed data from four major epidemiological studies—Ontario uranium miners,

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Saskatchewan uranium miners, Swedish metal miners, and Colorado Plateau uranium miners. The data included a total of about 500,000 person years at risk as well as 459 lung cancer deaths. Dr. Fabricant noted that this compared to 2.3 million person years of risk among Japanese survivors of the Hiroshima and Nagasaki bombings.

The Committee found that age at risk and time since exposure "significantly modify excess relative risk of lung cancer mortality"—risk decreases with time since exposure and age at risk, according to Dr. Fabricant. This contrasts previous risk models, he noted.

#### **Discrepancies With Linear No Threshold Theory**

Other studies have found an inverse relationship between low levels of

radon and lung cancer, though these results do not necessarily support the hormesis theory, according to which low levels of radiation confer a beneficial health effect.

Studies by Bernard L. Cohen, professor of physics and radiation health at the University of Pittsburgh, demonstrated a discrepancy between the data and the linear no threshold theory of radiation carcinogenesis, even when many confounding factors are considered. Dr. Cohen told seminar attendees, "The lung cancer rates in counties and states tend strongly to decrease as the average radon levels increase. The effect is statistically unquestionable by many, many standard deviations. This is in sharp contrast to the predictions of the linear no threshold theory that lung cancer rates should increase substantially as average radon levels increase."

In a paper on this work to be published by the Pennsylvania Academy of Sciences in a book on radon sometime in late 1989, Dr. Cohen wrote of an analysis to account for smoking by reviewing the data by states, in which there is data on cigarette sales from tax collection,

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“Even when all of the other potential socioeconomic confounding factors are included, the discrepancy with [the no threshold] theory is not substantially reduced; in fact it is reduced by less than was the case for counties, where smoking was not included in the regression.”

Pointing out but not endorsing one possible explanation for the data, Dr. Cohen said, “These results are very easily explained if there is hormesis theory of low dose rate. . . you could still have your linear no threshold theory and superimpose on it a hormesis effect, where a little bit of radiation, say by stimulating the immune system, gives protection against cancer.”

A case-control study Dr. Cohen is conducting also contrasts with the

linear no threshold theory. According to the linear no threshold theory, he noted, “houses where people die of lung cancer should have a higher radon level on an average than houses where people died of another type of cancer.” But preliminary data from his study give “no indication that radon levels in houses where people died of lung cancer are any higher than in houses where people died of some other type of cancer.”

Bertrand R. Brill, MD, PhD, director of research and professor of nuclear medicine at the University of Massachusetts, Worcester, in an interview with *Newsline*, called Dr. Cohen’s work “provocative” because it is based on such a large number of measurements.

David R. Maillie, PhD, associate professor of biophysics at the

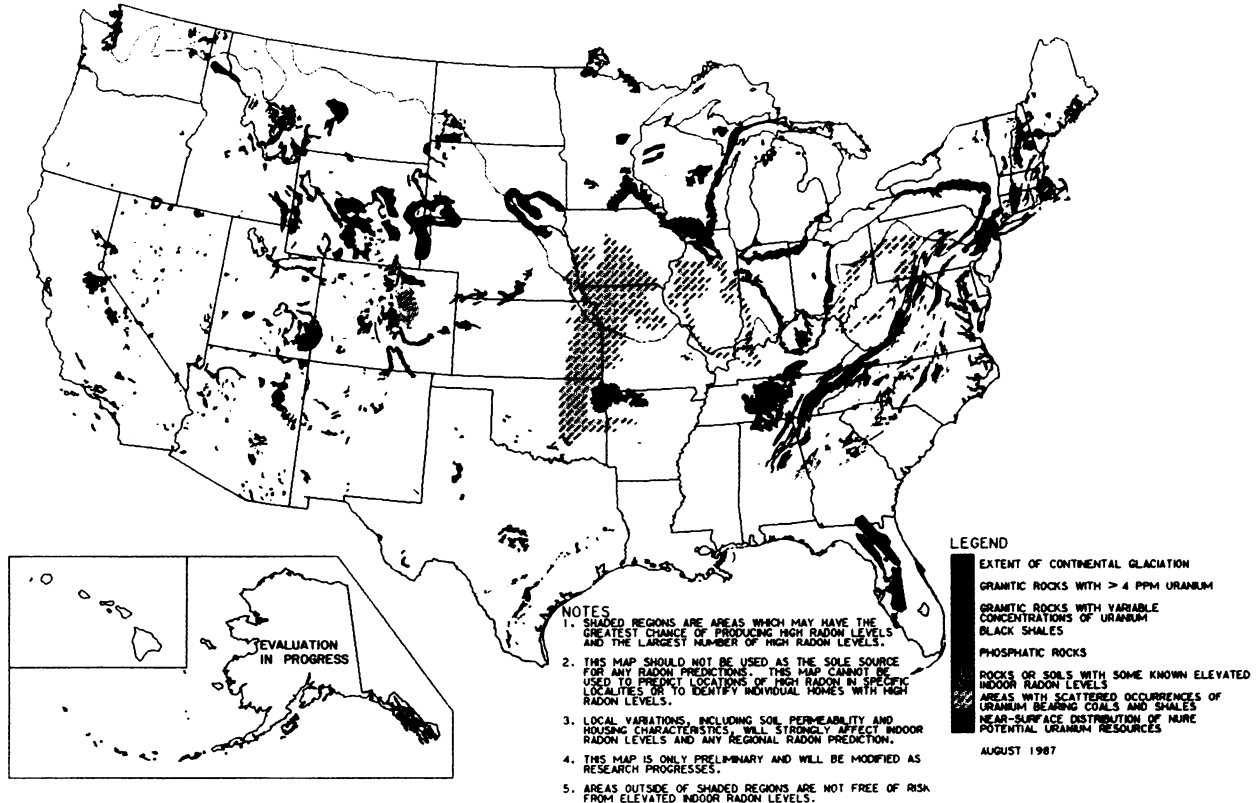
University of Rochester, told *Newsline* that an analysis he did of New York State indicated no relationship between areas with above average radon levels and areas with high lung cancer rates.

**Benefits of Mass Remediation Questioned**

There are certain levels at which remedial action should be taken, according to Dr. Mills. Otherwise, creating panic in the public about radon levels at which no adverse health effects have been clearly found can do more harm than good. “A typical home for lifetime exposure is less than 20 WLM. . . that’s considerably below where we’ve seen [lung cancers].” Dr. Mills questions the efficacy of remediating to get

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AREAS WITH POTENTIALLY HIGH RADON LEVELS



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levels to below 4pCi/L, let alone ambient levels. "The remediation program is unlikely to significantly reduce the number of lung cancers . . . I don't think we'll see a reduction such that it's really measureable." Because screening surveys generally do not measure the average level for an entire year or the amount of time people are actually exposed, he said, "I would certainly rely on average measurements for remediation. I wouldn't take any of the screening measurements and act on them." Dr. Mills told *Newsline*, "I worry about large amounts of money being spent to remediate these houses and schools based on these screening measurements."

Dr. Mills urged that public health would be much better served if much of the monies and effort expended to decrease lung cancer rates were shifted from an anti-radon campaign to an anti-smoking campaign. "This is my primary message to the public," he told seminar attendees: "The most effective means of reducing lung cancer deaths attributable to indoor radon is to reduce smoking, which reduces the risk to the smoker as well as to the non-smoker. This message best reflects the available scientific data and has other social benefits. That's the message that I did not hear

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given by the Public Health Service and EPA when they called for the whole survey of the United States. They failed to emphasize this fact.”

Similarly Dr. Fabricant said, “If one went ahead and modified all the homes in the United States that were in excess of 4pCi/L, then the decrease based on the most conservative estimate would be only 4-5% of the lung cancers that are caused annually in the US. Based on the available information,” he added, “the radon risk to the non-smoker appears to be much less than has been previously estimated. Protective measures are likely to be most effective simply by reducing radon risk to smokers. . .

who are already at a very high risk.”

The experts acknowledge the potential risks of radon at very high levels, however. Dr. Harley said, at the seminar that legislation is needed to identify homes with very high levels of radon. She promoted legislation that would require radon measurements when homes are bought and sold and when new homes are built. She said that if the EPA guidelines were raised up to about 8pCi/L and such legislation existed, then homes with potentially dangerous levels could be identified and remediated. “The advice, for say a 30pCi/L home is. . . it does need remediation, and the risk at that point is something like that of a smoker.” Dr. Mills also said that the EPA should raise the guidelines and that the radon programs should focus on homes and other buildings with higher levels. He said, “It is a serious national problem. . . when we get into some of these homes [with very high levels], we are concerned about the risk. . . 15pCi/L is a number that is reasonable to use for residences, schools, child care centers. . .” and the current occupational standard of 30pCi/L should remain in place.

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*Sarah M. Tilyou*