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YOUR HOUSE COULD BE KILLING YOU

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BY MARK BOWDEN

TEXT:

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MARK BOWDEN, a staff writer for Today, last wrote about the Pagan's Motorcycle Club.

Falling in love had meant another chance for Joel Nobel and Loretta Schwartz, so they decided to build a house to mark their fresh start. Both had struggled free of unhappy first marriages. Joel is a physician and founder of a non-profit, medical-engineering research laboratory; Loretta is an award- winning author and journalist. She, the writer, loves things romantic and old. He, the scientist, loves things efficient and new.

Building the house underground was Joel's idea. He fashioned models in a sandbox to convince Loretta they wouldn't be living like groundhogs. She could furnish the house with antiques. They would combine the ambiance of the past with enough modern-day efficiency to heat the entire house with a wood stove in the living room. Above all, it would be a home with no ghosts.

They were so excited about the project that they were married on the hilly, wooded site in Montgomery County where the house would be built. It was a traditional ceremony, four years ago last month. Joel, stocky and bearded, wore a light blue pinstripe suit. Loretta's red hair hung almost to the waist of her white satin gown. After exchanging vows, they celebrated with a small group of family and friends beneath a blue sky and the exuberant boughs of autumn.

When the house underground was finished a year later, it was a dream fulfilled. Set into the side of a hill, it was spacious and sunny, cool in summer and warm in winter. From within, there was a sweeping downhill view. "It was a real dream house," Loretta says. "We had wanted to create something that was ours, something that represented our commitment to each other. You might say it resulted from a kind of romantic imperative."

She and Joel had no way of knowing it then, but they might just as well have moved into a poorly ventilated uranium mine. Their dream house was dangerously radioactive. They had traded the ghosts of their pasts for a house haunted by the threat of cancer.

For two years, the couple lived happily in their new home. Then one day Joel, a curious and fastidiously careful man, decided to conduct some tests.

He had read in professional journals about the problem of indoor air pollution. Extremely "tight," energy-efficient homes frequently have ventilation problems. Sealing in valuable heat can also bottle up everyday poisons given off by insulation, gas stoves, water heaters and other household appliances. Neither Joel nor Loretta expected a serious problem. Neither of them smoked - cigarettes are a primary source of lingering indoor pollution - and Joel, with his expertise in health matters, had been careful to avoid using any construction materials known or suspected to be hazardous.

"But, well, you could say that I'm a man who takes nothing for granted," Joel says. So he set a number of small plastic testing cups in key locations around the house and left them there for the necessary three months. Then he took the cups to his lab at ECRI - Emergency Care Research Institute - on Butler Pike. He tallied the results. "I knew as soon as I went in to see him that day that something was wrong," Loretta says. "He looked stricken. He looked like something terrible had happened."

Joel was shocked by the test results. But there could be no mistake in the data. The plastic cups are designed to detect the presence of radon gas, a particularly menacing radioactive substance that causes lung cancer. A special plastic chip inside each cup showed microscopic tracings left by radioactive particles. According to Joel's interpretation of these tracings, he and Loretta and their two children were living in an indoor atmosphere 12 times more radioactive than federal standards allow in uranium mines.

The Nobels had stumbled upon the least-known major public health hazard of our time. There was no mistake in the test data. The atmosphere inside their bucolic suburban home was so radioactive it might as well have been located near a nuclear reactor that had just melted down, according to the danger levels that federal officials predict for such accidents.

"I was bewildered," Joel says. "Jesus Christ! If anyone ought to understand radiation health stuff, it would be me. Here I am, a professional in the health field, a doctor who served as medical officer on a nuclear submarine, and I had absolutely no idea what we were dealing with."

The danger of radon gas is like a well-kept secret. Diffusing up from the earth and out of some construction materials, trapped inside the well- insulated walls and windows of this energy-poor era, it is a killer that attacks invisibly and silently where people feel most comfortable and safe - at home.

Despite consistently disturbing data from small-scale surveys, there has never been a major study of the problem. Using what flimsy figures existed in 1980, the U.S. Environmental Protection Agency estimated that 10,000 Americans were dying each year from lung cancer caused by indoor exposure to radon gas. That estimate, which would make radon responsible for half the lung cancer deaths of non-smokers, was based upon extremely conservative health assumptions - for instance, that exposures to lower levels of radioactivity result in disproportionately fewer incidents of cancer, an assumption that many experts reject outright.

What a growing number of health physicists fear is that this problem, already bad, is rapidly worsening. And it is not just a problem that affects underground houses. The trend toward energy conservation means more people are "tightening" their above-ground houses. Conservation methods that keep heated air from flowing out of a house also keep dangerous pollutants indoors - including radon gas. A recent General Electric study found radon-gas levels in energy-efficient homes five times higher than in houses with only average heat retention. Using EPA's statistical methods, the scientist who performed that study calculated that for each 1 percent of homes that are tightened, an additional 500 people will die each year from lung cancer.

Radon gas is given off by radium, an element formed during the natural decay of uranium, one of the most common naturally radioactive substances on earth. Inhalation of radon can leave traces of radioactive material lodged in sensitive bronchial tissues. These materials emit alpha particles that can, over a period of time, interfere with the normal reproductive patterns of lung cells, turning normal cells into cancerous ones.

The connection between inhaling radon gas and lung cancer has been convincingly documented. Studies of uranium miners have shown that workers in improperly ventilated mines suffer much higher incidences of lung cancer than workers in other occupations. These increased incidences also correlate directly to the length of time workers spend in the mines and levels of radon gas in the air they breathe. Such studies demonstrate why radon ranks near plutonium on lists of hazardous radioactive materials.

Concentrations of radium in soil vary widely and unpredictably. A patch of earth may contain significantly more radium than a patch only hundreds of feet away. A house can have a radon problem for many reasons - construction materials, anything from cement to bricks, might contain radioactive material; the soil under a home might be especially radioactive; a basement well or a gravel-bed filter for a solar heat device might emit high levels of radon.

Because of the variable causes, it's extremely difficult to predict whether a given house will have a radon problem. A well ventilated home, if it rests on particularly radioactive soil, might have high radon levels. A poorly ventilated home might not have a radon problem if there is no significant source of radioactivity nearby. All that's certain is that any home with high radon levels

will have an even bigger problem if the gas is trapped by tightening methods.

Existing data on indoor radon pollution has been gathered by a scattered number of small studies, primarily by private researchers working on government grants. Richard Oswald, a scientist with a California firm that manufactures radon detection devices, has collated results from about 50,000 indoor tests. He estimates that up to 15 percent of the homes he has tested have radon levels high enough to present a significant health hazard. "We have done some work in eastern Pennsylvania," Oswald says, "and our readings were rather high on that particular survey."

The Pennsylvania Power & Light Co. tested 36 houses, mostly homes of company employees, and found several with unusually high levels of radon gas. More than half of the homes tested in that survey had levels of radon gas that exceeded home safety standards recently set in Canada. A study of 75 homes in the Philadelphia area conducted by researchers at ECRI showed 30 percent with radon levels above the Canadian standard. In the utility company study, homes with high readings tended to fall along a geological belt of similar soil that stretches from Easton, Pa., to Harrisburg. But no one knows why this particular stratum seems to diffuse particularly high levels of radon.

Pennsylvania health officials are aware of the radon problem, but have done little about it. For the past three years, state radiation experts have been preoccupied with studies related to the March 1979 accident at the Three Mile Island nuclear power plant near Harrisburg. Radon gas is "a heck of a problem, but what do we do?" asks Thomas Gerusky, who heads the Pennsylvania Bureau of Radiation Protection. "It's a national problem, an international problem. It would take a massive program to do the kind of study that is needed, to do something detailed enough and broad enough. The cost of doing that kind of evaluation would be very, very large. You have to consider what percentage of the population is going to be at risk before you undertake a study like that. It seems to me that that's the kind of decision that has to be made at the federal level."

Federal interest in radon and other indoor air pollutants grew during the late 1970s, but the severe budget restraints of the Reagan administration curtailed the few programs that were under way. Last year, the EPA decided to stop studying indoor air pollution, limiting its mandate to monitor air quality to outdoor air pollution. The scientist who headed EPA's research on indoor air pollution was barred recently from attending an international conference on the issue because, according to Science magazine, "he advocated the importance of indoor air pollution at a time when the agency is all but eliminating funding for this research."

The issue seems to fall smack in the center of political divisions over nuclear power. The nuclear power industry has shied away from publicizing the radon gas problem for fear of aggravating what it sees as public paranoia over radioactivity. Opponents of nuclear power face an even more alarming possibility. They advocate increased federal incentives to conserve energy, to

tighten homes. During the Carter administration, energy conservation was identified as the primary alternative to expansion of the nuclear power industry. Yet by encouraging people to tighten their homes, anti-nuclear scientists may be ensuring higher and more widespread public exposures to radiation than those predicted by any meltdown disaster scenario. The cure may turn out to be worse than the disease.

That possibility has become a renegade cause for Henry Hurwitz, an engineer for General Electric, one of the four nuclear reactor manufacturers in the United States. Hurwitz's own home in Schenectady, N.Y., tested by scientists from the same lab that employs him, was found to be 15th on a list of radioactive hot spots in New York State. Using government risk-estimate statistics for meltdowns at nuclear power plants - considered extremely conservative by many experts - Hurwitz calculates that the resident of any energy-efficient home may be exposed to a level of radioactivity comparable to that received by the "average imputed victim of a nuclear meltdown."

But Hurwitz does not use his calculations to argue that the public should be alerted to the dangers of indoor exposure to radon gas. He uses them to argue against what he sees as the government's overly strict regulatory posture on nuclear power. ". . . There are two seemingly plausible approaches to controlling risk to the public," Hurwitz says. "The first approach maintains that things should be viewed as dangerous until they have definitely been proven to be safe, while the second approach maintains that it is wasteful and irresponsible to alarm the public over things that have not been definitely proven to be dangerous . . . Because of the real and imminent dangers of normal existence, the second approach is usually the more practical."

Joel Nobel had a more visceral response to the radon levels in his house. "We went through 48 hours of sheer terror," he recalls.

The readings showed a level of radioactivity that would be considered dangerous by any measure. It was as if they and their two children - all militant nonsmokers (Joel has banned smoking at his laboratory) - were inhaling 50 cigarettes every day. The inherent danger, while not necessarily apparent to those unfamiliar with health-risk statistics, was strikingly clear to Joel Nobel. The odds of a nonsmoker's getting lung cancer in America are about one in a hundred. But if Joel were to live 30 years in his new home at the radon levels he had measured, most radiation health experts would have set his chances of getting lung cancer at one in 20. EPA risk estimates placed his odds closer to one in four. By that measure, it was at least statistically certain that one member of his family would eventually develop lung cancer.

He and Loretta kept the news from their children. They were frightened. They made immediate plans to move out. Selling the house was out of the question. They wondered whether they might be able to use it for storage. They sadly considered that it might be best to just dynamite the house and leave it buried forever.

But these were emotional responses, and Joel Nobel is a scientist. As much as his findings shocked him, they intrigued him. Where was the gas coming from? Could anything be done about it? He began searching for some explanation, calling colleagues around the country. He was given the name of Harvey Sachs, a scientist at Princeton University who was considered an expert on the emerging body of work on indoor air pollution.

"I got this call one day from Joel," recalls Sachs, now employed by Nobel's research institute. "He said, 'Hi, I'm Joel Nobel and I have a lot of radon in my house. I understand you're interested in things like that.' "

Sachs is a balding young man whose academic training is in oceanography. He became interested in energy conservation after he and his wife bought a drafty old house in Cranbury, N.J. Setting out to tighten his home without sacrificing clean air indoors, Sachs found himself asking questions no one could answer. "More than that," he says. "I found I was asking better questions than people the people I knew who were working in the field - questions about ventilation patterns and, ultimately, about what effect energy conservation methods would have on indoor air quality."

Sachs wasn't surprised by Nobel's findings. He and several colleagues had spent a year and a half working with homes in the Princeton area, testing for radon and other indoor pollutants, devising solutions to the problems encountered. His work had taught him that ridding a house of pollutants like radon gas was usually a fairly simple and inexpensive matter. He was confident that whatever the source of contamination in the underground house, he could find and eliminate it.

After the Princeton researcher visited the house and started planning his attack, Joel and Loretta's attitude changed. Sachs' meticulous approach and cheerful confidence impressed them. It would take six months of scientific detective work before the mystery was solved, six months of hardship and inconvenience, but the radioactivity in their dream house suddenly seemed less of a calamity. It had become a challenge.

"The first thing was to find out how fast the radon was building up," Sachs says. He mounted a large fan in the front door, and switched on a large overhead fan that Joel had installed in the laundry room as a precaution against fire. With all the windows open and the fans on, the entire inner atmosphere could be purged in 10 minutes. As soon as the fans were turned off and the windows closed, the radon levels shot up. Within 24 hours, they were back in the danger range.

The next step was to determine the radon source. Every inorganic substance in the house - brick, concrete, rock, wallboard - was suspect. Joel and Sachs were particularly suspicious of the thick, exposed concrete ceiling supports that spanned the length of the house. Sachs took small plastic garbage cans and sealed the open ends to the targeted surfaces. Then, after sufficient time for any radon emissions to build up inside, air samples were drawn from within

the containers through hoses attached to their sides. Cans were also attached to the exposed brick behind the wood stove in the living room, to the floors, walls and ceilings in every room. Sachs took 50 air samples in a day and a half.

He also crushed and sent samples of every kind of construction material used in the house to a U.S. Department of Energy laboratory in New York. There, the samples were tested for radon. The results were conclusive. The radon was not coming from any of the house's construction materials.

But his own tests showed that radon seemed to be coming from all of the walls.

"At first I suspected the wallboard, but after cutting out pieces of wallboard and testing it, we had found nothing," he recalls. The only other conclusion was that the radon was coming through the walls. But soil samples outside had not indicated abnormally high levels of radioactivity, certainly nothing to explain the readings they were getting inside. The clues were confusing.

It was winter. Joel and Loretta and the children were living in the house while Sachs worked. The windows had to be opened and the fans run every hour to keep radon levels down.

"Our romantic dream had turned into a nightmare," Loretta says. "We resorted to camping methods of survival, sitting around the house in full winter coats and draped in blankets. We had these guys from Princeton camping in here. This lasted all last winter. Joel's hands would get numb from the cold when he tried to work in his room. He and Harvey were confident that they could figure out the problem and solve it. But me, not being a scientist, well, I could only accept it on faith. It was a bizarre feeling of having an invisible enemy."

The testing stretched through winter to spring, and then into summer. They had weathered the cold, but summer's humidity finally chased the family out. The extreme air-exchange techniques had a peculiar effect on the underground house. Continually blowing warm air into the cool house turned it into an incubator for fungus. Mold began to grow everywhere. It grew on walls and floors and ceilings, over shoes and clothing and books, everything. "We had to tighten the house up," Joel says. "The house was being destroyed by fungus."

So they moved to a cottage on the grounds of ECRI while the detective work continued.

The tests of building materials had turned up nothing, the tests on surfaces were confusing, so Sachs devised new strategies. He grew more and more curious about the house's air circulation system. It seemed to affect the radon levels, but in an way exactly opposite from what one would expect. When the circulation system was on, radon built up faster than when it was off. Sachs worked with that phenomenon for weeks before figuring out what was happening.

"It turned out that the air-circulation system was leaky," he says. "It is a very tight house, but there are holes in a number of places - like around pipes or where the wallboard is cut away around the bathtub. When the circulation system is on, air inside ducts under the house tends to build up pressure. It is forced out of the 'holes' in that duct system and into the soil under the house. Eventually that air finds its way back into the house through normal ventilation paths, but not before it scavenges all of the radon gas out of the soil. Basically, they had a system with tremendous talent for removing radon gas from the soil and bringing it into the house."

If Sachs' theory was correct, then corrective measures would solve the problem. Acting on a suggestion from Joel, he took advantage of a network of drain pipes the cautious home owner had installed around the perimeter of the house to prevent flooding. He mounted small fans inside the drain pipes to suck air out of the soil under and around the house and blow it away before it could filter back inside.

The tactics worked. The radon levels inside the underground house fell dramatically, immediately. The house was free of significant traces of radon. The nightmare was over.

The radon problem has nothing to do with underground houses, I want to make that clear," Joel says, relaxing in the olive-drab scrub suit he usually wears behind his desk at ECRI. "It just so happens our house is built underground. But the problem is far more general than that. We think that this is going to become a major concern, if enough people are alerted to it."

When federal money for Sachs' research at Princeton ran out earlier this year, ECRI hired him to continue it. Now he's working on developing efficient, inexpensive ways to rid homes of dangerous air pollutants. One such approach employs an air-to-air heat exchanger, a device that can significantly improve the ventilation in a house without letting all the valuable heat escape. For most homes afflicted with indoor pollutants, an air-to-air heat exchanger is part of the answer.

"The important thing about the radon problem is to let people know that it can be solved, usually without great effort or expense," Sachs says. "We don't want to leave people with the impression that the only way to deal with a radon problem is to have a whole team of experts camped out in their living room for six months. Usually the problem is relatively easy to pinpoint and solve."

In Princeton, for instance, a home owned by one of Sachs' former colleagues was cleansed of high radon levels by running a pipe from the contamination source, a sump well in the basement, out through the basement wall. A small fan inside is attached to a timer that turns it on to periodically vent the sump. "It took a length of plastic pipe, a tiny fan that uses less energy than a light bulb, and about a half hour with a sledge hammer to knock a hole through the wall," Sachs says.

Radon gas contamination of homes poses a problem only so long as it remains unknown and untreated. As more and more people weatherize old homes and as contractors build tighter and tighter new ones, experts like Sachs believe more attention should be given to what besides heat is being bottled up inside. "After all," he says, "we only spend about 80 to 90 percent of our lives indoors."

Many health experts believe tests for radon and pollutants such as formaldehyde, tobacco smoke, asbestos and carbon monoxide ought to be conducted routinely after a home is built or tightened. Hospitals have long applied stringent air-quality testing and controls because traces of sterilizing gases and anesthetics can turn the atmosphere highly toxic, and more and more employers have begun to pay close attention to air quality in the workplace. But private homes, where most people spend most of their lives, remain untouched by safeguards.

"I think there are a lot of sick people out there who have no idea what is making them ill," Joel Nobel says. "The connections aren't being made." It is an issue that the National Academy of Sciences last year declared a matter of "immediate and great concern." But very little is being done about it.

Joel Nobel and Loretta Schwartz-Nobel are back living in their underground house, happily and safely. They were fortunate enough to have stumbled across the radon gas problem on their own, and resourceful enough to have solved it.

They are the exception.

THE EXPERTS

Besides Harvey Sachs at ECRI, the following scientists have conducted research on indoor air pollution:

Richard Oswald, Terradex Corp., 460 N. Wiget Lane, Walnut Creek, Calif. 94598. (415-938-2545).

Andreas George, U.S. Department of Energy, Environmental Measurements Lab, 376 Hudson St., New York, N.Y. 10014. (212-620-3653).

C.T. Hess, University of Maine, Physics Department, Orono, Maine 04473. (207-581-7745).

Anthony V. Nero, co-leader, Building Ventilation and Indoor Air Quality Program, Lawrence Berkeley Laboratories, University of California, One Cyclotron Rd., Berkeley, Calif. 94720. (415-486-6377).