16 piC/l, spot measurements found concentrations ranging from 250 piC/l at one point in the wall/slab junction to 476 piC/l at the sump-pump opening.

Spot measurements show which sources are most important and help you develop a plan of attack. The major disadvantage of track-etch monitors is that it takes over a month to get feedback. Instruments that give instant readouts are superior for fast diagnoses, but they typically cost a few thousand dollars and require special training to use. Geiger counters won't work.

You can measure radon concentrations in water using a version of the same track-etch monitor used for measurements in air. Several states will measure water concentrations as part of their water-testing programs.

Reducing radon concentrations

Once you've located soil-gas radon sources, the first priority is to block up the entry points as well as possible. Second, vent the radon to the outdoors as near to the source as possible.

Seal foundation entry points with materials that adhere well to masonry and are long-lived. Polyurethane caulks meet these requirements—they stick to almost everything except polyethylene, and cure to a flexible long-lasting rubber. If the entry points are neat holes and cracks, it is fairly easy to locate and seal them.

Ventilate as close to the source of radon as possible. Often this is best accomplished by ventilating soil gas from beneath the basement floor. One approach is to put a sealed cover on the sump hole, then pull air out with a small fan, and blow it to the outdoors. This sub-slab ventilation technique has proven effective in Sweden, Canada, and the United States. Figure 1 shows a typical sump-hole venting system.

If there are sub-slab drainage pipes or gravel, then soil gas can move about freely under the slab. Although this makes it easier for radon to enter the building, it also makes it easier for you to remove radon from under the slab. A single fan vent should do the job. Although little work has been done on sizing fans in these systems, fans capable of moving 70 to 100 cfm at 0.1 inch H_2O static pressure have been successful in radon mitigation work in New York. (A strong, quiet, in-line duct fan from Sweden is sold by R.B. Kanalflakt, Inc., 1121 Lewis Ave., Sarasota, Fla. 33577.)

If there isn't already a hole through the slab, one or more can be punched through. Unless there is a layer of drainage stone under the slab, you should excavate a hole in the sub-slab earth (about 3 feet wide by 1½ feet deep) to increase the surface area of earth exposed to the depressurized plenum. The number of holes needed may vary with the permeability of the soil. If the slab sits directly on a dense soil (clay) then you will need more holes. If the sub-slab soil is sand or, even better, crushed stone, you will need fewer holes.

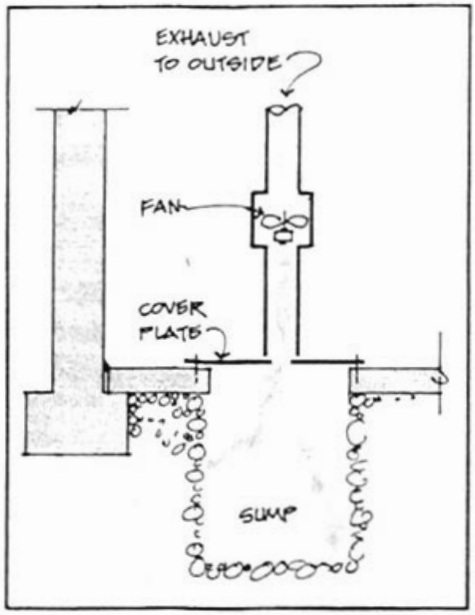

Figure 1. Open sumps are a common radon source. The solution is a tight-fitting cover, with a small duct and in-line exhaust fan venting to the outdoors.

AIB, a Swedish engineering firm with experience in this area, suggests one hole for every 300-500 square feet in relatively permeable soil. AIB also suggests using a fan powerful enough to move air at a static pressure of 1.2 inch H_2O, but that typical operating pressure differentials at each suction hole should be about 0.4 inch H_2O. Figure 2 shows a typical system for slabs poured with no drainage below.

A passive version of this uses a tall vent pipe, rather than a fan, to ventilate the sub-slab soil. In this case, the stack effect and wind blowing across the top of a stack power the suction. The major advantage to this natural chimney system is that it needs no electricity to operate. The major drawback is that the ventilation rate varies with changing temperatures and wind speed. Few results are available yet on this approach.

If the major sources of radon are not discrete cracks and holes such as wall/slab joints or sump holes, but are scattered over a large area, then isolating and venting the source can be difficult. Sometimes the floor above a crawlspace can be sealed and insulated, and fans or passive vents can be installed to ventilate the crawlspace. A crawlspace can be isolated from a full basement or adjacent living space by sealing the opening with plywood, caulk, and foam.

With an old stone foundation that has

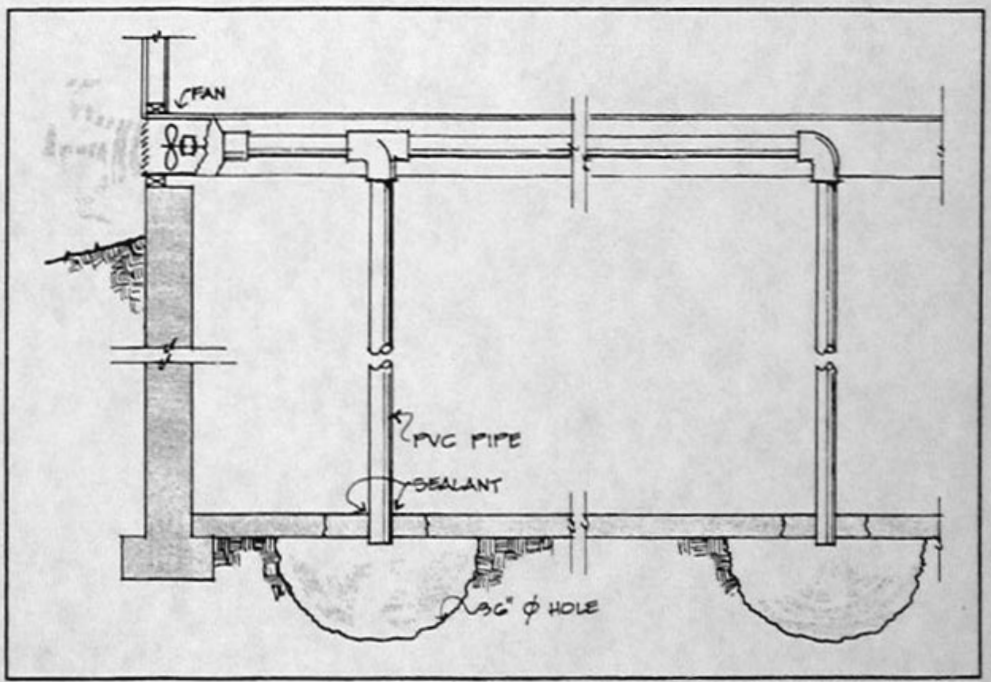

Figure 2. Holes can be punched through the slab to ventilate beneath. If drainage stone is not there, you should excavate to create "suction holes" — one for every 300 to 500 square feet.