#4738

TECH TALK

# Radon in Homes: The Alaska Experience

By Richard Seifert

For the past four years since radon was first found to be a concern in Alaska, the interest and awareness of radon as a special housing and health concern has continued to grow. In that time we have learned more about the features of a house in Alaska which would characterize it as "at risk" for radon and also about mitigation techniques that are most effective under Alaskan conditions.

Clearly radon must be able to enter a home in order to be a problem. Four factors must exist in a house locale for it to be a radon "at risk" house. Two of the factors are geological in nature:
1. There must be adequate uranium and, therefore, ample radon to provide a source for transport.
2. There must be enough permeability in the soil to allow rapid soil gas movement to carry radon from its origin to the interior of the home within two half-lives of time (six days or so).

The other two factors are determined by the structure of the house itself and the way in which it is operated:
3. The house must have soil contact and imperfections, holes, cracks, or intentional perforations which allow movement of soil gas with radon through the envelope of the basement or crawlspace.
4. There must be a lower pressure inside the house than in the soil so that soil gas flows into the house.

All of these characteristics are required in order for radon be a problem. This presents a series of options for mitigation since elimination of any one of the four characteristics will mitigate radon. Through two years of selective testing, it became clear that Interior Alaska, especially the uplands near Fairbanks, is a radon risk area. In the first year of radon screening tests, done non-randomly with Air-Chek brand charcoal screening kits, 52 percent of the tests (totaling 353) were at or above the remedial action level set by the EPA. More than 20 percent of the tests were above 20 piC/l, which is five times the EPA recommended remedial action level. Obviously, Fairbanks was a case worthy of further research.

Not only is the long heating season in Fairbanks a factor in radon transport, but throughout the heating season the oil-fired combustion system provides the negative pressure to move radon into the house and concentrate it. The heating system in a house tends to act as a pump sucking radon laden air into the bottom of the house and driving exhaust out the top.

All of these factors relate to an understanding of the problem in a specific geological setting. This does not mean that radon cannot be present in areas which are less suspect, such as flood plains, highly porous gravel in valleys, or deep silts. Certainly we have found less of a problem at these sites, but there are always spurious and inexplicably high levels in various places where one would not expect them. One such area is the Aurora Subdivision in Fairbanks. Another is Lakloey Hill on Badger Road in the North Pole area. The Lakloey Hill situation is a model of the larger hills to the north of Fairbanks, so it is more explicable than the case for Aurora Subdivision.

The somewhat alarming experience early on in Fairbanks led ultimately to Alaska's inclusion in the third round of EPA's Ten State Survey. The Alaskan EPA/DGGS survey was completed in the spring of 1989 and the results describe the conditions in Fairbanks uplands which constitute an "at risk" home:
* Built high on a hill slope with bedrock consisting of Birch Creek schist;
* Top soil depth is less than basement excavation, i.e. eight feet or less;
* Standard basement construction for daylight basement notched into hill;
* Oil-fired combustion heating system;
* Basement material either concrete or All-Weather Wood (AWW).

These conditions constitute an "at risk" radon home. Any house on a site with these conditions and construction styles should be tested for radon.

Along with the confirmation of these radon risk characteristics, the Alaska/EPA survey found that Interior Alaska has the highest proportion of homes with elevated radon concentrations as well as the individual homes with highest concentrations. In the Interior, 3% of homes within the sample population had screening levels higher than 20 piC/l and 17.6% of homes had radon screening levels that were higher than 4 piC/l. Figure 1 summarizes the home site geographic information which was included with the report of test results. This figure shows that 30-35% of homes built in the hills around Fairbanks have elevated radon concentrations.

"In the Fairbanks area, homes built in the surrounding hills with concrete slabs or basements in contact with bedrock yielded the highest radon levels. These areas also had the highest proportion of homes with basements in contact with the bedrock that did not have elevated radon concentrations. The data shown in Figure 1, for homes located on hillside sites, includes homes which

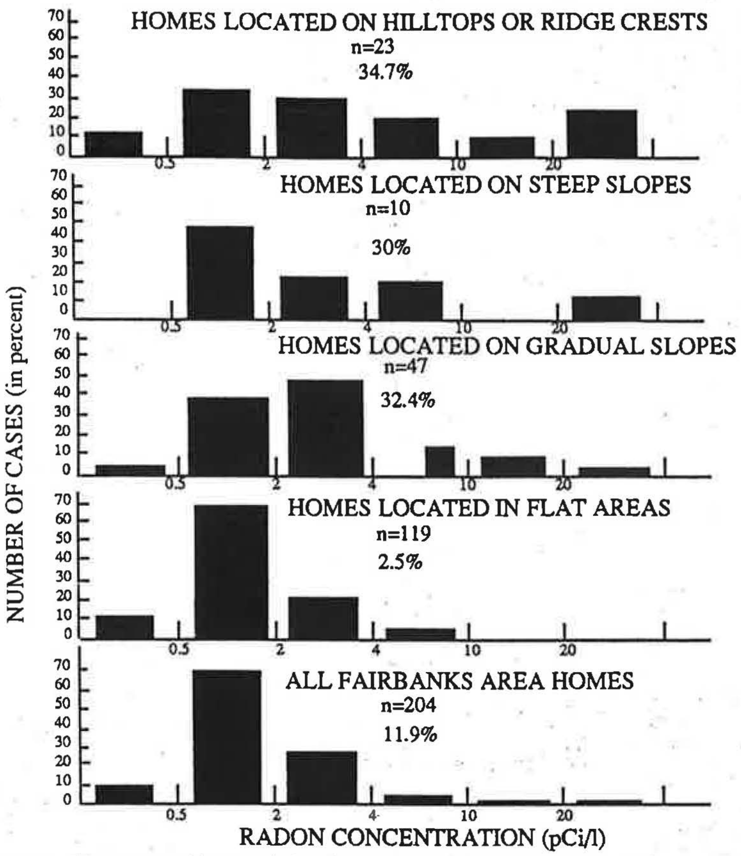


Figure 1. Histograms Summarizing Radon Measurements and Local Geography of Fairbanks Homes

are built on thick accumulations of windblown glacial silt (loess). Thick accumulations of loess appear to be an effective barrier to radon movement. Homes built on alluvium from the Tanana and Chena Rivers are also much less at risk. High radon concentrations in homes in contact with bedrock are likely to result from high fracture permeability of the bedrock as well as relatively high uranium concentrations in the schist which comprises local bedrock. Low radon concentrations in homes built on loess and alluvium may reflect low soil gas permeability, low uranium concentrations of soils, or both." (Nye and Kline, 1990).

**Mitigation Strategies In Alaska**

With the information on sites which are at risk, it is possible to pursue a mitigation strategy. From a review of the four conditions cited above which allow radon to enter homes, we can see that the first two geologic ones are givens of a site. Removing them would be expensive and unaesthetic. The structural conditions, leakiness, and pressure difference, are the practical candidates for mitigation. Seal the basement or crawlspace and/or change the pressure differential.

A review of the EPA mitigation literature shows combinations of these two methods as common approaches. Alaskan experience concurs with this, with more reliable results from sub-slab ventilation than from just sealing leaks.

Recent surveys show that in all but one case sub-slab depressurization accompanied by sealing of leaks in the basement or crawlspace works in radon mitigation.

There are climatic as well as geologic reasons why sub-slab depressurization is the mitigation of choice as opposed to any overpressurization of the slab or house interior. While it may be physically logical to overpressurize the interior of a home to exclude radon, this strategy also drives warm, moist, interior air out all nooks, crannies, keyholes, and doorsills so that at very cold temperatures an overpressurized system would very efficiently freeze-up doors, windows, and fire egress areas. Sub-slab depressurization is at presently the only option with a consistently high success rate. New construction on radon-suspect sites has been attempted with mixed results. Often immaculate detailing of air seals, vapor barrier detailing and interior concrete "sealant" finish work still does not result in a new home which has acceptable levels of radon. One such new construction resulted in a level of 16 piC/l. and therefore a pre-installed sub-slab ventilation system had to be utilized after the recommendations in the EPA publication "Radon-Resistant Residential New Construction."

While much remains to be learned about optimizing radon mitigation under Alaskan conditions, the fundamental physical parameters of the problem are understood. The honing and fine tuning of anti-radon construction techniques are being tried and tesed now, and will be reported further as we see the fruits of these tests.

**References**

Nye, C.J,. and Kline, K.T. ; *"Preliminary Description of Data Collected During the State/EPA Home Radon Surveys"*;January 1990.

US EPA; *"Radon Resistant Residential New Construction"*; 67 pp;July 1988.

Loudon, P. ; Arctic Technical Services; personal communications and unpublished data; 1990.

Musick, M.; Ester Construction; personal communication; 1989.