mounting. Other house doctor teams have built a box for the unit, but we haven't bothered as it is reasonably rugged. The panels mount to the doorway without disturbing the existing stops or weatherstripping, and install reasonably quickly. The fan unit is a bit cumbersome and heavy, but this is not a major problem since most of the time it is a short trip from the vehicle to the front door of the house. One person can just manage to get it out of the vehicle and carry it a short, level distance, but two people is normal. It is no fun getting it up a flight of steps. I believe it will just fit in an airline seat space next to a bulkhead. One reason for the weight is the tube for air flow, around the fan. The fan is mounted on a streamlined hollow strut across the tube; both tube and strut are fairly heavy gauge steel. The bridge unit sometimes gives trouble if the gap is at the maximum. The plate just barely laps and must be held just so as the lock handles are tightened. Any bigger gap (doorway higher than 7'-0") and it is useless; one resorts to cardboard and tape. Ken Gadsby, of Gadzco, tells me he is working on lightening up the unit and providing a larger bridge. The motor has sealed lubricants. The plywood panels get dents and minor scrapes and one needs to do minor repairs and touch up. (Ken Gadsby says newer models have formica over the plywood.) Generally, however, it has been trouble free.

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Radon: First in a Series on Indoor Air Quality

by J.D. Ned Nisson

Indoor air quality must be considered when building an energy efficient building. If not correctly dealt with, it becomes a problem.

A stuffy room has an air quality problem. The solution is simple - open a window. Not only was the solution simple, but the problem was easy to detect.

Not so simple to detect or solve are the potential problems associated with indoor air pollutants such as formaldehyde, nitrogen oxides, organic fumes, particulates and radon. These substances are often undetectable by the average person, even when they are present in harmful quantities.

In this article, the first in a series, we will discuss radon. What is it? Where does it come from? What harm does it do and, most important, what should the concientious designer/builder do about it. Much of this information is from Air to Air Heat Exchangers by William Shurcliff.

WHAT IS RADON?

Radon is a naturally occurring radioactive gas. It is a disintegration product of radium which itself is a decay product of uranium or thorium.

WHERE DOES IT COME FROM?

Radon is continuously being formed in the earth. It can get into our homes from several sources:

From the earth.

As a gas, radon is constantly leaking out of the earth. If not stopped it rises up into crawl spaces and basements.

From groundwater.

Radon is water soluble. It may dissolve in groundwater and travel long distances until finally reaching the surface. It may also be in well water.

From natural gas.

Much of the natural gas you purchase for cooking and/or heating contains radon. This is of particular concern with gas cook stoves which are not vented to the outside.

From concrete and masonry.

If these materials contain rock with uranium or radium in it, then radon will be produced and given off to the air. This may be of considerable concern in some passive solar buildings which employ rock or concrete thermal storage.

HOW RADIOACTIVE IS RADON?

When we talk about radioactivity, we are usually referring to the emission of highly charged particles called alpha particles and of energy given off as gamma radiation. Radon atoms in the air each give off one alpha particle and one photon of gamma radiation. The total amount of radiation given off depends upon how much radon is in the air.

Radon has a "half life" of four days, meaning that every four days, half of any collection of radon atoms will disintegrate, each yielding one alpha particle and one photon of gamma radiation. When the radon atom disintegrates, it ceases to exist as radon and is transformed into a "daughter" element which itself is radioactive, which also disintegrates (giving off radiation) and, which we shall see, is possibly the major health concern.

For a more in-depth discussion of the radioactivity of radon, the reader is referred to William Shurcliff's book referenced at the end of this article.

WHAT ARE THE HEALTH PROBLEMS ASSOCIATED WITH RADON IN HOUSES?

Radioactivity is dangerous. Alpha particles are highly charged particles which travel at high speeds. When they hit human tissue, they can cause chemical disruptions which may result in cancer or mutations. Gamma radiation is less serious but also potentially damaging.

Since radon is in the air, we breathe it in. Some of it is immediately exhaled, some of it dissolves in the water in our lungs. That which stays in our lungs will disintegrate, giving off radiation and forming "radon daughters" which also disintegrate giving off more radiation.

When radon disintegrates in the air, the radon daughters, which are particles, not gases, often tend to adhere to dust particles. We may breathe in some of those dust particles which then become lodged in the lungs. Current thinking is that these radon daughters are actually much more dangerous than radon itself.

DOES THIS MEAN THAT AIRTIGHT HOUSES ARE DANGEROUS?

This is the most important and most difficult question to answer. Several recent articles in the news media have portrayed the new generation of super energy efficient homes as glowing infernos of cancer causing radioactivity. This is certainly not the case. On the other hand, responsible members of the building community must consider the worst case and design buildings which will avoid all health hazards to the greatest extent possible (or practical). The worst case would be a house built in an area with a high soil uranium content. An airtight house with a concrete floor and no ventilation system would be asking for trouble. At the other extreme would be a house built in an area with very little naturally occuring radium or radon in which case there would probably be very little cause for concern no matter how the house was built.

Unfortunately all the answers are not in yet. Standards for acceptable limits of radiation doses are often vague and there are no definitive standards for acceptable radon levels for housing in this country. In Sweden the standard is 6.7 pCi/l (picocuries per litre) for old houses and 1.9 pCi/l for new houses (for an explanation of these units, see Shurcliff book). Only now is there any significant serious work being done on this topic. The issue is particularly difficult since the effects of radiation are not immediate and may take many years to manifest.

WHAT SHOULD WE DO WITH HOUSES BEING BUILT TODAY?

As with any pollutant, there are three ways to limit concentrations:

1. Stop or decrease the source of radon.

-- Protect the living space from the ground with an air barrier such as polyethylene under the floor. As Shurcliff points out in his Air to Air Heat Exchanger book, radon has a relatively short half life and the radon daughters are not gases. Thus merely slowing down the radon's travel may suffice.

-- Limit the amount of exposed concrete or rock in the living space, particularly if the materials are known to contain high concentrations of uranium or thorium.

-- Avoid gas stoves.

2. Remove the pollutant from the air.

There is no easy way to remove radon from air. However, radon daughters attach themselves to dust particles in the air. Filters and/or electrostatic precipitators which remove dust will also remove the radon daughters.

3. Ventilate the house.

This is the most important measure. Proper ventilation is an absolute must for airtight houses (not just for radon removal). A well designed ventilation system should distribute fresh air to all parts of the house at a rate of about 0.25 to 0.5 air changes per hour. For a 2000 square foot house, that would be about 70 to 140 cfm. An air to air heat exchanger should be installed to recover waste heat from the exhaust air. While no one at this point can definitely say how much ventilation is required and, in fact, it will vary depending upon the amount of pollutant given off to the air, 0.5 air changes per hour is probably quite safe.

IS THERE A WAY FOR THE LAYPERSON TO MEASURE RADON?

Terradex Corporation sells a radon detection unit which is hung in the home for three months, then sent to the lab for analysis. The units sell for $50 each, including analysis. Contact: Terradex Corporation, 460 N. Wiget Lane, Walnut Creek, CA 94598.

HOW CAN YOU LEARN MORE?

Here are a few references for further reading:

Air to Air Heat Exchangers by William Shurcliff, 19 Appleton St., Cambridge, MA 02138. $14.00

Proceedings of the International Symposium on Indoor Air Pollution. Contact Prof. John D. Spengler, Harvard School of Public Health, 665 Huntington Ave., Boston, MA 02115

Radiation and Human Health by J.W. Gofman, Sierra Club Books, 530 Bush St., San Francisco, CA 94108. 910 p. $29.95

Radiation Protection by Prof. Jacob Shapiro, Harvard University Press, Cambridge MA 02138. 1981, 500 p. $25.