Radon Gas and its Removal at the Ennis National Fish Hatchery

By John B. Shrable

I. What is it and where does it come from?

Radon gas is a naturally occurring inert (chemically inactive) gas in the radioactive decay chain from uranium and radium to lead. In other words, it comes from the natural breakdown (radioactive decay) of uranium. The soil and water in areas where uranium is found may contain high levels of radon gas. Radon has always been present in the air but outdoors it is diluted to such low concentrations to pose no health threat. However, indoors it can accumulate to high levels and become a health hazard.

II. How does it affect me?

The only known health effect associated with exposure to elevated levels of radon gas is an increased risk of developing lung cancer. It is not the gas itself that is associated with the increased risk of lung cancer, but it's immediate decay products or "daughters". These "daughters" are charged particles which emit high energy alpha radiation. When you breathe these particles into your lungs, further decay releases high energy radiation which can damage lung tissue and lead to lung cancer. EPA scientists have estimated that from 5.000 to 20,000 lung cancer deaths a year in the U.S. may be attributed to radon. The Surgeon General attributes about 85 per cent of all lung cancer deaths to smoking. Radon is the second leading cause of lung cancer. Your risk of developing lung cancer depends upon the concentration of radon and the length of time you are exposed. Radon risk estimates are based on scientific studies of miners exposed to varying levels of radon in their work underground.

III. How does radon get into your home or work place?

As a gas, radon can move through small spaces in the soil and rock on which a house is built. Radon can enter through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints and pores in block walls. Radon can also enter in water and be released when the water is used through faucets, dishwashers, clothes washers, bath tubs, and showers. Many fish hatcheries used packed columns to aerate water to remove nitrogen gas; and radon gas is released by the same process. When large volumes of water are aerated through packed columns inside hatchery buildings, very high levels of radon gas may accumulate.

IV. How is radon detected?

Since radon is a colorless, odorless and tasteless gas, special equipment is needed to detect it. Charcoal canisters and alpha track detectors are the lowest cost and most commonly used. For sources, contact your Regional Safety Officer or EPA office. Region VI has purchased a “Honeywell Professional Radon Monitor” with data printer for use on different stations. The charcoal canister and alpha track detector require long term (3-7 days and 2-4 weeks) exposure. The radon monitor gives immediate continuous readings and will store and print the data.

V. What units are used to measure radon?

Radon gas levels are reported in Picocuries per liter.

A. Picocurie (pCi) = a unit of measure of radioactivity. A curie is the amount of any radionuclide that undergoes exactly 3.7×10^{10} radioactive disintegrations per second. A Picocurie is one trillionth (10^{-12}) of a curie or 0.037 disintegrations per second.

B. Picocurie per liter (pCi/L) = a common unit of measurement of the concentration of radioactivity in a fluid. A picocurie per liter corresponds to 0.037 radioactive disintegrations per second in every liter of air. In 1986, the U.S. EPA issued a guideline for radon exposure for the general public. EPA has set the maximum acceptable level for constant exposure at 4.0 pCi/L (i.e., the amount of radon gas per liter of air that would result in 0.148 disintegrations per second).

C. Working Level (WL) = the unit used to express radon exposure in the work place. One working level (1 WL) = 200 pCi/L, or is defined as any combination or radon daughters in a liter of air that results in the release of 130,000 Mev (million electron volts) of alpha energy.

D. Working Level Month (WLM) = exposure to one working level for 170 hours. The WLM is commonly used as a unit of exposure. The current Mine Safety and Health Administration standard for cumulative exposure is 4 WLM per year (WLM/yr). In 1988, the National Institute of Occupational Safety and Health (NIOSH) established a recommended exposure level (REL) of one (1.0) WLM/yr cumulative exposure and an average work shift concentration of 1/12 of a WL.

1 WL = 200 pCi/L

1 WLM = exposure to 1 WL for 170 hours.

EPA limit of 4 pCi/L = 0.02 WL (200 pCi/L x .02 = 4 pCi/L)

1 WLM/yr = 170 hours x 200 pCi/L = 34,000

At Ennis NFH, 1 WLM/yr = 34 pCi/L x 1000 hrs/yr = 34,000. Therefore, the average acceptable radon concentration in the hatchery building can be about 34 pCi/L.

VI. Radon Monitoring at Ennis NFH

During May 1991, representatives from the Department of Health and Human Services (Denver) measured radon gas levels in the soil, water and buildings at the Ennis, MT National

Fish Hatchery.

A. Soil-gas: Soil-gas concentrations in the mountain west range from 500 to 1500 pCi/L. The average at Ennis was 30 pCi/L, indicating a low potential for indoor radon from soil-gas.

B. Spring water: The radon level in the incoming water to the hatchery building was 300 to 350 pCi/L. Again, this is low and would not cause a problem under normal household conditions. The commonly used rule of thumb is that 10,000 pCi/L of radon in water will result in about 1 pCi/L of radon in the indoor air with normal household use. At Ennis, the normal indoor hatchery water use is about 1,000 gpm, all of which is aerated through packed columns. The radon level in the water after passing through the columns was 100 to 120 pCi/L. Therefore, the columns were releasing about 65% of the radon gas from the water into the air in the tank room.

C. Indoor air (tank room): The average radon concentration in the tank room air was 136 to 312 pCi/L. This will vary with the number of tanks and volume of water used. As you can see, this is more than <u>60 times</u> the maximum acceptable level for constant exposure of 4 pCi/L set by EPA in 1986. But during 1991, Pat Dwyer came up with the idea of trapping the gas and venting it outside the building. This was done by inserting an inverted plastic tub around the base of the column and extending the tub 3" - 4" below the water level to trap the gas. Then a 1" vent pipe was inserted into the top of the tub and extended outside the building. These passive air collectors and vents were installed on all 38 columns in the tank room. Radon gas levels in the tank room air were reduced from 250 pCi/L to 25-40 pCi/L, which meets the Federal Occupations Health (FEOH) guideline of (1) WLM/yr. allowable exposure when the average exposure per worker is 1,000 hours/yr. at a concentration of 34 pCi/L.

Total materials cost for the off-gas collectors was about $600. This was a simple and inexpensive method of reducing the risk of exposure to radon gas to acceptable levels.