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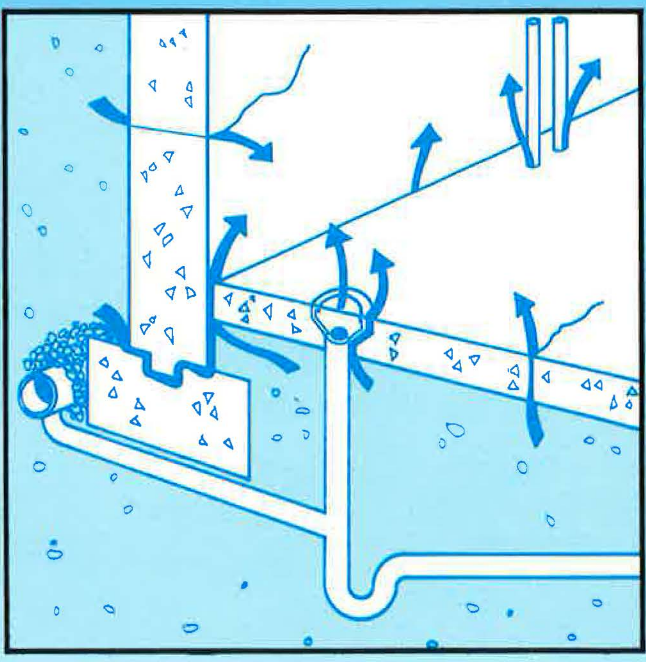
Guide to Radon Control



NHA 6181

Guide to Radon Control

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Canadä

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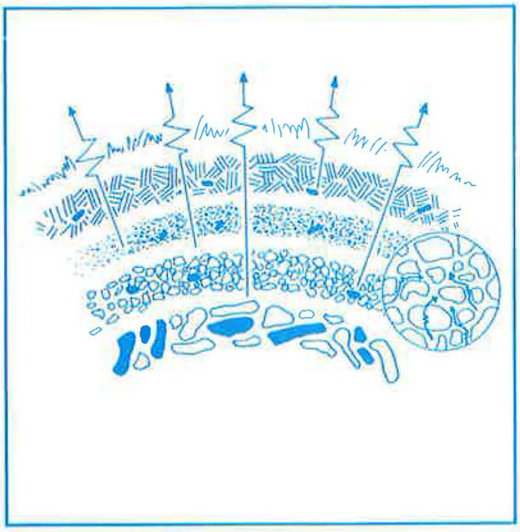
What is radon and where does it come from?

Radon is a radioactive gas produced by the decay of uranium, which is present to some degree in all soils. The decay process uranium undergoes is a continuous and normal part of nature; radon gas is present at varying levels everywhere except over oceans and lakes.

Radon is invisible and has no smell or taste, even when it exists at potentially harmful levels of concentration.

Radon is one of many "soil gases" that may be present in different soils in differing amounts. The small spaces between the individual soil particles are filled with air that moves through the soil. Gas released by biological processes and radon released by the soil mix with this air (soil gas) and are carried along by it (fig.l). Radon is not the only undesirable constituent of soil gas. There are other harmful substances carried into houses by soil gas, such as moulds, moisture and, in some areas, methane. Soil gas enters houses through the areas of the building that are in contact with the ground. One of the side benefits of constructing a house to be "radon resistant" is that the same methods eliminate or reduce the amount of harmful or undesirable soil gases that can enter.

In the outdoor air, radon that escapes from the earth is so diluted by the surrounding air that it does not present significant health risks. In a closed house, this dilution does not occur and the concentration is higher. How much radon accumulates in any particular house depends on a number of factors, including the concentration of radon in the surrounding soil, the type of soil, the way the house is constructed, the rate of soil gas entry, the rate of air exchange within the house, and even the time of day or season of the year.



1. This cross-section of the Earth's crust shows how radon and other soil gases travel through the soil.

How can radon affect my health?

Most information about the effects of radon comes from studies done on uranium miners over a period of many years. The best evidence available shows that risk is directly proportional to lifetime exposure, that is, the average level of radon to which you have been exposed since you were born.

This does not mean that everyone exposed to high levels of radon will get lung cancer. Risk depends on both the degree of concentration and the length of exposure to radon. Lifestyle also plays an important part. It has been shown that the risk of developing lung cancer as a result of exposure to radon increases significantly for a smoker.

Whatever the case, health problems from exposure to high concentrations of radon are not immediately evident. Many years pass between exposure to radon and any signs of lung cancer.

Why is there concern about radon now?

The health risks associated with exposure to radon gas have been known and studied for a long time in the industrial environment (uranium mines). It was thought that the concentration in houses was much lower and therefore of little concern. Recently, scientists and public health officials have discovered high levels of radon in homes. One of the most striking examples came in 1985 in Pennsylvania in the United States. There, a nuclear power plant worker set off radiation alarms not when he left the plant, but when he entered it. His house was tested and was found to have the highest concentration of radon in any home tested up to that time — many times higher than the permissible level in uranium mines. A similar occurrence has recently been reported in a Canadian nuclear research facility.

These occurrences are extreme cases. Nevertheless, high radon concentrations are not a rarity in Canadian homes. A number of studies conducted by Health and Welfare Canada between 1977 and 1980 in major urban areas across Canada showed that radon concentrations in some areas were significantly higher than normal. Further studies are being undertaken to determine the extent of the potential problem.

Increased attention to the radon problem can also be attributed in part to technological improvements in radon-testing devices, which have made this equipment much less expensive and more readily available to the general public.

How does radon lead to lung cancer?

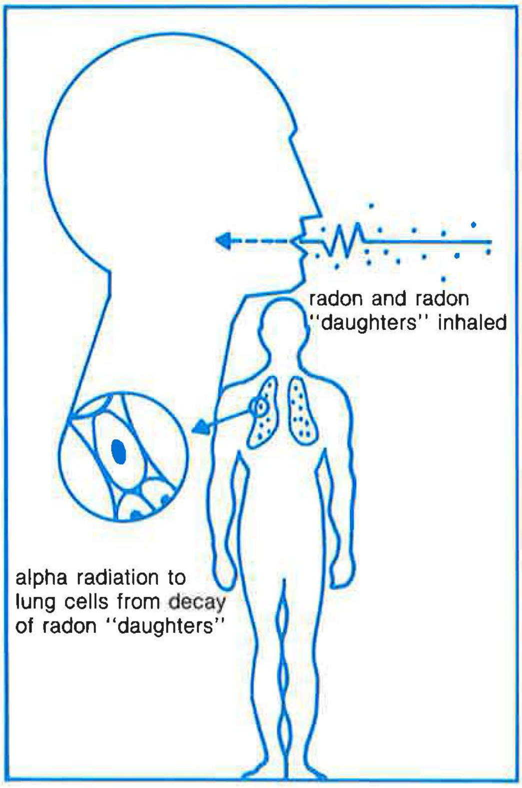
Radon undergoes spontaneous radioactive decay that transforms it into new elements. In the process, what is known as alpha, beta and gamma radiation is emitted; alpha particles are the most harmful. Radon is only one unstable element, a gas, created in a long decay process that starts with uranium and ends with stable lead. See fig.2.

ATOM	RADIOACTIVITY
Uranium-238 (in rock, soil) ↓	
Radioactive intermediates (Thorium, Protactinium, Radium, etc.) ↓	
Radon-222 (released as gas) ↓	alpha
MOST IMPORTANT RADON DAUGHTERS	
Polonium-218 ↓	alpha, beta
Lead-214 ↓	beta, gamma
Bismuth-214 ↓	alpha, beta, gamma
Polonium-214 ↓	alpha
Lead-210 ↓	beta, gamma (slow decay)
Bismuth-210 ↓	alpha, beta
Polonium-210 ↓	alpha, gamma
Lead-206	none (stable: end of series)

SOURCE: alphaNuclear, Mississauga, Ontario

2. The radioactive decay process of uranium that creates radon.

Radon gas itself is not the major instrument of harm to the lungs. It is the radioactive progeny, the "radon daughters" created by the decay of the radon itself that actually cause most of the radiation dose to the lungs. When radon decays, the new elements created are chemically active and attach themselves to microscopic dust particles or to droplets of moisture in the air. Once breathed into the lungs, the particles are deposited on the lung surfaces where the radiation released by the decay of these elements can damage lung cells and may cause lung cancer (fig.3).



3. Health risk.

How great is the risk from radon exposure?

While there is still some uncertainty about the risk from exposure to radon in homes, it is clear from studies on uranium miners that the risk of lung cancer increases with higher radon levels.

Authorities differ, but most estimate that radon causes 5 to 15 percent of all lung cancer deaths, which means 700–2,000 deaths every year in Canada. While these are not insignificant figures, it is important to keep them in perspective. The fact is that cigarette smoking causes many times more lung cancer deaths than radon.

How does radon get into houses?

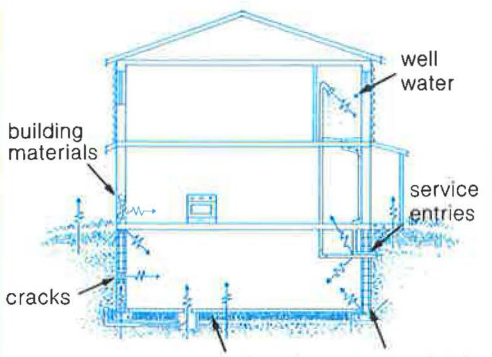
The soil around and below a house is by far the most significant source of radon. The air pressure in the house is normally slightly lower than in the soil and radon, along with other soil gases, is drawn into the house through every opening that connects with the soil.

In rural areas where the houses are supplied by wells, the radon concentration in the water can be high enough to be another significant source of radon. Municipal water systems generally have low levels since any dissolved radon usually has enough time to decay or escape.

Building materials such as concrete, brick and stone were once thought to be a major source, but the amounts of radon released are usually insignificant.

The common entry routes for soil gas and radon into a house are shown in figure 4. In order of importance they are: floor drains or sumps, basement wall/floor joints, joints and openings in floor slabs, cracks and joints in walls below grade level, and exposed earth surfaces inside the house itself.

How much radon enters a house depends on many factors, including how easily air can travel through the soil, how much radon is present in surrounding soils, the resistance of the basement walls and slab to air movement, and the pressure differences between the inside of the house and the surrounding soil. The radon concentration in the house then depends on the house volume and ventilation rate.



4. Some of the most common paths by which radon enters a house.

What can I do to reduce radon exposure?

In many cases high concentrations of radon can be eliminated by simple and inexpensive methods.

As mentioned earlier, radon from building materials is generally not significant. Radon from well water can be removed with activated charcoal filters and by aeration units. Radon entering basements from the surrounding soil is the major cause for concern.

There are three basic ways to combat high levels of radon gas concentration in a house: minimize the entry of radon gas into the house, redirect the radon-contaminated air away from the interior of the house, or replace radon-contaminated air in the house with cleaner air.

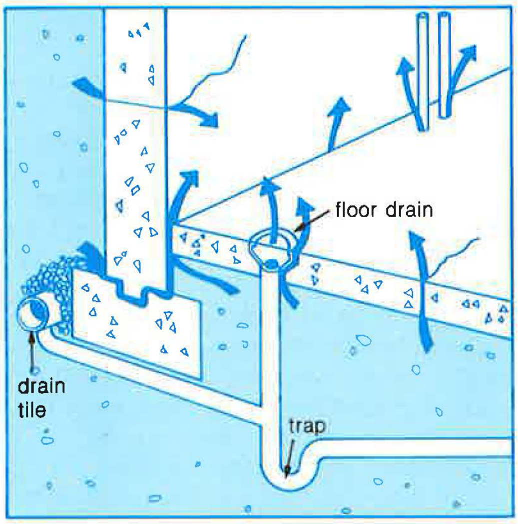
The first approach requires entry paths to be closed. The other two approaches depend on getting air moving through ventilation. Generally speaking, it is better to eliminate or divert radon entry than to allow radon to enter and then try to remove it through ventilation.

Eliminating basement entry paths

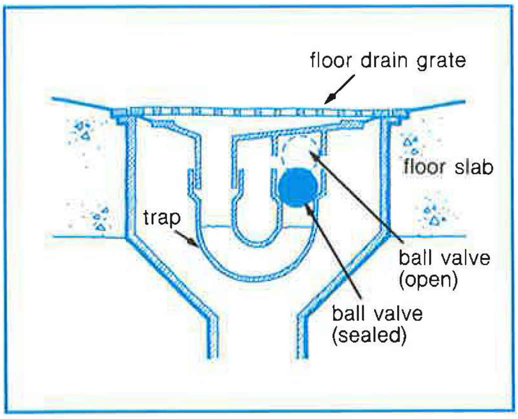
Houses with basements give radon more opportunities for entering the house than those built on or above the ground, simply because they have such a large area in contact with the soil. Some common entry points to basements and ways of dealing with them are listed below.

Floor drains and sumps

In most older houses, in many smaller communities, and in some large cities the sewer system is used for both sanitary and storm drainage. In houses with this system, floor drains or sump pumps connected to the perimeter drainage tile provide one of the largest points of entry for radon gas (fig.5).



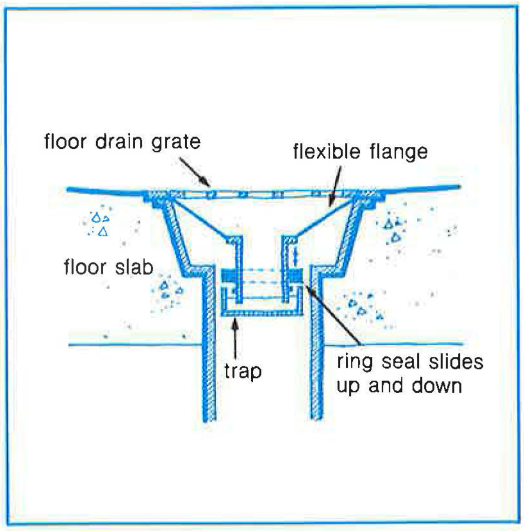
5. *Floor drain and drainage tile as a source of radon.*



6. *Self-sealing floor drain (gas trap).*

To keep the radon out, you should keep the trap filled with water. This requires a self-priming drain system, which consists of a small tube running from a sink or faucet (usually a basement washtub) to the trap. The tube releases water into the trap every time the tap on the sink is turned on.

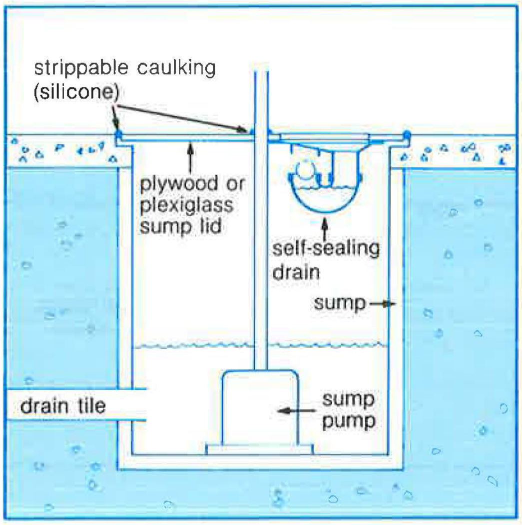
A more practical solution is a "gas trap" that allows water to pass down the drain but keeps gases from coming up. Some companies in Canada produce specially designed gas traps that homeowners can easily install in new or existing drains without special tools. These gas traps are particularly effective where the perimeter drain tile connects to the floor drain above the trap (figs.6 and 7). In some cases, if you trap a basement floor drain in this way you can eliminate up to 90 percent of the radon that might otherwise enter the house. It is important, however, to clean the gas trap annually to prevent accumulated dirt from interfering with the seal.



7. *Sealing floor drain (gas trap).*

In some areas, the perimeter drainage tile do not discharge into the floor drain or storm sewer, but into a sump from which the water is pumped to the street or the sewer. The drain into the sump is a major entry route for soil gas and radon. The sump pit cover should be sealed or made as tight-fitting as possible (fig.8). If the sump is also serving as a basement floor drain, a gas trap can be installed in the cover. Note that a submersible sump pump should be used, as the high humidity inside a covered sump is detrimental to a non-submersible pump. A vent pipe can be run from the sump to the outside of the house in order to divert radon gas. (See also the section, Ventilation using drainage tile.)

In newer houses in urban areas where there are separate sanitary and storm systems, and where there are no sumps, radon collected by the perimeter weeping tile will not have an easy route into the basement. Nevertheless, high radon levels can sometimes be found at floor drains. It is always a good step to keep traps filled or install a gas trap.



8. Sealing a sump pump.

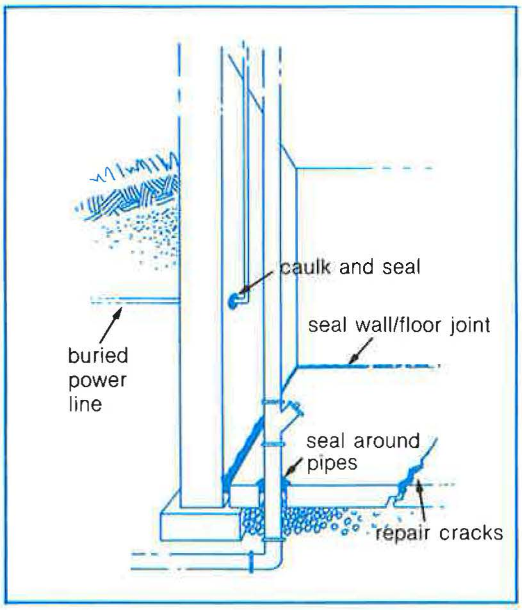
Sealing cracks and openings

Some of the obvious places radon can get into a basement are through wall and floor cracks, porous concrete block walls (see Concrete block basement walls, below), joints between wall and floor, openings around utility pipes and other underground services, expansion joints, and hollow steel teleposts.

Sealants at such openings must adhere well, remain flexible and have a long life. A good choice is a polyurethane caulking. Sprayed urethane foam can be used to seal large gaps. Silicone caulking does not adhere well to masonry or to damp surfaces, but can be useful in sealing sump covers. Whatever type of caulking is used, surface preparation will play a big part in making the seal a good one. As minimum preparation, the joints to be caulked should be cleaned with a wire brush and vacuumed. See figure 9.

Whether you should do the sealing job yourself depends mostly on your experience and what types of openings you need to seal. Large openings like those around drains or under basement toilets and tubs are not difficult to fill and seal. Wall/floor joints and small concrete cracks are more difficult to close effectively, and require widening by chiseling. It should be remembered that house settling, stresses, weathering and the natural aging of materials will all affect even a good sealing job over time. Regular maintenance of seals is important.

In new construction, heavy polyethylene should be placed below the basement slab to make it more resistant to the entry of radon and soil gases. The polyethylene should be carried up around the edge of the slab and sealed to the foundation wall at the floor/wall intersection.



9. Systems for excluding radon will be more efficient if all entrances into the house from the soil are properly caulked and sealed.

Covering exposed earth

Since radon enters the house from the soil, any areas of exposed earth present easy paths of entry. Covering the earth eliminates a major entry route, but it is important that the covering create an airtight seal. A poured concrete floor, though expensive, is a reliable method of covering exposed earth. The floor should be excavated to allow for 125 mm of coarse gravel to be placed under the slab in case soil ventilation is required later (see the section on Sub-slab ventilation for details). Polyethylene sheets should be placed below the slab and turned upward for future sealing to the walls.

A polyethylene cover alone provides only a short-term barrier. Certainly, if the area covered has any foot traffic or is used for storage, a polyethylene cover will not stand up. In crawl spaces, the polyethylene should be protected with a layer of sand to prevent soil gas pressures from lifting up and tearing the cover.

Concrete block basement walls

Hollow block walls tend to be very porous and can allow the passage of radon-laden air from below ground into the house. They may also be open at the top and have a large number of fine cracks in the mortar joints.

In the past, it has been suggested that drawing air from the wall cavities and exhausting it to the outdoors would be an effective measure against radon infiltration. In practice, this method has not been effective. Wall cavities are often not continuous, and excessive depressurization can draw air from the basement, leading to possible backdrafting of the furnace and hot water heater.

Block walls can be made more airtight if they are parged with cement, or covered by special coatings or a sheet material like polyethylene. An interior wall, sealed at the bottom to the floor slab and at the top where it meets the floor joists, will also reduce radon infiltration. A sub-slab ventilation system will probably provide the best results.(See the section on sub-slab ventilation.)

Preserved wood foundations

There is very little known about the penetration of radon into houses with preserved wood foundations (PWFs). If the foundation has been installed properly, the walls should be watertight and therefore "radon-tight." Check major potential points of entry such as the wall/floor joints and joints in the plywood floor, and seal and caulk all joints and entrances for pipes or utilities. Since PWFs are erected on a gravel base, a sub-slab ventilation system should work well, if needed.

Eliminating radon entry in houses without basements

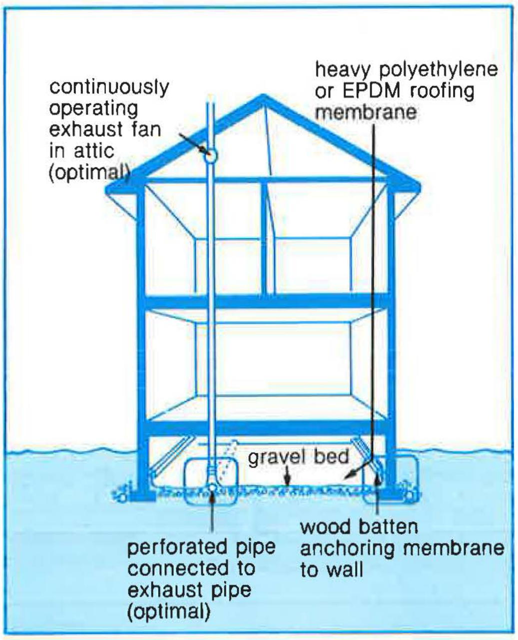
Slab-on-grade houses

Slab-on-grade houses generally have lower radon concentrations than houses with basements, but should still have all their openings, service entries and cracks sealed. A problem can occur if the heating system ducts run beneath the floor slab, since these can act as an entry route for radon. In favourable circumstances, sub-slab ventilation may be effective, but little research has been done on these houses in comparison with houses with basements.

Crawl space

In Canada, crawl spaces often contain water and sewer pipes and heating ducts. They are, therefore, insulated or heated, and are effectively part of the house. The preferable solution is to isolate the crawl space from the ground. One way is to cover the soil in the crawl space with heavy polyethylene and seal it to the foundation wall. The polyethylene should be protected by at least a 50 mm (2″) layer of sand and preferably by a concrete slab (fig. 10).

As an alternative, the house should be isolated from the crawl space as much as possible. The crawl space can then be ventilated either naturally or with a small fan. In practice, it is often difficult to effectively seal around all the ductwork, piping and other openings between the crawl space and the main floor. In cold climates, ventilating the crawl space means that ducts and piping will have to be insulated.



10. Sealing radon entry from a crawl space.

Diverting or removing radon through ventilation

There are various approaches that use ventilation to divert radon and prevent it from entering the house. These can be quite effective and may eventually be required by building codes for new houses. Most of these methods are beyond the scope of the handy homeowner and will require a knowledgeable contractor. It is also possible to reduce the build-up of radon within a home by increasing the general level of house ventilation. These varying methods are described below.

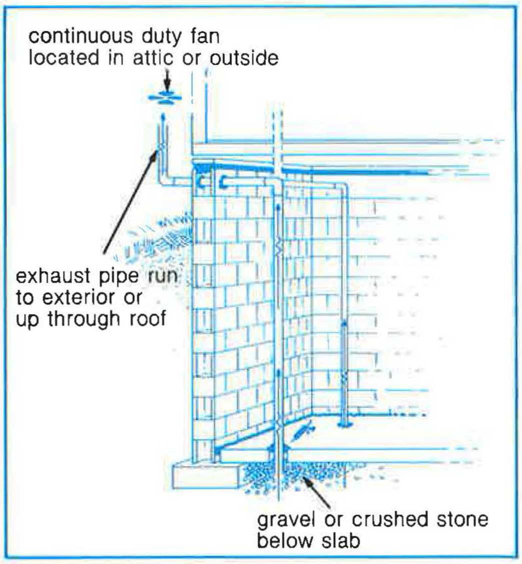
Sub-slab ventilation

The soil gas under the concrete floor slab is the highest in radon concentration, and can enter the house through any openings. In newer houses and in some older houses the floor slab usually has a layer of gravel or stone beneath it. A ventilation pipe placed through the floor slab into this gravel layer will draw up soil gases, including radon, and exhaust them to the air outside the house. The pipe should run up through the roof and a small exhaust fan should be installed in the attic. The pipe must be insulated where it is exposed to the outdoor air to prevent condensation and icing. This system is referred to as "sub-slab depressurization" (fig.11). If you are putting the system into an older basement, make sure there is gravel or porous soil under the slab to allow for the free flow of soil gases.

This system can be effective with hollow block walls, which, as noted earlier, are difficult to seal. It is being recommended for all new construction and building codes may eventually require that new houses be given a roughed-in sub-slab ventilation system. Once the house is occupied, radon levels can be checked and, if they are too high, the system can be completed and activated.

A similar approach is useful in crawl spaces. A pipe placed below the polyethylene cover directs radon to the exterior.

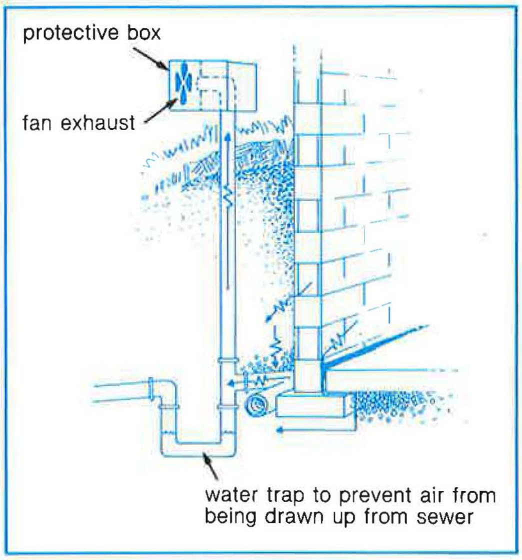
Researchers and contractors are also finding that "sub-slab pressurization" can be effective. Instead of air being exhausted from below the slab, the house's exhaust air is forced into the gravel layer below the floor. This method requires that the slab be well sealed and that the soil be neither too porous nor too impermeable to air movement.



11. A sub-slab ventilation system.

Ventilation using drainage tile

Because it collects radon from a large area around and below the house, the perimeter weeping tile system can be a major source of radon. This drainage system can be used to divert radon gas away from the house, by means of a ventilation pipe and fan connected to the weeping tile or to the sump pit. Air is then drawn out of the drainage system and exhausted to the outside. The exhaust pipe should be mounted on the exterior of the house or run up through the roof. The fan is best located in the attic or on the exterior (fig.12). Again, the pipe should be insulated when exposed to exterior air.



12. The perimeter weeping tile drain can be used to draw radon away from the house.

Ventilation of wall and floor cavities

A patented system which has proven to be effective in retrofitting basements in older houses provides ventilation in the spaces between the finished wall and the foundation wall, and between the raised floor and the slab. A conventional stud wall is built on the interior of the foundation wall and the finished floor is raised on sleepers. A small exhaust fan draws air from the cavities created to prevent any radon from infiltrating into the house. It is important that the floor and wall are well sealed, especially at the top of the wall, to avoid drawing air from the basement.

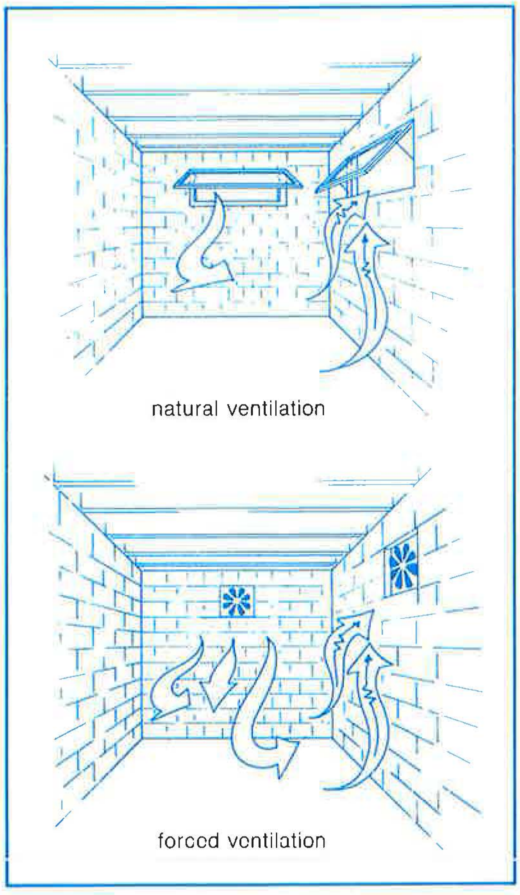
Increased house ventilation

Windows opened to create a cross draft may reduce radon concentrations, but natural ventilation alone, because it varies with wind and temperature differences, is not very reliable. A mechanical ventilation system provides increased ventilation, improved air quality and reduced radon concentrations (fig. 13).

Proper ventilation is an important part of any house design. A system that "balances" the amount of exhaust air and air entering the house provides good ventilation or air exchange. A good general reference on the problems of house ventilation and how to deal with the causes is the CMHC publication *Ventilation: Health and Safety Issues*. Another publication, *Guide to Ventilation Systems*, is planned.

One example of a balanced ventilation system is a heat recovery ventilator or air-to-air heat exchanger. These systems provide ventilation at a lower heating cost than fans but they have much higher installation costs and must be carefully maintained by heating and ventilation specialists. The size and airflow of ventilation units are limited by noise and the added cost of heating, and so acceptable units will rarely reduce the concentration by much more than a factor of three.

Where radon levels are high, ventilation alone may not be a practical solution. The amount of air exchange required to dilute the radon will be excessive, and the cost in terms of higher heating bills and personal comfort would be too great. It is also important to note that an unbalanced ventilation system may actually draw more radon into the house.



13. Natural ventilation helps lower radon concentrations but is not a permanent solution. A ventilation system should balance air exchange between the inside and the outside of the house.

Air filtering and air cleaning

The effectiveness of air-filtering or air-cleaning devices to reduce radon has not been adequately explored or studied. The theory is that filtration removes the airborne microscopic dust particles in the air and the radon decay products attached to them. However, the particles that are most easily removed are the larger ones with the lowest health risk, since it is the smaller particles that are deposited in the lungs. The overall value of filtration is, therefore, not clear.

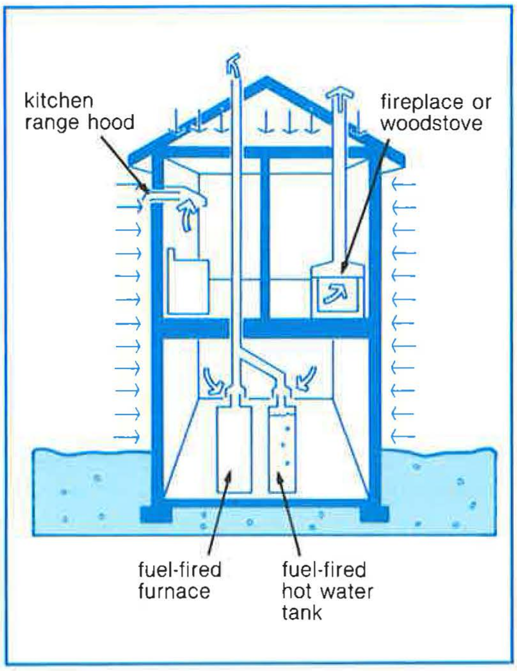
Electrostatic precipitation systems and thicker pleated furnace filters integrated into a forced-air heating system may reduce the concentration of the products of radon decay, but some researchers suggest that if the furnace fan is run continually to increase circulation, this will have a roughly equivalent effect at a lower cost. Smaller portable room filters will likely have little effect. There is some evidence, however, that portable ion generators may be effective in forcing radon daughters to "plate out" on walls and furnishings, where they can decay harmlessly.

The available studies on air-filtering and air-cleaning devices do not provide enough data to recommend the use of these devices as an effective means of achieving significant reductions in radon decay products in houses.

The effect of pressure differences

Air escapes from a tear in a balloon because the air inside the balloon is at a higher pressure than the surrounding air. Once the balloon is deflated, the pressures are the same, and there will be virtually no air movement through the tear. In the same way, radon gas and other soil gases will enter through cracks and openings in the foundation only if the air in the basement is at a lower pressure than the air in the surrounding soil. An important element in preventing radon entry, therefore, is to avoid depressurizing the basement. See fig 14. Depressurization of the basement can be avoided by the following means:

- a supply of make-up air for the furnace;
- a balanced ventilation system, rather than one that simply exhausts air from the house;
- no air leakage points in the upper floors.



14. Negative pressure inside the house.

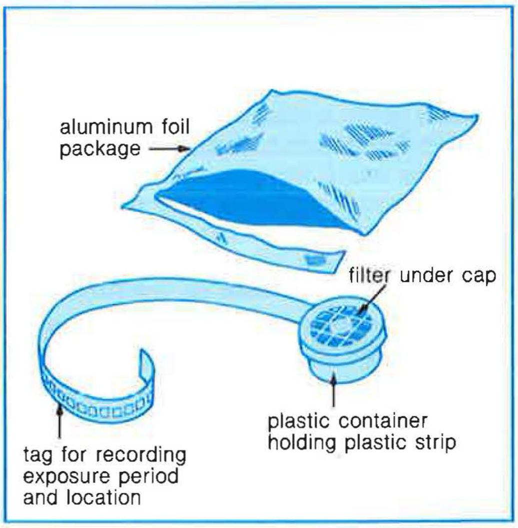
How can I find out how much radon I am exposed to?

Before you can begin to decide whether your health is at sufficient risk to warrant taking action to reduce radon concentration in your home, you must have some idea of the levels of radon present. Today, a number of companies in Canada and in the United States offer testing devices the homeowner can use to determine radon levels.

The two most common types of radon-measuring devices that are available today and are appropriate for home use are activated charcoal detectors and alpha track detectors; other methods that may have distinct advantages over these two are expected to become available. The company supplying these detectors usually sends them to the homeowner through the mail, and the homeowner places them in the area of the house where the radon level needs to be measured. The devices are then returned in a sealed envelope to the company for analysis. The results are reported to the homeowner. Though costs vary, most home monitoring with either of these devices can be done for $20 to $50.

Charcoal detectors Activated charcoal detectors consist of containers that allow radon to enter and be absorbed by the charcoal. They are exposed in the home for two days and then are returned by courier or priority post to the measuring company for a quick analysis. These devices are ideal in most instances for a screening test. They are easy to use, provide good results within the limits imposed by the shortness of the exposure time, and are inexpensive (fig.15).

15. Activated charcoal measuring devices come in a variety of types. Shown here are a "tea-bag" collector and a charcoal canister.



16. Alpha-track detector.

Alpha track detectors Alpha track detectors use a sheet of plastic in a container. As radon gas decays, the radioactive emissions of alpha particles damage the plastic. The container is returned to the company where the damaged plastic film is developed and the marks are counted to measure the level of radon to which the plastic was exposed (fig.16).

The alpha track method requires the device to be exposed for a longer period of time than that required for charcoal detectors, usually from two weeks to a year. A minimum of three months is suggested for a good reading. These devices are best suited to follow-up monitoring when a charcoal detector used for a screening test has indicated high levels of radon, and as a check after remedial measures have been undertaken.

Instantaneous monitoring

There are also a growing number of more sophisticated testing devices which give a reading within 15 minutes to an hour. They usually consist of scintillation cells which detect the impact of alpha particles on a special coating. These devices are very expensive and are used by contractors who specialize in testing and remedial work. They can be useful in determining the major locations of radon entry, and for that reason are often referred to as "radon sniffers." Since the testing is short-term, such methods are not reliable for determining typical radon levels.

Water sampling

Well water can be tested with special alpha track detectors designed for underwater use, or samples of water may be collected and sent for laboratory analysis.

Taking radon measurements

There are two steps you should take to measure radon levels in your home. The first measurement is a "sceening" test. The second is a longer-term test for confirmation. The collecting device should be placed in the area of the house most likely to have the highest radon concentration, usually the basement. Keep the detector away from drafts and heating registers. Ideally, doors and windows should be kept closed throughout the test period and for twelve hours before the test. To get reliable results, follow the directions supplied by the manufacturer very carefully. Accurately note the exposure period, and ensure that the testing lab receives the detector as soon as possible.

Indoor radon levels fluctuate, often by a factor of two or more from season to season, and by a factor of ten or more over a few days. Levels are generally higher at night than during the day, and higher in winter than in summer. The movement of low pressure fronts can also cause high levels for short periods, while a high pressure front may reduce radon levels to almost zero. Instantaneous readings, therefore, may not give a complete picture. The longer the period over which the reading is taken, the more reliable the result will be.

You will often see three measurements used for radon. The concentration of radon gas itself is measured in Becquerels per cubic metre (Bq/m^3) or pico-Curies per litre (pCi/L), while the concentration of radon progeny is measured in Working Levels (WL). It is possible to give a rough conversion between the three: 0.1 WL (working level) is about the same as Bq/m^3 (Becquerels per cubic metre) or 20 pCi/L (pico-Curies per litre), based on an equilibrium factor between radon and its daughters of about 0.5.

The unit used by Health and Welfare Canada is Bq/m^3, also preferred today by many other scientific bodies.

What is a safe level?

Since radon gas is carcinogenic (cancer-causing), the desirable level is one that is as low as possible. Various agencies have examined the risks involved in order to set realistic target levels.

Health and Welfare Canada has developed a guideline for radon levels, which has been recently ratified by provincial health authorities: "It is recommended that remedial measures be taken where the level of radon in a home is found to exceed 800 Bq/m^3 as the annual average concentration in the normal living area. Because there is some risk at any level of radon exposure, homeowners may wish to reduce levels of radon as low as practicable."

Health and Welfare Canada estimates that less than one percent of Canadian homes have levels of radon exceeding 800 Bq/m^3.

For comparison, average outdoor levels of radon are estimated to be about 8 Bq/m^3 (0.2 pCi/L or 0.001 WL) and average indoor levels are thought to be 40-150 Bq/m^3 (l-4 pCi/L or 0.005-0.02 WL).

Recent media attention has focused on the American system. The U.S. Environmental Protection Agency has set the target level for radon in homes at 150 Bq/m^3 (4 pCi/L or 0.02 WL). It has been estimated that one-third of all American houses may exceed this level, and therefore the EPA has recommended that all houses be tested. The U.S. Radon Abatement Act has recently been amended to indicate that the long-term goal is to reduce indoor levels of radon to the same as outdoor levels in the same vicinity. Health and Welfare Canada does not agree with EPA's assessment of the risk caused by radon, but suggests that homeowners reduce radon levels to as low as "practicable."

Interpreting the results of a radon test

If the results you receive from the monitoring company are low, 80 Bq/m^3 (2 pCi/L) or less, no further action is needed. It is still advisable, however, to undertake some basement-sealing work to ensure that other soil gases are not entering. You may even want to undertake basic sealing work prior to testing.

If the screening test result is more than 80 Bq/m^3 (2 pCi/L) but less than 800 Bq/m^3 (20 pCi/L), a second follow-up test in the living areas of the house over an extended period of time is recommended within the next year. If the result is above the guideline 80 Bq/m^3 (20 pCi/L), the follow-up test should be undertaken within not more than three months. If the screening test indicates high levels above 4 000 Bq/m^3 (l00 pCi/L), the follow-up test should be done immediately and the local or provincial health authorities notified.

If the confirming test indicates levels below 800 Bq/m^3 (20 pCi/L), no remedial action is required, although levels above 150 Bq/m^3 (4 pCi/L) may justify some low-cost measures. Levels above the guidelines require remedial measures to reduce them to levels below 800 Bq/m^3 (20 pCi/L). Remedial work is recommended within three months, unless the second test confirms high levels above 4000 Bq/m^3 (100 pCi/L), in which case action should be taken immediately.

A verifying measurement should be taken after remedial action to judge the effectiveness of the efforts made.

Remember that longer-term tests will give more reliable results. Instantaneous monitoring is only useful for determining where the major source of radon entry may be, and is not recommended for either screening or confirming tests.

How can I be sure that the home I am buying will not have a radon problem?

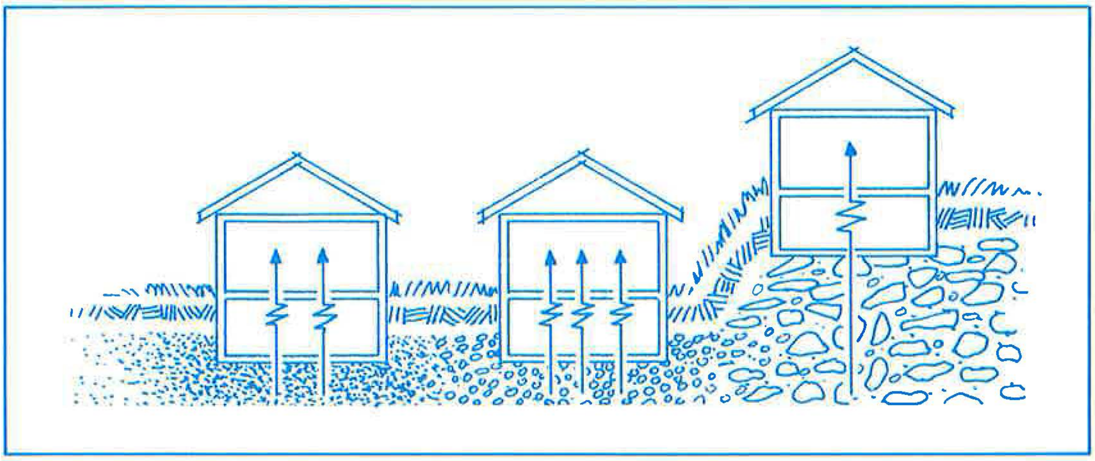
There are no reliable tests that can predict the radon level in a building before it is built. Much work has been done to identify types of soils and geologic formations that contribute to the likelihood of a radon problem arising in houses built in certain areas, but there are no definitive answers yet. Perhaps the best indication of potential problems is the occurrence of high levels of radon concentrations in existing houses in the neighbourhood. Even this is not a reliable gauge for an individual house as there is a great deal of variation between radon levels, even in houses of similar construction adjacent to each other (fig.17).

If you are concerned about the possibility of radon in a new house you are planning to buy, contact the provincial body responsible for radiation-related problems for assistance. You can also check with other homeowners in the area and with local government and builders' associations. You may decide that you want to make the purchase agreement conditional on the level of radon found in the house.

Some builders are already taking precautions to make their houses as "radon-resistant" as possible. Houses can be built in such a way that radon entry points are minimized and radon removal systems can be added with a minimum of expense. One such preventive feature is the installation of a pipe into the gravel layer below the basement slab to provide for a future sub-slab depressurization system.

As with all other aspects of house buying, get as much information as you can from more than one source and discuss any concerns you may have with the builder or seller of the house.

The question of responsibility and damages arising from suffering caused by elevated radon levels in a house involves complex legal questions. There is no legislation in place today regulating acceptable levels of radon concentration in houses.



17. Houses of similar construction adjacent to one another can have different radon levels depending on such factors as the soil under the house, the location and the house's air exchange rate.

How can I be sure to select the right company to do remedial work?

Like any other consumer issue that receives a lot of media attention, radon remedial work (or "mitigation" work) attracts both reputable and unscrupulous contractors. Just as you would check the credentials of an auto-mechanic, you should make sure that the contractor you select knows what he/she is doing. Ask for references. Try to find out if the contractor has the experience, training, and qualifications to deal specifically with remedial measures for radon problems. Check with owners of other houses the contractor has worked on. Call the local chamber of commerce, the Better Business Bureau, or the local home builders' association. Ask the contractor to describe proposed plans and expected results clearly. Be sure to have all work specified and the cost put down in writing. Being informed and discussing the problem with qualified people are your best assurances of success.

Sources of Information

Provincial offices available to answer questions about radon

Radiation Health and Safety Services
Occupational Health and Safety Division
Government of Newfoundland and Labrador
Department of Labour and Manpower
Beothuck Building, Crosbie Place
St. John's, Newfoundland
A1C 5T7

Tel: (709) 576-2645

Radiology Manager
Queen Elizabeth Hospital,
Charlottetown, Prince Edward Island
C1A 8T5

Tel: (902) 566-6277

Senior Radiation Health Officer
Department of Health
P.O. Box 488
Halifax, Nova Scotia
B3H 2R8

Tel: (902) 424-4077

Radiation Protection Services
Department of Health and Community Services
P.O. Box 5100
Fredericton, New Brunswick
E3B 5G8

Tel: (506) 453-2067

Chef de la Division de Radioprotection
Ministère de l'environnement du Québec
Suite 3860
5199 est, rue Sherbrooke
Montréal (Québec)
H1T 3X9

Tel: (514) 873-1978

Radiation Protection Service
Ontario Ministry of Labour
400 University Avenue, 8th Floor
Toronto, Ontario
M7A 1T7

Tel: (416) 965-8178

Head, Radiation Protection Section
Department of Medical Physics
Manitoba Cancer Foundation
100 Olivia Street
Winnipeg, Manitoba
R3E 0V9

Tel: (204) 787-2211

Head of Radiation Safety Unit
Department of Human Resources, Labour and Employment
Saskatchewan Place
1870 Albert Street
Regina, Saskatchewan
S4P 3V4

Tel: (306) 787-4486

Radiation Health Branch
Occupational Health and Safety Division
Community and Occupational Health
4th Floor, Donsdale Place
10709 Jasper Avenue
Edmonton, Alberta
T5J 3N3

Tel: (403) 427-2691

Radiation Protection Service
British Columbia Ministry of Health
307 West Broadway, Suite 200
Vancouver, British Columbia
V5Y 1P9

Tel: (604) 660-6630

Other sources

Dr. R.S. Eaton
Bureau of Radiation and Medical Devices
Health and Welfare Canada
775 Brookfield Road
Ottawa, Ontario
K1A 1C1

Tel: (613) 954-6676

Canadian Institute for Radiation Safety
(CAIRS)
595 Bay Street, Suite 1050
Toronto, Ontario
M5G 2C2

Tel: (416) 596-1617

Probe International
100 College Street
6th Floor
Toronto, Ontario
M5G 1L5

Tel: (416) 978-5858

Peter Russell
Research Division
Canada Mortgage and Housing Corporation
682 Montreal Road
Ottawa, Ontario
K1A 0P1

Tel: (613) 748-2306