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Office of Radiation Programs Washington, D.C. 20460
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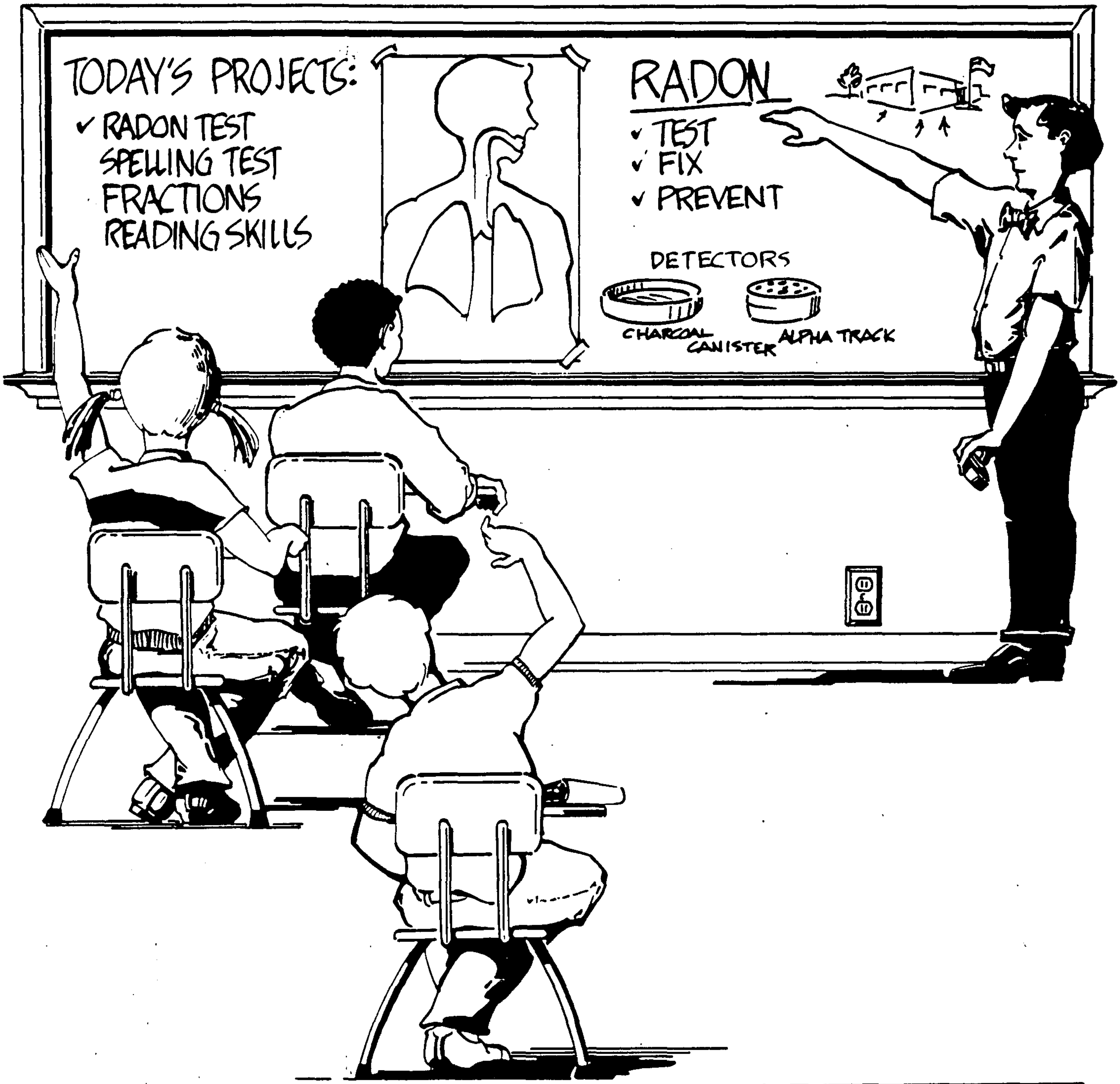
RADON MEASUREMENTS IN SCHOOLS

An Interim Report



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RADON IN SCHOOLS

I. PURPOSE OF THIS DOCUMENT

The U.S. Environmental Protection Agency (EPA) and other scientific organizations have identified an increased risk of lung cancer associated with exposure to elevated levels of radon in homes. Recently, schools in many States have also been tested for radon, and rooms with elevated concentrations have been found. Because indoor radon concentrations vary with building construction, ventilation characteristics, and the underlying soil and rock, the only way to determine if a particular school has elevated radon concentrations is to test it. As a result, an increasing number of schools throughout the country are initiating their own radon measurement programs.

To aid in this effort, EPA has developed this interim report for measuring radon in schools. This document provides school officials, groups such as Parent-Teacher Associations, and other interested persons with interim information on how to measure radon in schools and what to do if elevated levels are found. The guidance provided in this document incorporates several significant findings EPA has obtained in its initial studies of the radon problem in schools. Although more studies are being conducted to confirm the initial findings and to address other important school measurement issues, EPA believes that the knowledge gained from these early studies have important implications for schools planning to make radon measurements in the near future. As additional information on measuring radon in schools becomes available this interim report will be updated.

The first sections of this document contain facts about radon and the health risks associated with radon exposure. The next sections summarize what is known about radon in schools, and provide guidance for conducting radon measurements. The last sections describe how to interpret the measurement results and suggest techniques that can be used to reduce radon concentrations if elevated levels are found. An appendix to this document suggests methods for placing two types of radon measurement devices so that results obtained from room to room and from school to school can be compared.

II. RADON FACTS

Radon-222 is a colorless, odorless, tasteless, radioactive gas that occurs naturally in soil, rocks, underground water, and air. It is produced by the natural breakdown (radioactive decay) of radium-226 in soil and rocks. The radon breaks down to radon decay products that can attach themselves to particles in the air. Breathing radon decay products increases the chance of developing lung cancer. In outdoor air, radon is usually present at such low levels that there is very little risk. However, when radon enters a building, it and its decay products can accumulate to high concentrations. The Surgeon General's office of the U.S. Public Health Service and the EPA recognize that indoor radon constitutes a substantial health risk, and have publicly advised that most homes be tested. EPA also is encouraging the testing of other structures, such as schools and workplaces.

III. HEALTH EFFECTS

A. Effects on the General Population

Exposure to elevated radon concentrations has been associated with an increased risk of lung cancer. The risk depends not only upon the concentration of radon but the length of time for which a person is exposed. In general, risk increases as the level of radon, the length of exposure and an individual's smoking habits increases. Estimates of health risks associated with radon are based on lifetime exposure.

Not everyone who breathes radon decay products will develop lung cancer, and for those that do, the time between exposure and the appearance of cancer may be many years. Lung cancer generally does not appear until a person is at least 35 years of age; in most cases lung cancer is discovered between ages 45 and 85. The EPA and other scientific groups estimate that about 20,000 lung cancer deaths each year may be due to exposure to radon and its decay products. In 1987, there were about 138,000 lung cancer deaths in the United States; EPA estimates that about 15 percent may have been related to radon exposure. Smoking is clearly the major cause of lung cancer, and many lung cancers may be caused by the combined effect of radon exposure and smoking. In fact, the National Academy of Sciences estimates that exposure to radon and tobacco smoke in combination may be as much as ten times as serious as exposure to either pollutant by itself.

B. Effects on Children

There is currently limited data on how radon exposure affects children. Consequently, it is difficult to ascertain whether the risks from radon exposure are higher or lower for children than they are for adults. Most of the data relating lung cancer to radiation exposure during childhood comes from studies on Japanese atomic bomb survivors. These data suggest that children may be more susceptible than adults to cancers induced by radiation. However, sufficient time has not yet elapsed since the atomic bomb exposures to determine if the higher rate of lung cancer development in the exposed children will persist. Until more data become available, it is prudent to assume that children are at higher risk from exposure to radon than are adults for two reasons. First, children have smaller lung volumes and higher breathing rates, which may result in higher radiation doses to children from a given radon concentration. Second, the probability that a specific dose of radiation will induce cancer may differ with age.

IV. RADON EXPOSURE

A. Radon Exposure at Home

EPA has suggested an action level of 4 picocuries per liter (pCi/L) for residences based largely on the ability of current technology to reduce radon concentrations to that level or below. The risk associated with a lifetime exposure to a radon level of 4 pCi/L is roughly equivalent to that associated with smoking ten cigarettes per day. The Indoor Radon Abatement Act of 1988 sets a national goal of reducing annual average indoor radon concentrations to as close to outdoor levels as possible (Approximately 0.2 to 0.7 pCi/L). EPA is in the process of developing technologies to meet this goal. In addition, the EPA is currently revising the Citizen's Guide to reflect different action levels with their associated risks.

Radon exposure in homes has been identified as a national health problem. By 1988, EPA had assisted 17 states in making short-term "screening" measurements of radon concentrations in homes. The results of these State surveys indicate that one out of four homes in these seventeen states have screening radon levels above the EPA action level of 4 pCi/L.

Because many people, particularly children, spend much of their time at home, the home is likely to be the most significant source of radon exposure. Parents are strongly encouraged to test their homes for radon and take action to reduce elevated radon concentrations. Children and teachers may also be exposed at school, therefore EPA is encouraging the testing of schools.

B. Radon Exposure in Schools

Schools may be a significant source of radon exposure for children and staff. However, because occupancy patterns in schools differ from those in homes, the actual exposures received by each individual, or even by all students combined, are difficult to determine. Children, teachers and other school employees may spend most of their time in one room or may visit several classrooms each day. Each of these rooms may have different average radon concentrations. Until more information is available, it is reasonable to assume that a person remains in one school room for six to eight hours a day. This approach provides a margin of safety, since it probably overstates exposure if the rooms with the highest readings are used to assess the maximum health risk due to exposure at school.

V. RADON PROBLEM IN SCHOOLS

Elevated radon concentrations have been reported in schools in Virginia, Maryland, Pennsylvania, New Jersey, Florida, Washington, New York, Maine, Ohio, Iowa, Colorado, Tennessee and Illinois. EPA, with assistance from Fairfax County, Virginia, studied five schools in the winter and spring of 1988. In addition, EPA has analyzed data from various studies throughout the country. Several important findings from these investigations are described below. EPA is conducting further studies[4] to gain information useful for developing methods for measuring and mitigating radon in schools.

A. Available Information

Schools vary in their construction, heating, ventilation, air conditioning (HVAC), and occupancy patterns. EPA has collected information as to how these variables can affect radon concentrations and has considered this information in the development of this interim report.

First, EPA has observed that schools, unlike houses, may be built on several adjoining slabs. The joints between these slabs may offer entry points for radon to enter.

Second, investigating whether an HVAC system is designed and/or operated properly is an important part of understanding radon problems in a school. Sometimes schools were not designed with adequate ventilation. In other instances ventilation systems were not operated properly for reasons such as increased energy cost or uncomfortable drafts. Schools may have one or more complex HVAC systems. HVAC systems in the schools surveyed to date include central air handling systems, room-sized unit ventilators, and radiant heat. The unit ventilators and radiant heat can exist with or without a separate ventilation system. Central air handling systems and unit ventilators were most prevalent in the schools visited and are used in most newer, air conditioned schools.

Depending on the type of HVAC system in a school, operation of the system may produce positive or negative pressure conditions. Positive pressure within a school decreases the potential for radon entry, while negative pressure within a school increases the potential for radon entry. It has been observed that having the HVAC system operating normally, at a reduced rate, or completely shut down can increase or decrease radon concentrations depending on the type of ventilation system and the construction of the school. Even though elevated radon concentrations may exist when the system is off, there is a possibility that the elevated concentrations may dissipate when the system is on. On the other hand, a school may have a ventilation system that creates a negative pressure situation while operating. In this case, there is a greater potential for radon entry when the system is on.

Last, school occupancy patterns can have a varying effect on radon concentrations. Unlike homes, schools are usually closed on weekends and overnight. Because schools are usually unoccupied on weekends and overnight, the HVAC system is often turned down during these periods. This could have an affect on the radon concentrations and result in measurements that are not representative of radon concentrations to which children and school employees are exposed.

B. Initial Research Findings

The Fairfax County study produced the following findings which EPA also used in the development of this document:

- Radon concentrations in schools typically vary from room to room. Some classrooms may have elevated radon concentrations even if other rooms have relatively low radon concentrations.

- Schools in the same general area can have significantly different radon concentrations. Because of different construction techniques and underlying geology and soils, the results for one school do not apply to a school a few blocks away.

- Radon concentrations vary significantly over time. Changes in ventilation, occupancy patterns, weather conditions, and other variables may cause maximum and minimum screening concentrations in a room to vary by as much as a factor of 10 or more. Average concentrations may vary by a factor of two to three. The variability found in schools may be higher than that found in houses.

- Radon concentrations are considerably higher in basement and first floor rooms than on upper-level floors.

VI. RADON MEASUREMENTS IN SCHOOLS

Based on the findings discussed above, this section provides general guidelines for: (1) what rooms to measure; (2) what time of year to measure; (3) how to use screening and (4) how to interpret screening measurement results and conduct confirmatory measurements. In addition, two possible screening measurement options are presented. If one of these two options is selected, a detailed protocol for use of the radon measurement device described can be found in an appendix to this document. The last sections provide general information on reducing radon concentrations.

A. What Rooms to Measure

Based on available data, EPA is recommending that measurements be made in all rooms frequently used on and below the ground-level. More research is being conducted in this area to determine whether fewer rooms can be tested. Frequently used rooms include classrooms, offices, cafeterias, libraries, and gymnasiums. Areas such as broom closets and storage closets do not need testing since they are used infrequently.

If a school was constructed as an open-plan layout and does not have individual classrooms, measurements should be taken every 2,000 square feet. EPA is doing more research in this area. School officials may want to be flexible and test less frequently than every 2,000 square feet in open areas which are not routinely occupied. When deciding where to test, school officials should maximize testing in areas where there is a higher potential for radon entry (i.e. near structural joints and cracks).

If, for budgetary or other reasons, a school official chooses not to measure all rooms, those having the highest potential for elevated radon concentrations should be tested. Because ventilation systems can create low pressure conditions promoting radon buildup, and joints and cracks may allow radon to enter, the rooms most likely to have radon problems include: (1) basement classrooms, (2) occupied rooms that are isolated from the central ventilation system and only recirculates the room air; (3) rooms on or near structural joints such as adjacent slabs; (4) rooms with a large floor/wall joint perimeter; and (5) rooms that have floor slabs with significant cracks.

B. Time of Year to Measure

As with residences, radon screening measurements in schools should be made in the colder months (October through March) when windows and doors as well as interior room doors are more likely to be closed and the heating system is operating. This is generally known as "closed conditions." This situation tends to draw radon indoors by lowering indoor air pressures and creates a "worst-case" condition for estimating the highest radon level to which someone might be exposed. In open-plan schools, it may not be possible to isolate rooms or areas, but the building as a whole should be kept closed.

In warmer climates, screening measurements should still be made in the coolest months of the year when windows and doors are likely to be closed.

C. Radon Measurements

The long-term average radon and decay product concentrations which exist during hours when the school is occupied determines students exposure and therefore risk. Several factors make measurements of this long-term average radon concentration difficult. The process could take up to a full year and the techniques required are expensive and labor intensive. Longer term studies may be appropriate where reliable information indicates the potential for elevated radon concentrations. For initial measurements it may be appropriate to make concessions to cost and promptness. The methods in this report reflect EPA's best effort to identify appropriate techniques for initial screening and confirmatory measurements in schools.

Screening measurements taken over a short period of time under closed conditions are used to quickly determine if there is a potential radon problem. Measurements made under these conditions will produce results that represent the maximum concentrations to which students and teachers may be exposed. This is useful information because it is unlikely that the long-term concentrations, averaged over the full school year, will be greater than the screening results. Therefore, if the screening results are low, school officials can be confident that students are not exposed to high concentrations. More research is being done in this area and will be available with the final guidance.

The results of the screening measurements determine whether and what type of additional measurements are needed. If elevated levels of radon are found after taking a screening measurement, confirmatory measurements should be conducted before any corrective action is taken. The duration of the confirmatory measurement depends on the magnitude of the screening measurement results. (See Section VII) If elevated levels are found after a confirmatory measurement is taken, actions to reduce radon concentrations should be pursued. (See Section IX for more details.)

D. Screening Measurement Options

This section presents information on two passive detectors--charcoal canisters and alpha-track detectors-- because these are the devices most commonly available to school officials for conducting screening measurements. Other devices are available including electret-ion-chambers and continuous monitors. EPA has issued protocols for the use of other measurement devices in the report entitled "Indoor Radon and Decay Product Measurement Protocols" (EPA-520-1-89-006). In addition, school officials should contact State Radiation Control Offices or EPA Radiation Offices (see Appendix B) for more information on other devices.

Both the charcoal canisters and alpha track detectors can be used for conducting screening measurements. Charcoal canister measurements are used to quickly identify rooms and/or schools that have potential radon problems. There are two types of charcoal canisters commonly used. One is a two-day device and the other is a seven-day device. EPA is recommending that charcoal canister measurements be conducted during the weekend (See Section VI.D.1). Therefore, EPA recommends if a school official uses a charcoal canister for a screening measurement, the two-day device should be used. Charcoal canister measurements provide a "snapshot" of radon concentrations and are not representative of annual average radon concentrations. Alpha-track screening measurements typically are taken for three months. An alpha-track detector is an integrating device and gives a better estimate of the average radon concentration. Two options for conducting screening measurements in schools using these devices are outlined below. The advantages and disadvantages of each option are provided.

1. Charcoal Canister Option

This option involves using a two-day charcoal canister during the weekend with the ventilation system operating as it normally does during the weekday. This would not include normal reductions of the ventilation system at night. All frequently used schoolrooms on and below the ground-level should be tested. Measurements should be made during the coolest season of the year, and closed-school conditions (windows and doors shut) should be maintained to the degree possible to approximate a worst case situation to which children and teachers are exposed. The appendix provides further information on the placement of a two-day charcoal canister device.

ADVANTAGES

- Charcoal canisters yield quick results. A charcoal canister device provides a prompt initial indication of radon concentrations. The devices are in place for two days, sealed, and mailed to a testing laboratory. Results from the testing laboratory are usually returned in a few weeks.

- Charcoal canisters are relatively inexpensive. Charcoal canisters range in price from $10 to $30. If purchased in large quantities, the cost may be as low as $8 per canister. Prices are higher if the costs include the placement of the device by a professional contractor.

- Closed-Conditions are controlled on weekends. By measuring radon on the weekends, schools' windows and doors can be kept shut to maximize the radon potential.

- Tampering with charcoal canisters can be minimized on weekends. Tampering with the device affects the quality of the measurement and may produce inaccurate readings.

DISADVANTAGES

- Two-day measurements may be affected by ventilation systems. Two-day measurements may reflect fluctuations in radon concentrations caused by changes in the ventilation system operation. Longer measurements are less susceptible to these types of changes. (See Section V.A).

- Two-day measurements vary over time. Radon concentrations in schools can fluctuate dramatically over time. If two measurements are made in the same schoolroom on different weekends, the radon concentration may differ by a factor of 2 to 3.

- Charcoal canisters require prompt analysis. Radon attached to the charcoal begins to decay even when the canister is resealed. Once the radon measurement is made, charcoal canisters must be promptly returned to the laboratory. The use of large numbers of canisters requires careful planning to avoid delays.

- Two-day charcoal canisters may be affected by extreme humidity and temperature conditions. While most laboratories can compensate for these factors, unusually high or low temperatures or humidities can affect the result, and the laboratory should be alerted of such conditions.

2. Alpha Track Detector Option

This option involves using an alpha-track detector for a three-month period. As with the charcoal canister, all frequently used rooms on and below the ground-level should be tested. The measurements should be made in the winter season or, in warmer climates, the coolest season of the year. Although closed school conditions are preferable, it is not as crucial as it is with the charcoal canister because the measurements are for longer periods of time. The advantages and disadvantages of this option are outlined below.

ADVANTAGES

- An alpha-track detector provides a better basis for making decisions on reducing radon concentrations. Measurements made with alpha-track detectors versus charcoal canisters give a better estimate of the average radon concentration. Alpha-track detectors are better integrating devices than charcoal canisters and are not as affected by fluctuating radon levels. The use of alpha track detectors is advantageous for school officials that believe they may be pressured into taking corrective action upon finding elevated radon levels without conducting confirmatory measurements.

- Alpha-track detectors do not require immediate analysis. Unlike the charcoal canister, no radon decay occurs in the alpha track detector once the measurement is taken. The time from when the radon measurement is completed and when the device is sent to the laboratory is not as critical and large numbers of detectors can more easily be handled.

DISADVANTAGES

- Alpha-track detectors cost more than charcoal canisters. They range in price from $20 to $40, but may be obtained for as low as $15 each if purchased in large quantities. Costs will increase if the detector is professionally placed.

- If tampered with, alpha-track detectors can give inaccurate readings. Because an alpha-track detector must be used while school is in session, children and adults might tamper with the device.

VII. UNDERSTANDING SCREENING MEASUREMENT RESULTS AND CONDUCTING CONFIRMATORY MEASUREMENTS

Whether a screening or a confirmatory measurement is made, a school official must understand how to interpret the measurement result and how to effectively communicate the information. If elevated levels are found the school official must decide on what type of confirmatory measurements to take.

The screening measurement does not represent the long-term average radon level to which school children and teachers are exposed. If elevated levels are found with a screening measurement, school officials should take confirmatory measurements before taking permanent steps to reduce the radon concentration.

There are two important reasons why EPA recommends that no funds be expended to reduce radon levels before making confirmatory or diagnostic measurements. First, there is always the possibility that a single measurement may be faulty, due to laboratory or clerical errors. Second, radon levels fluctuate so greatly that a single measurement (especially a two-day measurement) may be made during an unusual peak in the radon concentration. Making a second measurement will better assess the concentrations to which students are routinely exposed. Confirmatory measurements should be made under weather and ventilation conditions as similar as possible, and in the same locations as the original screening measurements.

A. Interpreting Two-day Screening Measurement Results

The following recommendations are summarized in Figure 1.

- If the results of two-day screening measurements are greater than about 20 pCi/L, confirmatory tests should be conducted under weather and ventilation conditions as similar as possible to the original screening tests. Detectors should be placed in the same locations and ventilation conditions should also be similar.

  Confirmatory tests should be conducted over a two-day to a four-week period. The shorter measurement period of two days or one week should be used when the result of the screening measurement is extremely elevated, for example, when it is greater than about 100 pCi/L.

  i. Two-day, weekend confirmatory test - Measurements should begin and end at the same time as the original screening measurements.

  ii. One-week confirmatory test - There are several methods that can be used to measure over a one-week period. These include longer-term charcoal canisters (i.e. seven-day diffusion barrier), continuous radon monitors, and electret-ion-chambers. (Refer to the EPA report "Indoor Radon and Decay Product Measurement Protocols" EPA-520-1-89-006). Measurements over a week's time will yield information about radon levels during occupied as well as unoccupied conditions.

  iii. Four-week confirmatory test - Both electret-ion-chambers and short-term alpha-track detectors can be used to measure over a one-month period. (Refer to EPA report "Indoor Radon Decay Product Measurement Protocols" EPA-520-1-89-006). Measurements over one month will yield information about radon levels during several weeks during both occupied and unoccupied conditions.

- If the results of two-day screening tests are between 4 and 20 pCi/L, confirmatory tests should be made to ensure that levels are high enough to warrant permanent corrective action. Confirmatory tests should be conducted over at least a nine-month school year, or over 12 months if the school is used year round. There are two options for measurement methods that can be used over this time period: long-term electret-ion-chambers or year-long alpha-track detectors. (Refer to EPA report "Indoor Radon Decay Product Measurement Protocols" EPA-520-1-89-006).

- If the results of a two-day screening test are less than 4 pCi/L, school officials need to consider on a case-by-case basis whether further measurements should be made. As mentioned previously, when using a two-day screening test, average radon concentrations can vary by a factor of 2 to 3 over time. Therefore, school officials need to consider this variability when making decisions on whether further measurements should be made. In some schools where EPA has done work on reducing radon concentrations, EPA has been successful at reducing levels to below 4 pCi/L. This is dependent on the schools construction and HVAC system, the source of the radon problem and the radon concentration initially. This is based on limited data and more research in this area is being conducted. School officials should recognize that there is still a health risk associated with a lifetime exposure of 4 pCi/L and that Congress has set a national goal for indoor radon concentrations of outdoor ambient levels (0.2 to 0.7 pCi/L). If screening test results are below 4 pCi/L, long term average levels are probably also below 4 pCi/L.

B. Interpreting Three-month Screening Measurement Results

As discussed previously, a three-month screening measurement provides a better estimate of the long-term average radon levels in a school room than does a 2-day screening measurement. However, as with all measurements, EPA advises that some additional testing, either in the form of confirmatory or diagnostic measurements, be made before permanent corrective action is taken. The following recommendations are also summarized in Figure 2.

- If the results of three-month screening measurements are greater than 20 pCi/L, EPA recommends that school officials begin investigating possible radon entry points by conducting diagnostic measurements (see Section VIII). Diagnostic measurements will help school officials understand the distribution of radon levels throughout the school. Actions to reduce elevated radon concentrations should be conducted within the time frames outlined in Table 1.

FIGURE 1

Screening Measurement Guidance: Two-Day, Weekend Measurement Option

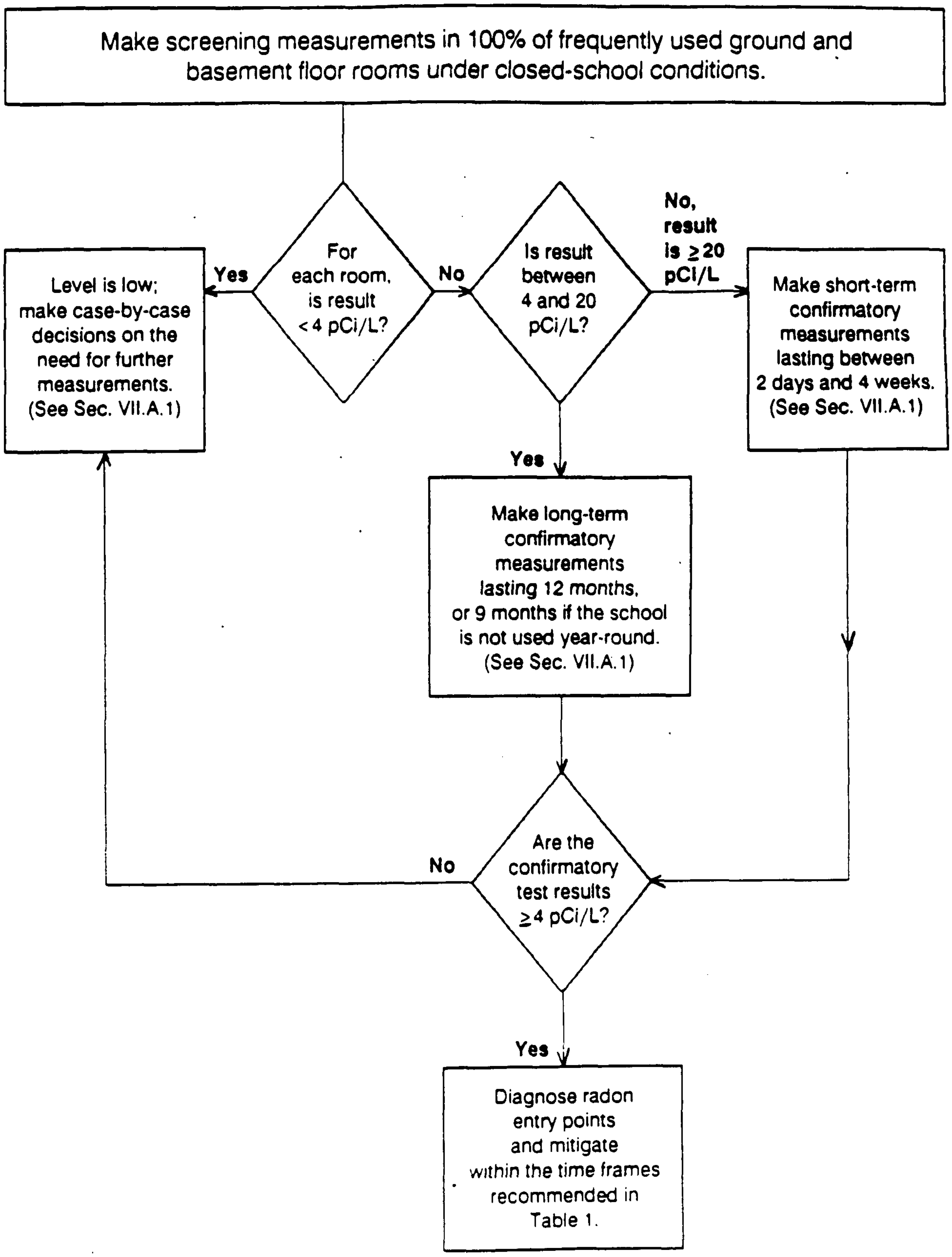
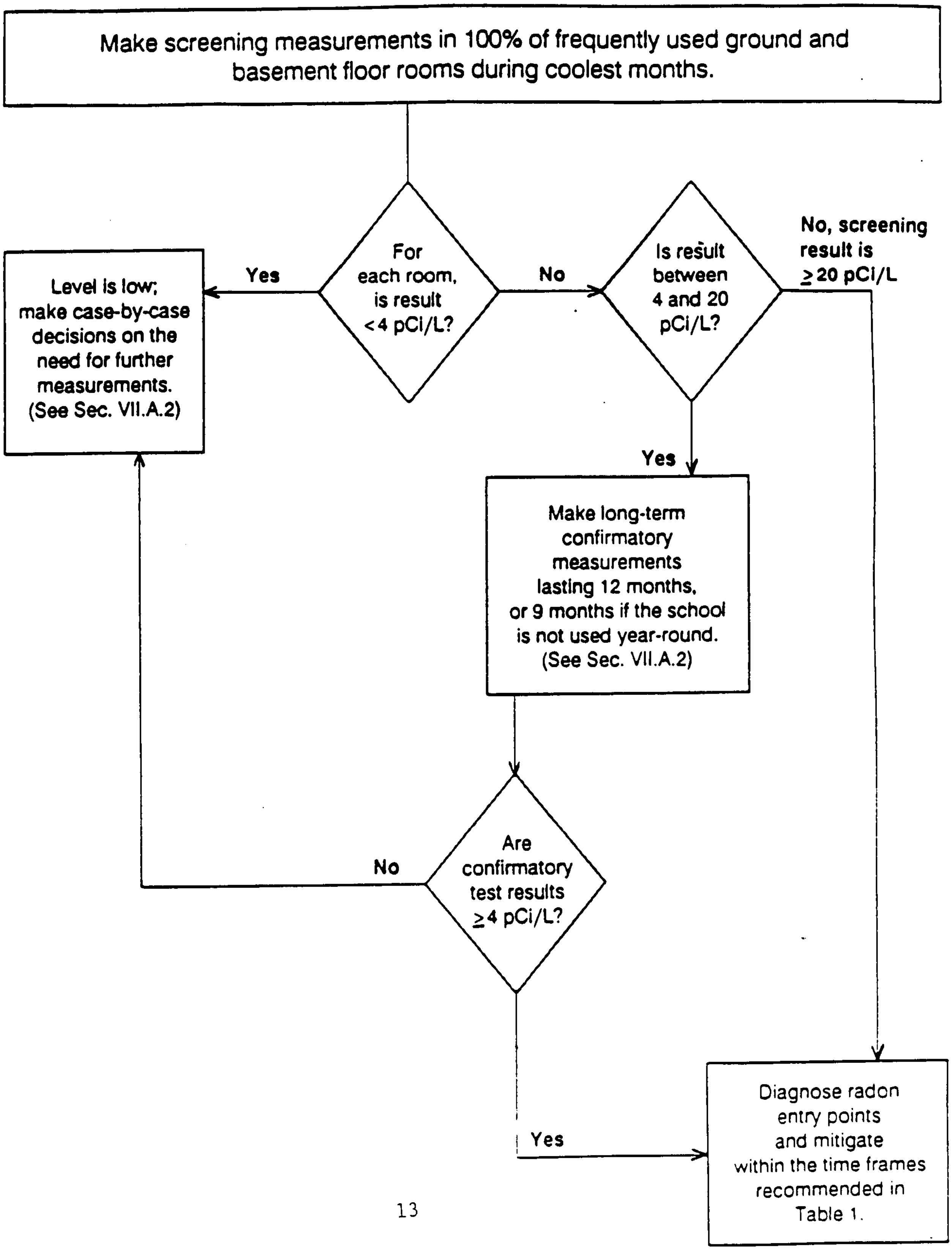


FIGURE 2

Screening Measurement Guidance: Three-Month, Winter Measurement Option



- If the results of three-month screening measurements are between 4 pCi/L and 20 pCi/L, confirmatory tests should be conducted over at least a nine-month school year or 12 months if the school is used year-round. Such long-term confirmatory tests will provide school officials with valuable information on long-term, average concentrations. There are two options for measurement methods that can be used over this time period: long-term electret-ion-chambers or alpha-track detectors. (Refer to EPA report "Indoor Radon Decay Product Measurement Protocols" EPA-520-1-89-006).

- If the results of a three-month screening measurement are less than about 4 pCi/L, school officials need to decide on a case-by-case basis whether further measurements should be made. In some schools where EPA has done work on reducing radon concentrations, EPA has been successful at reducing levels to below 4 pCi/L. This is dependent on the schools construction and HVAC system, the source of the radon problem and the radon concentration initially. This is based on limited data and more research in this area is being conducted. School officials should recognize that there is still a health risk associated with a lifetime exposure of 4 pCi/L and that Congress has set a national goal for indoor radon concentrations of outdoor ambient levels (0.2 to 0.7 pCi/L). If test results are below 4 pCi/L, long term average levels are probably also below 4 pCi/L.

VIII. RECOMMENDED TIMEFRAMES FOR REDUCING RADON CONCENTRATIONS

EPA recommends that school officials use the following guidelines when considering the urgency of taking action to reduce elevated radon concentrations. The recommendations are also summarized in Table 1.

These guidelines are for remedial action based on the results of confirmatory measurements.

- If a confirmatory measurement is greater than 20 pCi/L, school officials should take action to reduce levels as low as possible. EPA recommends that action be taken within several weeks. The urgency of corrective action is greater as the levels increase. For example, if levels are about 100 pCi/L or greater, school officials should consult with appropriate state or local health officials to consider temporary relocation until the levels can be reduced.

- If a confirmatory measurement is about 4 to 20 pCi/L, school officials should take action to reduce levels as low as possible. EPA recommends that action be taken within a few months.

TABLE 1

RECOMMENDED TIMEFRAMES FOR REMEDIAL ACTION

If the results of confirmatory measurements are:	The recommended timeframe for taking action to permanently reduce radon levels is:
Greater than about 20 pCi/L	Within several weeks. The urgency of remedial action increases if levels are greater than 100 pCi/L and school officials should consult with state or local health radiation protection officials to determine if temporary relocation is appropriate until the levels can be reduced.
Greater than about 4 pCi/L, but less than about 20 pCi/L	Within several months.
Less than about 4 pCi/L	The need for corrective action must be assessed on a case-by-case basis.

- If a confirmatory measurement is less than 4 pCi/L, school officials should consider on a case-by-case basis whether action to reduce radon concentrations below 4 pCi/L should be taken. School officials should recognize that there is still a health risk associated with a lifetime exposure of 4 pCi/L and that Congress has set a national goal for indoor radon concentrations of outdoor ambient levels (0.2 to 0.7 pCi/L). School officials should consult with qualified contractors to determine the feasibility and cost associated with reducing levels below 4 pCi/L. School officials can contact their State Radiation Control Office (see Appendix B) for a listing of qualified radon contractors.

IX. REDUCING RADON CONCENTRATIONS

If confirmatory measurements indicate a need for radon reduction, school officials should work in conjunction with an experienced radon mitigation contractor to diagnose the problem and determine which mitigation options are feasible. School officials can contact their State Radiation Control Office (see Appendix B) for a listing of qualified radon mitigation contractors .

Diagnostics begins with a visual inspection to identify possible radon entry routes. Possible areas of radon entry include joints between foundations, utility openings in foundations, wall-to-floor joints, and exposed earth in basements. Short-term radon measurements, such as grab samples or charcoal canister measurements, may be made near such locations to help assess where best to begin corrective actions.

Because school design, construction and operation patterns vary considerably, it is not possible to recommend "standard" corrective actions that apply to all schools. Costs for radon reduction will also be school specific and will depend on the initial radon level, the extent of the radon problem in the school, the school design, construction and operation of the HVAC system and the ability of school personnel to participate in the diagnosis and mitigation of the radon problem. In some cases, maintenance personnel may be able to install radon reduction systems with the guidance of an experienced radon mitigation contractor.

In initial research efforts, EPA modified mitigation techniques proven successful in residential housing and installed them in a number of schools. The applicability of these mitigation approaches to other schools will depend on the unique characteristics of each school. The radon reduction techniques studied in these initial schools include:

- <u>Installation of a sub-slab suction system to create a lower air pressure beneath the slab so that air flows out of the school rather than in through the cracks and openings in the foundation and floor</u>. Results indicate that sub-slab suction is much more effective when there is crushed stone under the slab. Schools without crushed stone under the slab or schools with many internal walls may require an alternative approach or a larger number of suction points.

When possible, installation of a sub-slab suction system should always be accompanied by sealing of radon entry routes. Sealing will increase the effectiveness of the system and also reduce the energy costs associated with operation of a sub-slab suction system.

- Adjustment of the air handling systems to maintain a positive air pressure in the school to discourage the inflow of radon. This technique, referred to as pressurization, can be an effective temporary means of reducing radon levels depending on HVAC system design. Whether such a technique is a feasible long-term solution depends upon factors such as the proper operation of the system by maintenance personnel, changes to the outside environmental conditions and any additional maintenance costs and energy penalties associated with the changes in the operation of the HVAC system.

- Sealing openings and cracks in contact with the soil to reduce radon entry. Sealing alone has been only marginally effective in reducing radon levels, particularly when the initial radon levels are high.

A major research program is underway to develop technology to reduce elevated radon levels in schools. Guidance on recommended radon reduction actions will be published as soon as possible. Preliminary results indicate that many school reduction programs will be relatively straight forward. Others, however, may require more complex solutions.

APPENDIX A:

PROTOCOLS FOR USING TWO RADON MEASUREMENT DEVICES

PROTOCOL FOR USING TWO-DAY CHARCOAL CANISTERS TO MEASURE INDOOR RADON CONCENTRATION

PURPOSE

This protocol provides guidance for using an activated charcoal device to obtain accurate and reproducible screening measurements of indoor radon concentrations. This protocol describes, in general terms, the placement of charcoal canisters, selection of location for measurement, retrieval of the charcoal device, and required documentation.

Activated charcoal devices are passive devices that do not need power to function. The passive nature of the activated charcoal allows continual adsorption and desorption of radon. The adsorbed radon undergoes radioactive decay during the measurement period. The technique does not uniformly integrate radon concentrations during the exposure period and, therefore, represents a short-term screening measurement.

The charcoal canister commonly used consists of a circular container 2 1/2 to 4 inches in diameter. It is approximately 1 inch deep, filled with 0.9 to 3.5 ounces of activated charcoal. One side of the container is fitted with a screen that keeps the charcoal in, but allows air to diffuse into the charcoal. The canister is pre-sealed with a cover until it is ready to be deployed.

To initiate the measurement, the cover is removed to allow air to diffuse into the charcoal bed. Radon in the air will be adsorbed onto the charcoal and will subsequently decay, depositing decay products in the charcoal. At the end of the measurement period, the canister is resealed with the cover and returned to a laboratory for analysis. Specific directions are usually supplied with the devices.

EQUIPMENT

Activated charcoal devices made specifically for ambient radon monitoring can be obtained from commercial suppliers. To obtain up-to-date information on available firms, school officials should contact their State Radiation Control Office or their EPA Regional Radiation office (see Appendix B). Only agencies which are state certified or approved by EPA should be used.

The following equipment is required to perform charcoal canister measurements in each schoolroom:

- Charcoal detector(s) sealed with a protective cover.
- An instruction sheet for the individual placing the canister (i.e., school facility personnel) and, if sent by mail, a shipping container and a mailing label for returning the canister(s) to the analytical laboratory.

- Data collection log.

The canister should not be deployed if the individual who performs the test will not be able to complete the measurement by the time selected for closing the canister and returning it to the laboratory.

MEASUREMENT CRITERIA

The following conditions should exist during a measurement period to ensure that the conditions are as standardized as possible.

- The measurement should be delayed if the school is undergoing/planning remodeling, changing the heating, ventilating, and air conditioning (HVAC) system, or making other modifications that might influence the radon concentration during the measurement period.

- To a reasonable extent, the school should be closed, with all windows and external doors shut (except for normal entry and exit) for at least 12 hours prior to and during the measurement period. Normal "entry and exit" includes brief openings and closings of doors. Any opening to the outside should not be left open for more than a few minutes.

- While furnaces, exhaust fans, central HVAC systems may be operated normally, systems such as window fans should not be operated for at least 12 hours prior to and during the measurement period.

- The measurement should not be conducted if major weather or barometric changes are expected, or when storms with high winds are predicted during the measurement period. Weather predictions on local news stations generally provide sufficient information to allow satisfying this condition.

- Schools should measure during the weekend hours so that closed-conditions can be more easily satisfied. Measurements during these hours will also minimize the possibilities of children interfering with the charcoal canisters. Ventilation systems should not be shut down or operated at a reduced rate (i.e., no night-time reductions) during the weekend when the measurement is made

- Canisters can be placed on Friday afternoon or Saturday morning and collected on the Monday morning (rather than Sunday afternoon) without adversely affecting the readings.

- Measurements should be done during the coldest months of the year, as it is during these months that the radon concentrations will be at their highest in the school due to lack of open windows.

- Charcoal canisters should be placed in schoolrooms as soon as possible after they are purchased. They should remain tightly sealed until they are placed.

LOCATION SELECTION

The following criteria should be applied to select the location of a canister within an individual schoolroom.

- Select a position where the canister will not be disturbed during the measurement period.
- The canister should be in open air that people breathe, e.g. not in a drawer or closet.
- The canister should be placed flat on a shelf or table at least 20 inches above floor level with the detector's top face at least 4 inches from other objects.
- The canister should not be placed near drafts caused by HVAC vents, or windows and doors. Avoid locations near excessive heat or in direct, strong sunlight, and areas of high humidity.
- The canister should not be placed close to the outside walls of the schoolroom.
- In gymnasiums or schools designed with the open-room concept, charcoal canisters should be placed every 2,000 square feet.

Remove the protective cover from the canister to begin the measurement. Save the cover and tape to reseal the canister at the end of the measurement. (A handy way for saving the cover and tape is to place the lid on the bottom of the canister and hold it in place with the tape). Inspect the canister to see that it has not been damaged during handling and shipping. It should be intact, with no charcoal leaking. Place the canister with the open side up. Do not allow anything to impede air flow around the canister.

Accurately fill in the information called for on the data form on the canister. Record the canister serial number in a log book along with a description of where the canister was placed in the school and the room. The person responsible for placing the charcoal canister should maintain the log book.

RETRIEVAL OF DETECTORS

The canisters should be deployed for a two-day measurement period. In schools, a two-day measurement should take place on a weekend.

At the end of the measurement, the canister should be inspected for any deviation from the conditions described in the log book at the time of deployment. All changes should be noted. The canister should be tightly resealed using the original protective cover.

The person responsible for the retrieval of the canister should send the canister to the laboratory as soon as possible, preferably the day of termination. Devices returned several days later may produce invalid results as the radon decays with the passage of time.

DOCUMENTATION

It is important that information about the measurement be recorded in a permanent log. This information includes:

- The date and time of the start and stop of the measurement.
- Whether closed-school conditions, as previously specified, are satisfied.
- The exact location of the instrument drawn on a diagram of the school and schoolroom if possible.
- Serial number of the canister and a code number or description that uniquely identifies building, room, and sampling position.
- Other easily gathered information that may be useful including the type of school (i.e., compartmentalized, open-class room), the type of heating system, and the existence of basement or crawl space.
- General operating conditions for HVAC characteristics (e.g., run continuously, shut down on weekends).

QUALITY ASSURANCE PROCEDURES

To minimize uncertainty in the results and ensure that measurements are as accurate as possible, any school undertaking radon measurements should follow quality assurance (QA) procedures. The two quality assurance procedures that the school administrator needs to be concerned about are duplicates and control detectors. These terms are defined below along with a suggested procedure for carrying out a QA program. More technical information on QA for charcoal canisters can be found in "Indoor Radon and Radon Decay Product Measurement Protocols," USEPA (EPA/520-89-006).

DUPLICATES

Duplicates are side by side measurements that analyze the precision of the measurement taken in a school. A duplicate measurement involves putting a second measurement device next to the original detector. Side-by-side measurements should be done with either 10 percent of the number of detectors placed or 50, whichever is smaller. For instance, if the school official, (or individuals responsible for placing the measurement devices) place detectors in 100 rooms in a school, 10 (i.e., 10 percent) of these rooms should have two detectors placed side-by-side as duplicates for a total of 110 detectors. The duplicate and the original detector should be treated identically in every respect.

They should be shipped, stored, opened, installed, removed, and processed together and not identified as duplicates to the processing laboratory. Data from duplicate detectors should agree to within ten percent, on average, for radon concentrations of 4 pCi/L or greater. Consistent failure in duplicate agreement indicates an error in the measurement process that should be investigated.

CONTROL DETECTORS

Control detectors are used to monitor whether there is a problem during shipping, storage or processing of the detectors which would cause an error in the measurement. Control detectors are kept in their original package without being opened and then returned to the laboratory with the exposed measurement devices. Control detectors should be opened, immediately resealed for the remainder of the exposure period, and then returned to the laboratory with the exposed measurement devices. The purpose of opening the package is to make it indistinguishable from the exposed detectors so that laboratory workers will not know that the detector is a control. The number of control devices used should be five percent of the detectors deployed or 25, whichever is smaller. For instance, if the school official (or individual responsible for placing the measurement device) places 100 detectors, 5 detectors should be handled and shipped using the same procedures that are used for the other detectors, except that the control detectors should be left in their original packages and not exposed. The results of the control detector should be monitored closely to see if the measurement devices were affected by the shipping, storage or processing. If the analysis laboratory reports values for these control detectors greater than about 1 pCi/L, school officials should contact the analysis laboratory and request an explanation.

PROTOCOL FOR USING ALPHA TRACK DETECTORS TO MEASURE INDOOR RADON CONCENTRATION

PURPOSE

This protocol provides guidance for using alpha-track detectors (ATD) to obtain accurate and reproducible measurements of indoor radon concentrations. This procedure describes the placement of the ATD, measurement criteria, location selection for measurement, retrieval of the ATD, and documentation requirements.

An ATD is a small piece of plastic or film enclosed in a container with a filter-covered opening. Radon diffuses through the filter into the container and alpha particles emitted by the radon decay and its products strike the detector and produce submicroscopic damage called alpha tracks. At the end of the measurement period, the detectors are returned to a laboratory. Plastic detectors are placed in a caustic solution that accentuates the alpha tracks so they can be counted using a microscope or an automated counting system.

EQUIPMENT

ATDs are available from commercial suppliers. These suppliers offer contract services in which they provide the detector and subsequent data readout and reporting for a fee. A list of firms that currently sell this device is available from State Radiation Control offices and regional EPA Regional Radiation offices (see Appendix B). Only agencies which are state certified or approved by the EPA should be used.

The following equipment is needed to use ATDs to measure radon in a school.

- An ATD in an individual, sealed container, such as an aluminized plastic bag to prevent extraneous exposure before deployment.
- A means to attach the ATD to its measurement location if it is to be hung from the wall or ceiling.
- An instruction sheet for the individual who will place the ATD and, if it is to be mailed, a shipping container and a prepaid mailing label for returning the detector to the laboratory.
- Some means (such as tape) will be needed at the time of retrieval to reseal the detector prior to returning it to the supplier for analysis.
- Data collection log.

MEASUREMENT CRITERIA

Certain conditions should exist in the school during the measurement period to standardize the measurement conditions as much as possible.

- The measurement should be delayed if the school, is undergoing or planning remodeling, changing its heating, ventilation and air conditioning (HVAC) system, or making other modifications that might influence the radon concentrations during the testing period.

- To a reasonable extent, the schoolroom, as well as the individual rooms, should be closed; with all windows and doors closed (except for normal entry and exit) during the measurement period. However, a few days with the windows open will not seriously jeopardize the result of a three-month measurement. ATD measurements should be conducted during the colder months.

- In warm climates., the standardized conditions are satisfied by the criteria listed above. Air conditioning systems that recycle interior air can be operated.

- Central heating and ventilation systems should be operated continuously during the measurement periods. This includes exhaust fans.

PLACEMENT OF THE ATD

ATDs should be placed in the school as soon as possible after they are received. School officials should not order more ATDs than they can reasonably expect to install within a few months to minimize chances of measurement error.

LOCATION SELECTION

The following criteria should be applied to select the location of the detector within a room.

- A position must be selected where the ATD will not be disturbed during the measurement period. In addition, children should be educated as to the purpose of the device and the importance of not interfering with the measurement.

- The detector should be in the open air that the occupants breathe (at least 30 inches above the floor and at least 4 inches from other objects).

- The detector should not be placed near drafts caused by HVAC systems, windows, doors, etc. Avoid locations near excessive heat, such as radiators and baseboard heaters.

- Detectors should not be placed close to the outside walls of the schoolroom.

- In areas such as gymnasium, or where a school has open classrooms, ATDs should be placed at least every 2,000 square feet.

Frequently it is convenient to suspend detectors from the ceilings or walls. They should be positioned at least 8 inches below the ceiling. The location should be coordinated with the teacher to be certain it is acceptable for the measurement period.

The measurement begins when the protective cover or bag is removed. Cut the edge of the bag or remove the cover so that it can be reused to reseal the detector at the end of the exposure period. Inspect the detector to make sure it is intact and has not been damaged in shipment or handling.

Fill in the information requested with the detector. Also, record the detector serial number in a log book along with a description of the location of the school room (i.e., the room number) and also the location of the detector in the room in which the detector was placed. If it is necessary to relocate the detector during the exposure period, note this information in the log book, along with the date it was relocated. Individuals responsible for the placement of the detector (i.e., school facilities personnel) should maintain the log books.

RETRIEVAL OF DETECTORS

At the end of the measurement period, the detector should be inspected for damage or deviation from the conditions entered in the log book when the detector was placed. All changes should be noted in the log book. Enter the date of removal on the data form provided with the detector and in the log book. Reseal the detector using the protective cover or bag with the correct serial number for that detector or with the cover originally provided. If a bag is used, the open edge of the bag is folded several times and resealed with tape. If the bag cover has been destroyed or misplaced, the detector should be wrapped in several layers of aluminum foil and taped shut. After retrieval, detectors should be returned as soon as possible to the analytical laboratory for processing.

DOCUMENTATION

It is important that enough information about the measurement is recorded in a permanent log so that data interpretations and comparisons can be made. Information that should be recorded includes:

- The date and time of the start and stop of the measurement.

- Whether closed conditions, as previously specified, are satisfied.
- The exact location of the ATD(s) including a diagram of the schoolroom and school.
- Serial number and manufacturer of the detector along with a code number that uniquely identifies building, room and sampling position.
- Other easily gathered information that may be useful: the type of school (i.e., compartmentalized, or open-room), type of heating system, and the existence of crawlspace and/or basements.
- General operating procedures for heating, ventilation, and air-conditioning characteristics (HVAC) (e.g., run continuously, shut down on weekends).

QUALITY ASSURANCE PROCEDURES

To minimize uncertainties in the results and ensure that measurements are as accurate as possible, any school undertaking radon measurements should follow quality assurance (QA) procedures. The two quality assurance aspects that the school official needs to be concerned about are duplicates and control detectors. In the following paragraphs, these terms are defined and a procedure is given for carrying out a QA program. More technical information on QA for ATDs can be found in "Indoor Radon and Radon Decay Product Measurement Protocols," USEPA (EPA/520-89-006).

DUPLICATES

Duplicates are side by side measurements that analyze the precision of the measurements taken in a school. A duplicate measurement involves putting a second measurement device next to the original detector. Side-by-side measurements should be made with either 10 percent of the number of detectors placed or 50, whichever is smaller. For instance, if the individual responsible for placing the measurement devices places detectors in 100 rooms in a school, 10 (i.e., 10 percent) of these rooms should have two detectors placed side by side as duplicates, for a total of 110 detectors. The duplicate and original detectors should be treated identically in every respect.

They should be shipped, stored, opened, installed, removed and processed together and not identified as duplicates to the processing laboratory. Data from duplicate detectors should agree to within 20 percent, on average, at radon concentrations of 4 pCi/L or greater. Consistent failure in duplicate agreement would indicate an error in the measurement process that should be investigated.

CONTROL DETECTORS

Control detectors are used to monitor whether there is a problem during shipping, storage, or processing of the detectors which would yield an inaccurate measurement. Control detectors should be opened, immediately resealed for the remainder of the exposure period, and then returned to the laboratory with the exposed measurement devices. The purpose of opening the package is to make it indistinguishable from the exposed detectors so that laboratory workers will not know that the detector is a control. The number of control detectors used should be five percent of the detectors deployed or 25 whichever is smaller. For instance, if the individual responsible for placing the measurement device) places 50 detectors, 3 detectors should be handled and shipped using the same procedures that are used for the other detectors except that the control detectors should be left in their original package and not exposed. Information about the control detectors should be recorded in the logbook. The results of the control detector should be monitored closely to see if the measurement devices were affected by the shipping, storage, or processing. If the analysis laboratory reports values for these control devices greater than about 0.1 pCi/L for a 12-month measurement or 0.5 pCi/L for a 3-month measurement, school officials should contact the analysis laboratory and request an explanation.

APPENDIX B:

STATE RADIATION CONTROL OFFICES AND

EPA REGIONAL RADIATION OFFICES

The following appendix is a listing of State Radiation Control offices and EPA Regional Radiation offices. Users of this report are encouraged to contact these offices for questions regarding radon and measurement of radon in their school.

STATE RADON CONTACTS

Alabama
Radiological Health Branch
Alabama Department of Public Health
State Office Building
Montgomery, AL 36130
(205) 261-5315

Alaska
Radiological Health Program
Alaska Department of Health and Social Services
P.O. Box H-06F
Juneau, AK 99811
(907) 465-3019

Arizona
Arizona Radiation Regulatory Agency
4814 South 40th Street
Phoenix, AZ 85040
(602) 255-4845

Arkansas
Division of Radiation Control and Emergency Management
Arkansas Department of Health
4815 W. Markham Street
Little Rock, AR 72205
(501) 661-2301

California
California Department of Health Services
Room 334
2151 Berkeley Way
Berkeley, CA 94704
(415) 540-2134

Colorado
Radiation Control Division
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220
(303) 331-4812

Connecticut
Radon Program
Toxic Hazards Section
Connecticut Department of Health Services
150 Washington Street
Hartford, CT 06106
(203) 566-3122

Delaware
Division of Public Health
Delaware Bureau of Environmental Health
P.O. Box 637
Dover, DE 19901
(302) 736-4731
(800) 554-4636

District of Columbia
DC Department of Consumer and Regulatory Affairs
614 H Street, NW
Room 1014
Washington, D.C. 20001
(202) 727-7728

Florida
Office of Radiation Control
Department of Health and Rehabilitative Services
1317 Winewood Boulevard
Tallahassee, FL 32399
(904) 488-1525
(800) 543-8279 (consumer inquiries only)

Georgia
Georgia Department of Human Resources
878 Peachtree Street, Room 100
Atlanta, GA 30309
(404) 894-6644

Hawaii
Environmental Protection and Health Services Division
Hawaii Department of Health
591 Ala Moana Boulevard
Honolulu, HI 96813
(808) 548-4383

Idaho
Bureau of Preventative Medicine
Division of Health
Idaho Department of Health and Welfare
450 West State Street
Boise, ID 83720
(208) 334-5927

Illinois
Illinois Department of Nuclear Safety
Office of Environmental Safety
1301 Knotts Street
Springfield, IL 62703
(217) 786-6384
(217) 786-6399 for Citizen's Guide

Indiana
Division of Industrial Hygiene and Radiological Health
Indiana State Board of Health
1330 W. Michigan St.
P.O. Box 1964
Indiannapolis, IN 46206
(317) 633-0153
(800) 272-9723 (in State)

Iowa
Bureau of Radiological Health
Iowa Department of Public Health
Lucas State Office Building
Des Moines, IA 50319
(515) 281-7781

Kansas
Radiation Control Program
Bureau of Air Quality and Radiation Control
Kansas Department of Health and Environment
Forbes Field, Building 740
Topeka, KS 66620
(913) 296-1560

Kentucky
Radiation Control Branch
Division of Radiation and Product Safety
Department of Health Services
Cabinet for Human Resources
275 East Main Street
Frankfort, KY 40621
(502) 564-3700

Louisiana
Louisiana Nuclear Energy Division
P.O. Box 14690
Baton Rouge, LA 70898
(504) 925-4518

Maine
Indoor Air Program
Division of Health Engineering
Maine Department of Human Services
State House Station 10
Augusta, ME 04333
(207) 289-3826

Maryland
Center for Radiological Health
Maryland Department of Environment
2500 Broening Highway
Baltimore, MD 21224
(301) 631-3300
(800) 872-3666

Massachusetts
Radiation Control Program
Massachusetts Department of Public Health
23 Service Center
North Hampton, MA 01060
(413) 586-7525 or
In Boston, Robert Hallisey
(617) 727-6214

Michigan
Division of Radiological Health
Michigan Department of Public Health
3423 North Logan
P.O. Box 30195
Lansing, MI 48909
(517) 335-8190

Minnesota
Section of Radiation Control
Environmental Health Division
Minnesota Department of Health
717 Delaware Street, S.E.
P.O. Box 9441
Minneapolis, MN 55440
(612) 623-5348

Mississippi
Division of Radiological Health
Mississippi Department of Health
3150 Lawson Street
P.O. Box 1700
Jackson, MS 39215
(601) 354-6657

Missouri
Bureau of Radiological Health
Missouri Department of Health
1730 E. Elm
P.O. Box 570
Jefferson City. MO 65102
(314) 751-6083
(800) 669-7236 (in State)

Montana
Occupational Health Bureau
Montana Department of Health and Environmental Sciences
Cogswell Building, A113
Helena, MT 59620
(406) 444-3671

Nebraska
Division of Radiological Health
Nebraska Department of Health
301 Centennial Mall South
P.O. Box 95007
Lincoln, NE 68509
(402) 471-2168

Nevada
Radiological Health Section
Health Division
Nevada Department of Human Resources
505 E. King Street
Carson City, NV 89710
(702) 885-5394

New Hampshire
Bureau of Radiological Health
Division of Public Health Services
Health and Welfare Building
6 Hazen Drive
Concord, NH 03301
(603) 271-4674

New Jersey
Radiation Protection Element
New Jersey Department of Environmental Protection
729 Alexander Road
Princeton, NJ 08540
(609) 987-6402
(800) 648-0394 (in State)

New Mexico
Radiation Licensing and Registration Section
New Mexico Environmental Improvement Division
1190 St. Francis Drive
Sante Fe, NM 87504
(505) 827-2940

New York
Bureau of Environmental Radiation Protection
New York State Health Department
2 University Plaza
Albany, NY 12237
(518) 458-6450
(800) 458-1158 (in State)
(800) 342-3722 (NYSEO) Training Information

N. Carolina
Radiation Protection Section
Division of Facility Services
North Carolina Department of Human Resources
701 Barbour Drive
Raleigh, NC 27603
(919) 733-4283

N. Dakota
North Dakota Department of Health
Missouri Office Building
1200 Missouri Avenue
Room 304
P.O. Box 5520
Bismark, ND 58502
(701) 224-2348

Ohio
Radiological Health Program
Ohio Department of Health
1224 Kinnear Road
Suite 120
Columbus, OH 43212
(614) 644-2727
(800) 523-4439 (in State)

Oklahoma
Radiation and Special Hazards Service
Oklahoma State Department of Health
P.O. Box 53551
Oklahoma City, OK 73152
(405) 271-5221

Oregon
Oregon State Health Department
1400 S.W. 5th Avenue
Portland, OR 97201
(503) 229-5797

Pennsylvania
Pennsylvania Department of Environmental Resources
Bureau of Radiation Protection
P.O. Box 2063
Harrisburg, PA 17120
(717) 787-2480
(800) 23-RADON (in State)

Puerto Rico
Puerto Rico Radiological Health Division
G.P.O. Call Box 70184
Rio Piedras, PR 00936
(809) 767-3563

Rhode Island
Division of Occupational Health and Radiation
Rhode Island Department of Health
206 Cannon Building
75 Davis Street
Providence, RI 02908
(401) 277-2438

S. Carolina
Bureau of Radiological Health
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
(803) 734-4700/4631

S. Dakota
Division of Air Quality and Solid Waste
South Dakota Department of Water and Natural Resources
Joe Foss Building, Room 217
523 E. Capital
Pierre, SD 57501
(605) 773-3153

Tennessee
Division of Air Pollution Control
Bureau of Environmental Health
Department of Health and Environment
Custom House
701 Broadway
Nashville, TN 37219
(615) 741-4634

Texas
Bureau of Radiation Control
Texas Department of Health
1100 West 49th Street
Austin, TX 78756
(512) 835-7000

Utah
Bureau of Radiation Control
Utah State Department of Health
288 North, 1460 West
P.O. Box 16690
Salt Lake City, UT 84116
(801) 538-6734

Vermont
Division of Occupational and Radiological Health
Vermont Department of Health
10 Baldwin Street
Montpelier, VT 05602
(802) 828-2886

Virginia
Bureau of Radiological Health
Department of Health
109 Governor Street
Richmond, VA 23219
(804) 786-5932
(800) 468-0138 (in State)

Virgin Islands
Division of Environmental Protection
Department of Planning and Natural Resources
179 Altona and Welgunst
Charlotte, Amalie, V.I. 00801

Washington
Environmental Protection Section
Washington Office of Radiation Protection
Thurston AirDustrial Center
Building 5, Mail Stop LE-13
Olympia, WA 98504
(206) 586-3303
(800) 323-9727 (in State)

W. Virginia
Industrial Hygiene Division
West Virginia Department of Health
151 11th Avenue
South Charleston, WV 25303
(304) 348-3526/3427

Wisconsin
Radiation Protection Section
Division of Health
Wisconsin Department of Health and Social Services
5708 Odana Road
Madison, WI 53719
(608) 273-5180

Wyoming
Radiological Health Services
Wyoming Department of Health and Social Services
Hathway Building, 4th Floor
Cheyenne, WY 82002
(307) 777-6015

EPA Regional Radiation Offices

EPA Region 1
JFK Federal Building
Boston, MA 02203
(617) 565-3234

EPA Region 2
26 Federal Plaza
New York, NY 10276
(212) 264-4418

EPA Region 3
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-4084

EPA Region 4
345 Courtland St. N.E.
Atlanta, GA 30365
(404) 347-3907

EPA Region 5
230 South Dearborn Street
Chicago, IL 60604
(312) 353-2205

EPA Region 6
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-7208

EPA Region 7
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2893

EPA Region 8
999 18th Street
Denver Place, Suite 500
Denver, CO 80202-2413
(303) 293-1709

EPA Region 9
215 Fremont Street
San Fransisco, CA 94105
(415) 974-8378

EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-7660

For information on which EPA Region your state is in, see below.

Alabama...........4
Alaska...........10
Arizona...........9
Arkansas..........6
California........9
Colorado..........8
Connecticut.......1
Delaware..........3
District of Columbia.......3
Florida...........4
Georgia...........4
Hawaii............9
Idaho............10
Illinois..........5
Indiana...........5
Iowa..............7
Kansas............7
Kentucky..........4
Louisiana.........4
Maine.............1
Maryland..........3
Massachusetts.....1
Michigan..........5
Minnesota.........5
Mississippi.......4
Missouri..........7
Montana...........8
Nebraska..........7
Nevada............9
New Hampshire.....1
New Jersey........2
New Mexico........6
New York..........2
North Carolina....4
North Carolina..........4
North Dakota............8
Ohio....................5
Oklahoma................6
Oregon.................10
Pennsylvania............3
Rhode Island............1
South Carolina..........4
South Dakota............8
Tennessee...............4
Texas...................6
Utah....................8
Vermont.................1
Virginia................3
Washington.............10
West Virginia...........3
Wisconsin...............5
Wyoming.................8