Territory of Guam
Teritorion Guam

OFFICE OF THE GOVERNOR
UFISINAN I MAGA'LAHI
AGANA, GUAM 96910 U.S.A.

6-12-90

JUN 06 1990

The Honorable Joe T. San Agustin
Speaker, Twentieth Guam Legislature
155 Herman Cortez Street
Agana, Guam 96910

Dear Mr. Speaker:

Transmitted herewith is Bill No. 1127, which I have signed into law this date as Public Law No. 20-184.

Sincerely,

JOSEPH F. ADA
Governor of Guam

Attachment

TWENTIETH GUAM LEGISLATURE
1990 (SECOND) Regular Session

CERTIFICATION OF PASSAGE OF AN ACT TO THE GOVERNOR

This is to certify that Substitute Bill No. 1127 (LS), "AN ACT TO CREATE A TASK FORCE TO STUDY THE EXTENT OF AND TO REDUCE THE EXPOSURE FROM RADON CONTAMINATION IN SCHOOL BUILDINGS ON GUAM, AND TO APPROPRIATE TWO HUNDRED FIFTY THOUSAND DOLLARS THEREFOR, SUBJECT TO REIMBURSEMENT BY FEDERAL FUNDS," was on the 23rd day of May, 1990, duly and regularly passed.

JOE T. SAN AGUSTIN
Speaker

Attested:

HERMINIA D. DIERKING
Senator and Acting Legislative Secretary

This Act was received by the Governor this 30th day of May, 1990, at 11:30 o'clock A.m.

Therese F. Duenas
Assistant Staff Officer
Governor's Office

APPROVED:

JOSEPH F. ADA
Governor of Guam

Date: June 6, 1990

Public Law No. 20-184

TWENTIETH GUAM LEGISLATURE
1990 (SECOND) Regular Session

Bill No. 1127 (LS)
Substitute

Introduced by:

M. D. A. Manibusan
M. C. Ruth
E. M. Espaldon
A. R. Unpingco
E. R. Duenas
T. V. C. Tanaka

AN ACT TO CREATE A TASK FORCE TO STUDY THE EXTENT OF AND TO REDUCE THE EXPOSURE FROM RADON CONTAMINATION IN SCHOOL BUILDINGS ON GUAM, AND TO APPROPRIATE TWO HUNDRED FIFTY THOUSAND DOLLARS THEREFOR, SUBJECT TO REIMBURSEMENT BY FEDERAL FUNDS.

BE IT ENACTED BY THE PEOPLE OF THE TERRITORY OF GUAM:

Section 1. The Directors of the Department of Education, the Guam Environmental Protection Agency, the Department of Public Health and Social Services, and the Department of Public Works are hereby members of the Radon Contamination Task Force, with the director of the Guam Environmental Protection Agency to serve as chairman. Such Task Force shall define appropriate specifications for a study of school buildings to determine the location and extent of radon contamination and mitigation measures necessary to reduce the exposure of school children and staff to unsafe levels of radon. The Task Force shall, if necessary, contractually retain specialists who have documented expertise in conducting tests and in determining mitigation measures, and shall apply for assitance from any federal programs which are available. Comprehensive testing of Guam's schools shall commence no later than six (6) months following enactment of these provisions, and shall be completed within one (1) year. A report including recommendations for correcting any contamination problems shall be prepared and submitted to the Governor and to the Legislature no later than six (6) months after completion of the testing.

Section 2. Two Hundred Fifty Thousand Dollars ($250,000) are hereby appropriated from the General Fund to the Guam Environmental Protection Agency, which shall be the lead agency of the Radon Contamination Task Force, and which shall manage the funds therefor in accordance with Section 1 of this Act. Such appropriation shall remain available until expended.

Section 3. Funds recovered from the federal government for radon testing purposes shall reimburse the General Fund for amounts expended pursuant to this Act, up to Two Hundred Fifty Thousand Dollars ($250,000).

TWENTIETH GUAM LEGISLATURE
1989 (FIRST) Regular Session

ROLL CALL SHEET

Bill No. 1127 Date: 5/23/90

Resolution No. ____

QUESTION: ______________________

	AYE	NAY	NOT VOTING	ABSENT
J. P. Aguon	✓			
E. P. Arriola				✓
J. G. Bamba	✓			
M. Z. Bordallo	✓			
D. F. Brooks	✓			
H. D. Dierking	✓			
E. R. Duenas	✓			
E. M. Espaldon	✓			
C. T. C. Gutierrez	✓			
P. C. Lujan	✓			
G. Mailloux	✓			
M. D. A. Manibusan	✓			
T. S. Nelson	✓			
D. Parkinson	✓			
F. J. A. Quitugua	✓			
E. D. Reyes	✓			
M. C. Ruth	✓			
J. T. San Agustin	✓			
F. R. Santos	✓			
T. V. C. Tanaka	✓			
A. R. Unpingco	✓			
	20			1

Senator Madeleine Z. Bordallo

Chairperson, Committee on Health, Welfare & Ecology
Twentieth Guam Legislature

VICE CHAIRPERSON:

COMMITTEE ON HOUSING & COMMUNITY DEVELOPMENT

COMMITTEE ON ECONOMIC DEVELOPMENT

MEMBER:

Committee on Energy, Utilities & Consumer Protection

Committee on General Governmental Operations

Committee on Justice, Judiciary & Criminal Justice

Committee on Youth, Human Resources, Senior Citizens & Cultural Affairs

Committee on Rules

Legislative Member Commission on Self-Determination

May 23, 1990

The Honorable Joe T. San Agustin
Speaker, Twentieth Guam Legislature
163 Chalan Santo Papa
Agana, Guam 96910

Dear Mr. Speaker:

The Committee on Health, Welfare and Ecology , to which was referred Bill No. 1127: **"AN ACT TO ESTABLISH A TASK FORCE TO CONDUCT A STUDY TO DETERMINE THE EXTENT OF RADON CONTAMINATION IN THE SCHOOL BUILDINGS ON GUAM AND TO DETERMINE THE NECESSARY MEASURES TO REDUCE RADON EXPOSURE"**, does recommend that the Bill be Passed by the Twentieth Guam Legislature.

Votes of committee members are as follows:

To Pass	12
To Not Pass	0
To Report Out Only	0
To The Inactive File	0
Abstained	0
Off-Island	0
Not Available	0

Respectfully submitted,

Madeleine Z. Bordallo

MADELEINE Z. BORDALLO

Enclosures

163 Chalan Santo Papa • P.O. Box CB-1 Agana, Guam 96910 • Tel: 472-3425/3426/3427

COMMITTEE ON HEALTH, WELFARE AND ECOLOGY

REPORT ON BILL NO. 1127

"AN ACT TO ESTABLISH A TASK FORCE TO CONDUCT A STUDY TO DETERMINE THE EXTENT OF RADON CONTAMINATION IN THE SCHOOL BUILDINGS ON GUAM AND TO DETERMINE THE NECESSARY MEASURES TO REDUCE RADON EXPOSURE"

PREFACE

A Public Hearing on Bill No. 1127 was conducted by the Committee on Health, Welfare and Ecology on **February 13, 1990 at 2:00 p.m. in the Legislative Session Hall.**

Members Present: Health Committee Chairperson Senator Madeleine Z. Bordallo, Senators Pilar C. Lujan and Martha C. Ruth.

Witnesses Heard: Mr. Fred M. Castro, Administrator Guam Environmental Protection Agency; Mr. James L. Canto, GEPA and Mr. Vince Leon Guerrero, Department of Education.

Written Testimony: Mr. Fred M. Castro, GEPA Administrator; and Ms. Anita A. Sukola, Director, Department of Education.

SUMMARY OF TESTIMONY

Initial screening (Phase I) is currently underway at 17 Guam schools. Preliminary results show the presence of radon is some rooms. The USEPA limit is 4 picocuries per liter of air (4pCi/L).

Funds for further testing (Phase II) are needed. Federal funds of $23,000 has been applied for, but it is not known what services can be obtained with this amount. Also, the bill proposes to begin mitigation efforts, which include construction, building alteration, and air conditioning. Present plans for air conditioning installation in schools are for 20% increments per year.

A estimated cost breakdown, length of each phase and uses of Federal and local funds was requested by the chairperson during the hearing.[Both the Dept. of Education and Guam EPA prefer to work together on assesing radon in schools, rather than to work through a task force.]

COMMITTEE FINDINGS/RECOMMENDATIONS

The Committee finds that radon gas exists on Guam, so testing is highly advised. Funding for mitigation is premature, however, until the problem is accurately assesed through Phase II testing and cost-effective remedies are posited.

The Committee therefore substitutes Bill No. 1127, and **recommends Bill No. 1127, as Substituted by the Committee to be Passed** by the Twentieth Guam Legislature.

ATTACHMENTS

1. Voting Sheet on Bill No. 1127.
2. Bill No. 1127.
3. Letter by Mr. Fred Castro, Administrator GEPA, dated 3/27/90.
4. Testimony by Mr. Fred M. Castro, Administrator GEPA.
5. Testimony by Ms. Anita S. Sukola, Director DOE.
6. Information Paper on Radon by the American Cancer Society.
7. Radon in Schools by the United States EPA.
8. Article in The American School Board Journal dated November 1989 "Controlling the Radon Threat".
9. "Radon Measurements in Schools: An Interim Report", prepared by the United States EPA, March 1989.
10. Fiscal Note on Bill No. 1127.
11. Committee Member Attendance Sheet.
12. Witness Attendance Sheet .

COMMITTEE ON HEALTH, WELFARE AND ECOLOGY

VOTING SHEET

ON BILL NO. 1127

"AN ACT TO ESTABLISH A TASK FORCE TO CONDUCT A STUDY TO DETERMINE THE EXTENT OF RADON CONTAMINATION IN THE SCHOOL BUILDINGS ON GUAM AND TO DETERMINE THE NECESSARY MEASURES TO REDUCE RADON EXPOSURE"

COMMITTEE MEMBER	TO PASS	NOT TO PASS	TO REPORT OUT ONLY	TO PLACE IN INACTIVE FILE
MADELEINE Z. BORDALLO Chairperson	✓			
GORDON MAILLOUX Vice-Chairperson	✓			
ELIZABETH P. ARRIOLA Member	✓			
HERMINIA D. DIERKING Member	✓			
PILAR C. LUJAN Member	✓			
TED S. NELSON Member	✓			
EDWARD D. REYES Member	✓			
ERNESTO ESPALDON Member	✓			
MARILYN D.A. MANIBUSAN Member	✓ 5/23/90			
MARTHA C. RUTH Member	✓ 5/23/90			
TOMMY TANAKA Member	✓			
ANTONIO R. UNPINGCO Member	✓			

TWENTIETH GUAM LEGISLATURE
1989 (FIRST) Regular Session

Introduced
DEC 28 '89

Bill No. 1127(LS)

Introduced by: M. Manibusan

AN ACT TO ESTABLISH A TASK FORCE TO CONDUCT A STUDY TO DETERMINE THE EXTENT OF RADON CONTAMINATION IN THE SCHOOL BUILDINGS ON GUAM AND TO DETERMINE THE NECESSARY MEASURES TO REDUCE RADON EXPOSURE.

BE IT ENACTED BY THE PEOPLE OF THE TERRITORY OF GUAM:

Section 1. There is hereby established a Radon Testing and Mitigation Task Force to be composed as follows:

1. The Director of Guam Environmental Protection Agency or his designee.
2. The Director of Education or her designee.
3. The Director of Public Health and Social Services or her designee.
4. The Director of Public Works or his designee.
5. Specialists selected by the above four persons who have the necessary expertise to conduct the testing and assist in determining the measures to mitigate the radon contamination. Such specialists not to exceed five (5) persons.

Section 2. The "Task Force" shall be aware and take advantage of any federal programs which provide assistance.

Section 3. Not later than six months after the date of the enactment of this statute, the "Task Force" shall establish a program to test sample the Guam Schools. The testing shall be completed not later than one year after the date of this enactment.

Section 4. The "Task Force" shall after completion of the necessary testing prepare a report with recommendations for correcting contamination problems and submit the report to the Governor with information copy to the Legislature. This report shall be done in an expeditious manner and in no case later than six months after completing the testing.

Section 5. The sum of five hundred thousand dollars ($500,000) is hereby appropriated for funding this Radon Testing and Mitigation Task Force.

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GUAM ENVIRONMENTAL PROTECTION AGENCY

AHENSIAN PRUTEKSION LINA'LA GUAHAN

D-107 Harmon Plaza, 130 Rojas St., Harmon, Guam 96911 Tel. No. 646-8863/5 FAX: 646-9402

MAR 27 1990

MAR 27 1990

Honorable Madeleine Z. Bordallo
Chairperson
Committee on Health, Welfare and Ecology
Twentieth Guam Legislature
163 Chalan Santo Papa
Post Office Box CB-1
Agana, Guam 96910

Dear Senator Bordallo:

The purpose of this letter is to provide your Office with information regarding costs, timeframes and available funding sources for radon monitoring/remediation activities within the public school system as proposed under Bill No. 1127.

After discussions with the Department of Education (DOE), it is our understanding that DOE is willing to conduct long-term radon monitoring within the public school system utilizing in-house personnel resources. Based upon Mainland school statistics, costs for implementing similar radon monitoring activities in school systems using school personnel are approximately $1,500 per school. Considering increased costs owing to the type of radon monitoring device purchased, shipment of these devices to Guam or purchase from local retailers, this cost may be 50% higher on Guam. Therefore, the cost for long-term radon monitoring of Guam's public school system utilizing in-house school personnel, may be as high as $2,250 per school. Since there are thirty-five (35) schools in the public school system, the total anticipated cost for implementing long-term radon monitoring may be $78,750.

The timeframe for implementing long-term radon monitoring activities within public schools must coincide with the actual school year when students are in attendance. Monitoring during summer months when schools are vacant or minimally utilized will not give accurate data on radon levels. Interim protocols, developed by U.S.E.P.A. for school radon monitoring activities, recommend monitoring of radon levels over a full school year to determine the annual average radon levels in classrooms. Since this protocol is based upon seasonal variations affecting Mainland schools, it is our opinion that shorter monitoring periods may be appropriate for Guam's schools as long as the monitoring is conducted during portions of both the wet and dry seasons. We feel that long-term radon monitoring of Guam's schools should be three to six months in duration. Based upon this consideration, as well as the time required for purchase of the radon monitoring devices and training of school personnel in their use, it is our feeling that implementation of radon monitoring in public schools is not realistic for this school year. Our recommended timeframe for this monitoring should occur during the 1990-1991 school year.

Regarding anticipated costs to develop remediation recommendations to reduce radon levels in school buildings, it is not possible to approximate these costs. A qualified radon remediation contractor will be required to assess each school building in conjunction with long-term radon monitoring data collected from classrooms. These assessments include evaluation of each building structure, foundation, air conditioning system and will involve short-term monitoring to pinpoint radon entry areas into buildings. To the best of our knowledge, there are presently no qualified radon remedial contractors on-island. A qualified contractor will have to be contracted from off-island and may spend several months, following completion of long-term radon monitoring efforts, to assess all the public school buildings on Guam. Based upon these assessments, remediation recommendations can be developed for each school to reduce radon levels. The costs for these remediation assessments and development of recommendations are anticipated to be substantial.

We are only aware of U.S.E.P.A. grants as funding sources to conduct radon monitoring and remediation activities. However, these grants are available to states and insular areas to establish radon programs which encompass radon assessment, problem response, and public education activities. As previously stated to you and the health committee, the Guam E.P.A. has applied for an E.P.A. radon grant to establish a radon program on Guam. This grant will enable our Agency to purchase radon monitoring equipment to determine radon levels within all private schools on Guam utilizing our present staff resources. Additionally, it will provide our Agency with some contract funds to survey radon levels in a representative sample of residential homes on-island. It is our understanding that these grant funds are limited and are not guaranteed from year to year.

As we indicated in our testimony, we are supportive of the intent of Bill No. 1127. We are particularly supportive of the funding level proposed to be allocated to radon monitoring and remediation activities under this Bill. Since it is not presently possible to accurately determine the costs for development of remedial recommendations by a specialized radon contractor, we suggest that the proposed funding level remain at $500,000 to cover this cost, as well as the anticipated cost for radon monitoring.

Should you have any questions or require further clarification, please contact my Office as soon as possible.

Sincerely,

FRED M. CASTRO
Administrator

CC: Director, DOE

GUAM ENVIRONMENTAL PROTECTION AGENCY
AHENSIAN PRUTEKSION LINA'LA GUAHAN
D-107 Harmon Plaza, 130 Rojas St., Harmon, Guam 96911 Tel. No. 646-8863/5 FAX: 646-9402

FEB 13 1990

Senator Madeleine Z. Bordallo
Chairperson
Committee on Health, Welfare and Ecology
Twentieth Guam Legislature
P.O. Box CB-1
Agana, Guam 96910

Subject: Testimony on Bill 1127

Dear Senator Bordallo:

We have reviewed Bill No. 1127 proposing the establishment of a task force comprised of representatives from several Government of Guam departments and technical experts for the purpose of implementing radon monitoring and remediation measures in Guam's schools. The Bill further allocates $500,000 to the task force for these activities. Although we are supportive of the basic intent of this Bill, particularly the funding for radon testing and remediation, we feel that these activities can be more effectively carried forth through joint efforts between the Guam E.P.A. and Department of Education, rather than through a task force.

As you may be aware, the Guam E.P.A. and Department of Education have already jointly undertaken short-term radon screening tests in half of Guam's public schools. This is a necessary first step in accordance with Federal E.P.A. interim protocol to identify radon problems in schools. The second step in testing activities of this nature is to implement long-term monitoring of at least a full school year to further define the extent of school radon problems. Discussion between the Guam E.P.A. and Department of Education have identified two possible options in this regard. One of these options is to contract with a private consultant to conduct long-term monitoring. To the best of our knowledge, there are no on-island consultants which can provide these long-term monitoring services. The second option is to have available school personnel to conduct this testing, after training and under Guam E.P.A. guidance. Based upon Mainland school statistics, costs for long-term radon monitoring are approximately $1,500 per school.

Our on-going effort within the local government is consistent or closely aligned with national developments on radon mitigation in schools. It is a matter of great concern but we must not as a community be unnecessarily alarmed. We must facilitate and maintain a forward direction towards mitigating the problems with radon and safeguarding our Island's schools as a matter of high priority. Bill 1127 allows for the much needed next step. The Guam Environmental Protection Agency is fully committed to continuing our joint cooperative efforts with the Department of Education.

Sincerely,

FRED M. CASTRO
Administrator

OFFICE OF THE DIRECTOR
DEPARTMENT OF EDUCATION
GOVERNMENT OF GUAM
P.O. BOX DE
AGANA, GUAM 96910
TEL.: 472-8901/2/3/4

ANITA A. SUKOLA
Director of Education

Deputy Director

February 13, 1990

Senator Madeliene Z. Bordallo
Chairperson,
Committee on Health, Welfare and Ecology
Twentieth Guam Legislature
P.O. Box CB-1
Agaña, Guam 96910

Testimony on Bill 1127

Dear Senator Bordallo:

We have reviewed Bill 1127 which establishes a Task Force of Government of Guam agencies to address the problem of monitoring radon gas and implementing remediation efforts to reduce radon gas in our schools and which also appropriates $500,000 to implement the legislation.

The Department of Education (DOE) agrees with the intent of Bill 1127, however, in consultation with the Guam Environmental Protection Agency (GEPA), we concur with their position that a small task force, comprised of GEPA and DOE would be adequate to quickly address the intent of Bill 1127. If consultation and assistance from other departments are necessary, we feel that the current level of inter-agency cooperation will be adequate without having to formally involve them in a task force. As you know, the more members a task force has, the more difficult it is to coordinate and schedule meetings, since we each have many responsibilities to meet.

In cooperation with the Guam Environmental Protection Agency, the Department of Education is fully committed to addressing the problem of radon gas in the public schools of Guam. Any assistance from the Legislature in this regard will be greatly appreciated.

ANITA A. SUKOLA

AMERICAN CANCER SOCIETY
CANCER RESPONSE SYSTEM – 646 9885 KRISTY Anderson
Printed On: 11/28/89
1-800-ACS-2345

Number 2640 Date Reviewed 08/24/89

RADON

Radon is a colorless and odorless gas produced naturally by the radioactive decay of uranium in soil. National attention continues to focus on radon in indoor air in homes, and the environmental risk it carries for causing human lung cancer.

The results of continuing surveys of radon levels in U.S. homes have recently been released by the U.S. Environmental Protection Agency (EPA). They increase our understanding of the extent of this problem, and they suggest that the distribution of homes with excessive radon levels at which remedial action may be necessary (over 4 pico curies/liter by current EPA advisories) may be wider than previously thought. Earlier studies had focused on several northeastern states, particularly in regions where granite/shale soils are prevalent (soils in which uranium concentration are more likely to be found). The most recent EPA surveys suggest that increased radon levels may be encountered with equal frequency in states elsewhere, especially in the north central region of the country.

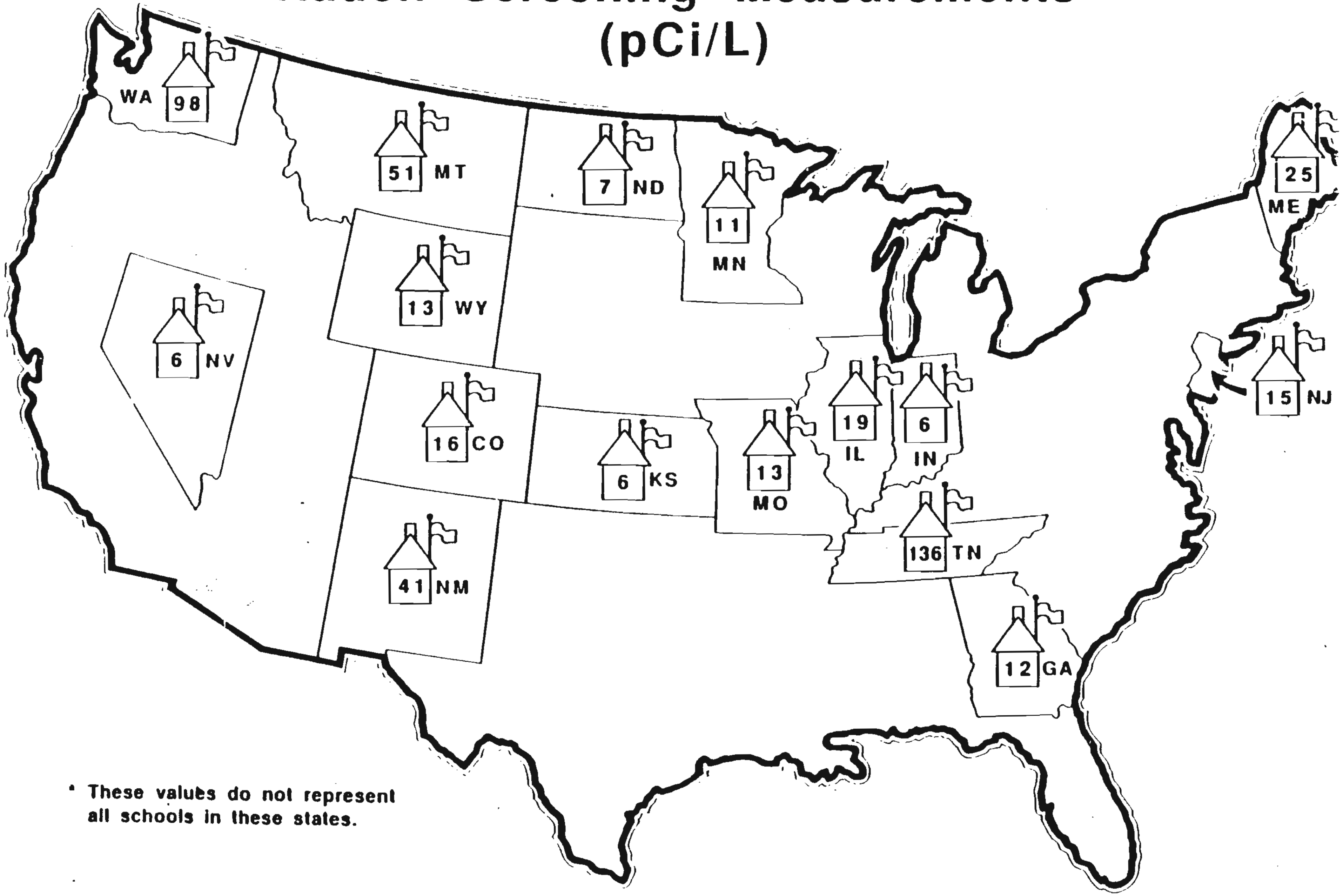
Exact levels of lung cancer risk remain uncertain, although at levels substantially higher than 4 pico curies/liter, and particularly for cigarette smokers, the risk can be considerable. A new study issued in August of 1989 by the New Jersey State Department of Health found that radon levels 50% below the minimum federal standard of 4 picocuries can still be blamed for lung cancer among New Jersey residents who have lived under such conditions for at least 10 years.
The New Jersey study is the first of its kind, and will need further validation. However, it is important to note that if possible, a reduction of risks, including the cessation of smoking, is recommended.
Uncertainties arise both from the complexities of the risk assessment process and from the variable conditions under which radon levels in homes are measured (basement versus upstairs air, sensitivity of measuring devices, duration of air sampling, time of year, etc.) The American Cancer Society is currently supporting research on more accurate methods for personal exposure monitoring.
At the present time the ACS has issued no specific recommendation regarding home radon testing or remedial actions to be taken with respect to this environmental risk. If people are concerned, they should consider testing their homes. They can obtain information regarding testing and remediation from the EPA or from state and local governmental agencies. As a practical matter, reduction of radon levels in home air involves both adequate home ventilation and sealing crack in basements and foundations through which radon gas may seep from soil. Of great importance, of course, is the fact that cigarette smoking considerably magnifies risk of lung cancer from radon exposure (on the order of ten fold). Cessation of smoking, especially where excess radon levels may exist, should be strongly urged.
State and local offices of the EPA will provide names of reputable companies that perform radon testing and renovations. EPA offices also distribute two free booklets--A Citizen's Guide to Radon: What It Is and What to Do About It, and Radon Reduction Methods: A Homeowner's Guide. You can write for copies to the EPA Public Information Center, 401 M Street S.W., Washington, D.C. 20460. If you need help finding a local or state office, call the EPA at 202-475-9605.

REFERENCES:
ACS Background Paper, November 1986.
ACS, DE-14, September 16, 1988
Amy Stone, Science Editor, August 24, 1989

RADON IN SCHOOLS

- Elevated Radon Levels Found In Schools Throughout the U.S.
- Radon May be Especially Hazardous to Children
- Schools Should be Tested for Radon
- EPA is Releasing Guidance for Measuring Radon in Schools
- Radon is a Fixable Problem in Schools
- Protect Children by Reducing Radon in Both Schools and Homes

Highest Schoolroom Radon Screening Measurements* (pCi/L)



* These values do not represent all schools in these states.

SCHOOL PROTOCOL DEVELOPMENT STUDY SCREENING RESULTS

No. States	16
No. Schools	130
No. Rooms	3000
Rooms > 4 pCi/L	19 percent
Rooms > 20 pCi/L	3 percent
Schools with at least 1 Room > 4 pCi/L	54 percent
Highest Level Found	136 pCi/L

Radon Facts

no. 1

SOURCES AND CHARACTERISTICS OF RADON

Radon is an invisible, odorless, radioactive gas produced by the decay of uranium in rock and soil. Radon decays into radioactive particles which, if inhaled, may cause damage to lung tissues and increase the risk of lung cancer.

- As uranium decays, it produces radium, which in turn releases radon gas. Once released, radon migrates through permeable rocks and soil, eventually escaping into the atmosphere or into buildings.

- High levels of naturally occurring radon are most likely to occur where there are significant amounts of uranium in the ground. Radon may also be found in areas contaminated by activities such as uranium or phosphate mining.

- Soils can also be a source of radon and are the medium through which radon travels. Soil permeability plays an important role in determining whether or not radon will be able to move indoors.

- Radon gas can seep into a home through cracks in the foundation, areas around drainage pipes, sump pumps, and other openings in the foundation or walls.

- When radon gas decays, it gives off radioactive products. These decay products pose the real health threat. Unlike radon gas, radon decay products are solid particles which can remain in the lungs. When the trapped particles decay, the surrounding lung tissue is damaged.

- Radon levels greater than 4 pCi/L have been documented in every state surveyed.

- Available data indicate that perhaps 10% or up to 8 million of the houses in the United States may have annual average radon levels reaching or exceeding 4 pCi/L.

- Virtually every house in the United States has some level of radon gas in its air (estimates suggest that average annual indoor levels range between about 1 to 2 pCi/L). Most homes, however, will not have high enough levels to require reduction efforts.

Radon Facts

- The only way to be certain about radon levels is to test.
- EPA has developed "A Citizen's Guide to Radon" to provide homeowners with facts about radon, to help them measure radon in their homes, and to help them evaluate their personal risk should they find elevated levels.

Radon Facts

no. 2

RADON RISK ASSESSMENT

To account for uncertainty, scientists generally express the risks associated with a particular radon level as a range of numbers. The risk estimates given in "A Citizen's Guide to Radon" are based on the advice of EPA's Science Advisory Board, an independent group of scientists.

- o Radon risk estimates are based on epidemiological studies of underground miners exposed to varying levels of radon. Consequently, the amount of certainty scientists feel about the risk estimates for radon is considerably more than if they had to rely on animal studies alone.

- o An increased risk of lung cancer is the only known health effect associated with exposure to elevated radon levels.

- o The health risk is posed not by the radon gas itself, but by the short-lived radon decay products, which can be inhaled and trapped in a person's lung. As these decay products break down, they release small bursts of energy which can damage lung tissues and lead to lung cancer.

- o EPA estimates that about 20,000 lung cancer deaths a year in the United States may be attributed to radon. (The American Cancer Society expects that about 155,000 people will die of lung cancer from all causes in 1989. The Surgeon General attributes roughly 85% of all lung cancer deaths to smoking.)

- o Risk of lung cancer from radon exposure depends on both the concentration of radon and duration of exposure.

- o EPA's risk assessments assume an individual is exposed to a given concentration of radon over a lifetime of roughly 70 years, and spends 75% of his or her time in the home.

Radon Facts

RADON IN SCHOOLS

As with residential structures, radon may become trapped in buildings such as schools. The Superfund Amendments and Reauthorization Act (SARA) requires EPA to assess radon levels present in "structures where people normally live or work, including educational institutions." The Indoor Radon Abatement Act also requires EPA to conduct a study of the nation's schools. EPA considers radon in schools to be a high priority because:

- o High levels of radon gas can occur in classrooms. Schoolrooms with radon levels greater than 4 pCi/L have been found in many States throughout the U.S.
- o Studies from the atom bomb experience suggest that children may be more susceptible to harm from certain types of radiation.
- o Exposure to elevated radon levels early in life may increase a child's risk of lung cancer.
- o Problems in schools are likely to be in specific building areas such as ground floor classrooms.
- o EPA has successfully reduced classroom radon levels in several States, including Maryland and Virginia, by applying some of the same mitigation techniques as those used in residential structures.
- o EPA has developed interim guidance for measuring radon in schools, and is planning to initiate a national survey of schools in 1990.

Radon Facts

School Protocol Development Study for Radon Measurement in Schools

The objective of this study is to gather data for developing protocols for measuring radon in school buildings. The existing protocol for radon measurement in homes may not be appropriate for schools, which are constructed and occupied differently.

The Environmental Protection Agency (EPA) will work with interested States and school districts to conduct the study in two phases.

The first phase consists of 2-day screening measurements in approximately 100 school buildings. These 100 schools were selected from those school districts and schools which expressed an interest in participating in the study. The final selection was based on certain criteria (e.g., proximity to areas with homes exceeding the Agency's guideline of 4 pCi/L, school size, location). Screening measurements were made in each participating school using charcoal canisters placed in all regularly occupied rooms that were in contact with the ground. The measurements were taken during a weekend with the HVAC systems operating as they normally would during the week.

The second and more in-depth phase of the study will be conducted subsequently on a subset of the schools screened in Phase I, focusing on those schools and districts where high levels of radon were found. Four schools in each of five school districts (20 schools) will be selected and tested using both short-term (2-day) and long-term (3 months, year-long) radon measurements.

In Phase II, EPA will investigate several factors critical to designing the school protocol. These factors include the relationship between radon levels and room location, building structure, weather conditions, and the influence of heating and ventilation systems. Also important are the relationship of short-term to long-term measurements, the relationship of these measurements to the radon levels actually present during school hours, and the existence of a correlation (if any) in radon levels between rooms. EPA wants to determine if less than 100 percent of the rooms in a school can be tested to characterize radon levels accurately.

Radon Facts

SUMMARY OF INTERIM REPORT- RADON MEASUREMENT IN SCHOOLS

o EPA has developed an interim report, Radon Measurements in Schools, to assist school officials in conducting radon measurements. The report is available from State Radiation Control offices or EPA Regional Radiation offices (see Fact Sheet No. 21).

o The interim report contains facts about radon and the health risks associated with radon exposure. It summarizes what is known about radon in schools and provides guidance for conducting radon measurements. It also describes how to interpret the measurement results and suggests techniques that can be used to reduce elevated radon concentrations.

o The interim report outlines two suggested options for conducting a radon screening measurement:

1) Two-day charcoal canister measurements on the weekend with ventilation systems operating continuously.

2) Three month alpha track detectors.

Other devices are also available for use by school officials and are described in the "Indoor Radon and Radon Decay Product Measurement Protocols," USEPA (EPA/520-89-006).

o EPA recommends testing for radon in all below-ground and ground level rooms which are frequently used. This would include classrooms, office areas, libraries, gymnasiums, and cafeterias. Areas such as broom closets and storage rooms need not be tested.

o Radon measurements should be made in the cooler months of the year when doors and windows are most likely to be closed.

o EPA encourages schools to lower their radon levels as much as possible. School officials should recognize that there is still a health risk associated with lifetime exposure to 4 pCi/L and that Congress has set a national goal for indoor radon concentrations of

Radon Facts

SUMMARY OF INTERIM REPORT - RADON MEASUREMENT IN SCHOOLS (CONT.)

outdoor ambient levels . The urgency of remedial action increases as the radon levels increase.

- o If the screening measurement for a room is between 4 and 20 pCi/L we suggest that schools conduct year long measurements to confirm the screening results. If the annual average is still greater than 4, we recommend that schools try to lower these levels within the next several months. If the 2-day screening measurement is 20 or greater, we recommend a follow-up measurement of two days to four weeks to confirm the screening measurements. If the levels are still greater, remedial action should be taken within several weeks to lower the radon levels.

- o EPA is currently conducting further studies to gather data for refining and updating the measurement guidance for schools. The final guidance will be available in Fall/Winter, 1990.

Radon Facts

EPA ASSISTANCE TO SCHOOLS (CONT.)

- Planning a mitigation training program for school officials and contractors from schools where elevated radon levels were found in the initial phase of EPA's school study. EPA is also planning to conduct a limited number of mitigation and classroom training courses throughout the country to educate school officials and contractors about radon measurement and mitigation in schools.

- Implementing a State grants program through which schools can apply for testing and mitigation assistance.

- Planning a national survey of public and private schools to determine the national scope of the radon problem in schools.

- Planning to develop a Radon Potential Map of the United States which will identify potential high radon risk areas in the U.S.

- Developing a program to assist some States in performing surveys of schools in the next winter season. This program will be conducted as part of EPA's existing State/EPA Residential Indoor Radon Survey.

- Collecting school radon data from several commercial radon testing companies and States.

- Developed a radon poster for Junior and Senior High Schools, and an article in Science Teacher Magazine. Radon Division staff have also provided information for additional magazines whose audiences are educators.

- Assisting up to 40,000 students and teachers in schools nationwide to learn about radon as part of the National Geographic Society Kids Network.

Radon Facts

EPA ASSISTANCE TO SCHOOLS

EPA is providing schools with assistance in three major areas: 1) Radon testing , 2) Mitigation, and prevention research and application, and 3) Education. EPA's approach for radon in schools is to help States, communities and school officials identify elevated radon levels and then reduce the radon levels.

The EPA Radon Action Program has provided assistance to schools since 1987. The following is a list of EPA's past, current and planned school activities:

o Completed an extensive study of radon behavior in several different types of school structures in Fairfax County, Virginia. Data from this study indicate that radon concentrations can vary dramatically within a school.

o Developed and released guidance for radon measurements in schools titled *Radon Measurements in Schools.* This document was prepared using data from the Fairfax County study, an additional 70 Fairfax County schools, and over 100 Pennsylvania schools.

o Completed the initial phase of a year-long investigation of radon in schools across the U.S. This study indicates that many schools across the country are likely to have elevated levels of radon. The results of this study will be used to update the interim guidance on schools.

o Provided on-site mitigation assistance to schools in Maryland and Virginia. These initial mitigation studies show that schools can be mitigated using radon reduction techniques similar to those used in homes.

o Publishing a report which describes radon reduction techniques for use in schools.

o Continuing research to refine existing cost-effective techniques for preventing radon entry in new schools and for reducing radon problems in existing schools.

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Controlling the radon threat needn't be another costly nightmare

By Matthew R. Freije

WHEN THE U.S. Environmental Protection Agency (E.P.A.) tested schools across the U.S. for the presence of radon gas, E.P.A. officials didn't expect to find many problems.

They were wrong. Although E.P.A. purposely selected testing areas that were considered unlikely to have high radon levels, 54 percent of the schools tested had at least one unsafe room, and 19 percent of the classrooms measured above 4 picocuries of radon per liter of air (4 pCi/l), the level at which E.P.A. urges remediation. One classroom was measured at 136 pCi/l—comparable to smoking four packs of cigarettes a day.

As a result of its study—which included 3,000 classrooms in 130 schools in 16 states—the E.P.A. last spring urged all schools to conduct tests for radon. E.P.A. now estimates that the radon danger in schools is at least as severe and widespread as it is in homes. In urging that all school buildings be tested, E.P.A.'s voice will add to the clamor of students, parents, and teachers who are demanding that school boards ensure the air they breathe is free of harmful levels of radon.

Eventually, E.P.A.'s finding should inspire a rash of radon-related claims and lawsuits. In one likely type of lawsuit, a student or employee who contracts lung cancer (smokers included) might sue a school system that did not address high radon levels. (You should clarify with your school system's insurance company whether your liability policy excludes radon claims under the general category of either "nuclear hazards" or "pollution," although the courts have yet to reveal how they intend to interpret these exclusions.)

Obviously, the best way to start eliminating any potential radon danger in your schools and to head off possible litigation is to test your schools thoroughly. The prospect of conducting radon tests might send a wave of anxiety through board members who are still up to their necks in asbestos tests and removal.

Matthew R. Freije is president of Alpha-tech, Inc., an Indianapolis company that specializes in radon consulting and testing nationwide.

Fortunately, radon is much easier—and cheaper—to detect and eliminate than asbestos. If you and your administrators are willing to do some homework, you can avoid the pitfalls.

Before you do anything else, make sure you—and the appropriate administrators—read E.P.A.'s *Radon Measurements in Schools: An Interim Report.* The report, published in March 1989 and available from E.P.A.'s regional offices, summarizes information about radon, discusses the problems of measurement in schools, gives details on how detection devices should be placed, and outlines alternatives for reducing radon levels.

Classroom variations

Above all, testing for radon requires thoroughness. Radon levels vary unpredictably among communities, schools, buildings, even classrooms. In E.P.A.'s study, two classrooms separated by only an accordian wall had levels of 22 pCi/l and 2 pCi/l.

This unpredictability stems from a combination of factors—primarily, the strength of the radon source, the radon entry rate, and the amount of ventilation. For example, sandy soil might not contain a strong radon source, but the gas passes through sand much more freely than through other soils, so the entry rate is much faster. Sandy soil also allows radon to be drawn from more distant sources.

To take another example, a school with good ventilation might have rooms that have negative air pressure—that is, an imperceptible vacuum. The increased entry rate of radon caused by the negative pressure might more than offset the benefits of ventilation.

In short, you should consider any room or building in contact with the ground a potential danger zone. If the radon source is strong enough or the entry rate is high enough, even second-floor rooms could be unsafe. E.P.A. emphasizes that the only way to determine radon levels is to test every classroom at or below ground level.

Testing your buildings

Compared to asbestos and some other hazards, testing for radon is easy. Here is an overview, based on my research on the radon industry and interviews with scientists and E.P.A officials. You should begin with a screening test, which involves six steps:

1. *Select a measurement device.* The most commonly used devices for radon screening are charcoal or alpha-track detectors. These small, passive devices are placed in each room, where they "collect" radon for laboratory analysis. Charcoal devices measure over a period of from one to seven days; alpha-track devices measure over a period of from one month to a year. Each type of detector has advantages and disadvantages that you should research and consider before choosing; each also is available in many designs. Some designs are less suitable for a school than others. Using alpha-track devices over a period of several months, for example, runs a high risk of tampering and loss. If the screening test indicates high levels of radon, you should confirm the results with more thorough tests using a combination of charcoal, alpha-track, and other devices.

2. *Select a manufacturer and laboratory.* Be cautious and thorough in choosing the company that manufactures and supplies the devices and the laboratory that analyzes the results. Radon tests can be quite accurate—but that accuracy depends on the detector and laboratory equipment you use. E.P.A. offers a list of companies that have passed its proficiency tests for radon testing. Choose only from firms on that list—but don't expect presence on the list to guarantee quality.

Visit laboratories, if practical, before making your final selection. Ask about the analysis capacity of the lab (how many devices it can analyze per month). If it has a large backlog, your detectors might sit in storage for three or four days or even longer before being tested, which can drastically decrease the accuracy of a charcoal test.

The company's financial stability is also important. Most radon laboratories are small, and even larger firms might be short of cash and unprofitable. If you are sued because of a radon-related health problem, the written report of your test results might be only as credible as the company behind it. If the company no longer exists, its test might seem dubious.

3. *Analyze your buildings and select*

rooms to test. Because radon levels can vary so much from room to room, E.P.A. recommends testing every occupied room at or below ground level. Testing only every other room might alarm the occupants of untested rooms—and might overlook a hot spot. If the school budget won't allow testing every room at once, you can test different rooms over several months. (In some cases, due to economies of scale the total cost might be cheaper if all rooms are measured at once.)

4. *Keep careful records.* For the results to be interpreted correctly (and stand up in court), testers need to keep a logbook that records dates and times of the beginning and end of the test, the serial number and exact location of each detector (drawn on diagrams of the schools and classrooms), plus other details, such as the type of heating system and its operating routine and the existence of a basement or crawl space beneath the building.

5. *Conduct the test.* Testing involves placing the radon detectors, recording data in the logbook, retrieving the detectors, and shipping them to the lab. If the previous steps have been done well, conducting the test should be relatively simple.

Testing should be conducted over a weekend to minimize tampering and get better closed conditions.

6. *Interpret the results.* If the screening test detects high levels of radon, the finding should be verified by follow-up tests based on E.P.A.'s recommendations. For the follow-up tests to be as accurate and useful as possible, most school systems will need the advice of building engineers and radon experts.

If school personnel are willing to conduct a significant amount of preliminary research, they probably can handle the previous six steps themselves. That course is least expensive but runs more risk of error. One risk of the do-it-yourself route is that the test might appear to lack credibility. If an outside company handles every aspect of the test, the test itself will cost more but will require little labor on the school system's part. A third option is to have a professional conduct every step except Step 5, using school personnel to distribute and collect the testing devices.

In each case, the cost of the screening test will depend on the magnitude and complexity of the test. Surprisingly, high quality doesn't cost much more than a slapdash job. The small difference in cost is worth it: You will base consequential decisions on your test results, and if the results are wrong, you'll probably never know; nothing will break or leak.

Reducing radon levels

Taking care of a school radon problem once it's been diagnosed usually is simple; in fact, school maintenance and repair crews might be able to do the work themselves.

The most practical and proven method of reducing radon concentrations is to prevent the entry of radon into the building. Radon is most often kept out by making the air pressure in the radon-contaminated rooms higher than that of the surrounding soil. As an additional safeguard, it is common to seal cracks and utility openings.

E.P.A. school studies show that a leading contributor to elevated radon levels—and a key to reducing radon—is the heating and air-conditioning system. Many such systems create negative air pressure, which

(Continued on page 45.)

How the radon risk stacks up to other perils

Radon-222 is a colorless, odorless, tasteless, radioactive gas that occurs naturally in soil and rocks. Radon is not a threat outdoors, but it seeps into buildings, where it sometimes accumulates to perilous concentrations. Uranium miners have been concerned about radon for decades. The current radon scare was sparked when a worker in a Pennsylvania nuclear power plant tripped radiation sensors as he *entered* the plant. The problem was traced to radon in the worker's home, which measured 2,700 picocuries per liter (pCi/l)—a level with health effects comparable to smoking more than 3,000 cigarettes a day. Since then, E.P.A. has discovered that the presence of radon in buildings is severe and widespread.

Radon is the leading cause of lung cancer among nonsmokers. (For smokers, regular exposure to the gas increases the risk of lung cancer tenfold, according to the American Cancer Society.) The products of the decay of radon attach themselves to particles in the air. The radioactive particles, which are called "radon daughters" or "progeny," become lodged in the lungs as we breathe, penetrating some of the most cancer-sensitive cells in the human body. As the decay process continues, the particles release bursts of energy that damage lung tissue. Damaged cells can multiply rapidly and uncontrollably, causing lung cancer.

Scientists are fairly certain of the dangers of radon, because the risk estimates are based on studies of humans—approximately 40,000 miners—rather than of laboratory animals. Here's how the risk from radon exposure compares with other risks:

- *Other radiation sources.* According to the National Council on Radiation Protection and Measurement, radon is the source of more radiation for the average American than all other sources (such as X-rays, cosmic rays, and nuclear fallout) *combined.*
- *Other environmental hazards.* When the pervasiveness of the gas is taken into account, radon is significantly more severe than all other environmental hazards (asbestos, formaldehyde, toxic chemicals, pesticides) *combined.* According to the E.P.A., exposure to asbestos will cause from 25 to 45 deaths this year. Radon will kill approximately 20,000.
- *Chest X-rays, smoking.* Exposure to 4 pCi/l of radon (E.P.A.'s safety level) is comparable to having 300 chest X-rays a year or smoking half a pack of cigarettes a day.

It is prudent to assume that children are at greater risk from radon exposure than are adults. Studies of Japanese survivors of the atomic bomb suggest children are more susceptible than adults to radiation-induced cancers. A child's smaller lung volume and higher breathing rate increases his radon dose from a given concentration. That means the danger might be greater in elementary schools, since their students usually occupy the same (potentially contaminated) classroom day after day for months.—M.R.F.

Dropouts

(Continued from page 34.)

plagued with chronic failure when they entered the program have passed their G.E.D. and asked to go back to high school for their senior year. And some have higher goals: One 17-year-old, who lives by herself and is raising a baby while working at several jobs, scored in the 90th percentile on the G.E.D. She plans to go to college and pursue a career in psychology.

One problem we are trying to address is that approximately 30 percent of the enrollees in NOW probably don't have the ability to pass the G.E.D. We don't want to set them up for yet another failure, so we are considering starting a new vocational program in which they can be successful.

Like UPP, NOW costs the school system little new money—just some $1,500 in materials—thanks to federal and vocational education funds and the fact that we used our regular vocational education teachers in the program.

To keep up the momentum of both NOW and UPP, we have continued both programs over the summer, adding new students to the current ones. The funding for NOW is ongoing. We hope, however, that preventive programs the Dayton schools are initiating in the lower grades eventually will eliminate the need for both programs.

We've come to the conclusion that a student who is two or more years behind in school is unlikely to graduate with a conventional high school diploma. In most cases, helping such a young person requires a new approach. The best hope, we think, is raising these students' self-esteem, helping them catch up with their peers by passing the G.E.D., and teaching them vocational skills that make them employable. It's too early to predict what long-term effect these programs will have on our dropout rate, but the first year's results are promising. □

How do you rate this article? Please turn to the reply card facing page 42 and circle 196 if you think it's excellent, 197 if you think it's good, and 198 if you think it's poor. Thanks.

Radon

(Continued from page 26.)

pulls radon in through wall and floor cracks, expansion joints, and openings for utility lines. Conversely, if the heating and air-conditioning system can be adjusted to pressurize the room, the entry of radon can be prevented. In some cases, simply leaving the air system on for more hours during the day will make the building safe.

When such adjustments will not solve a radon problem, the most common solution is installing a "subslab suction" system. This method uses pipes and fans to lower the air pressure *underneath* the school building, thereby reducing the entry of radon.

High radon is a lot like high blood pressure. It's easy to ignore because you can't see it or feel it. The danger won't become evident until far in the future. The odds are your schools don't have a severe radon problem, but you won't know until you test. If you do find a radon problem, the remedy is usually not costly. The greatest danger comes from doing nothing. □

How do you rate this article? Please turn to the reply card facing page 42 and circle 184 if you think it's excellent, 185 if you think it's good, and 186 if you think it's poor. Thanks.

Perspectives

(Continued from page 46.)

mitment to local determination.

These efforts combined to exert enormous pressure on local school boards and their state associations. They saw proposals for solutions (and nonsolutions) crisscrossing the nation in wave after wave. Gradually, the climate grew receptive to the idea that the public schools indeed have a nationwide dimension that mirrors, on one hand, the national interest in good education and, on the other, either a federal or collective state role to respond to it.

The point: A place exists for nationwide collective action by school boards on national education issues—irrespective of their federal or nonfederal nature—and NSBA, as the creature of its Federation Members, is the natural association to serve as the local school board's advocate on them. By ceding responsibility to NSBA on these matters, the Federation Members set the framework in the association's forty-ninth year for the emergence of a new NSBA.

2. *NSBA has grown proactive in national, as well as federal, issues affecting public schools and their governance.* The 1989 NSBA Delegate Assembly initiated NSBA's comprehensive proactive thrust. Then-President Leonard Rovins unabashedly declared that NSBA was embarking on a new course of advocacy and action as the champion of the local school board on both national and federal issues.

3. *NSBA Federation Members are looking to NSBA for more and varied services to assist them in serving their local school boards better in the national and federal dimensions.* As education issues increasingly take on national aspects, the potential for NSBA to work closely with state associations expands dramatically.

NSBA has an unparalleled opportunity to become a true national/federal partner of state associations. If properly nurtured through mutual trust and respect—according equal status and recognition and establishing fair and sensible business arrangements between NSBA and our Federation Members—NSBA and state associations together can prosper. The programs and services that can be created, developed, and marketed jointly by the new partners are limited only by the burgeoning need for them in the local community and by our collective imagination in anticipating and responding to that need.

4. *The need for differential services from NSBA is pressing, because Federation Members are as diverse as the states they represent.* If ever an impossible chore existed, it is to develop any one program or service across the spectrum of possible offerings that is of equal value to all the members of the NSBA Federation. The state associations vary widely in terms of budgets, numbers of employees, and ranges of services. Programs and services, to be of genuine value, must be differential. Another way of saying it: There is an urgent and convincing case for tailor-making many of NSBA's programs and services for interested state associations on an association-by-association basis.

As NSBA moves into its fiftieth year, it is being transformed from what began in the 1940s as primarily a provider association into a true leader association. This is a profoundly significant transformation. All associations, by their very nature, are providers. They provide products and services to their constituencies. But most never cross the chasm separating the more passive provider from the proactive leader.

Over the long view, NSBA was created primarily to be a provider. In the mid-1960s, it began to bridge the gap to a leader association. In the late 1980s, the national dimension was addressed. In 1989, NSBA is completing that bridge by evolving into a vigorous leader association that both provides and leads.

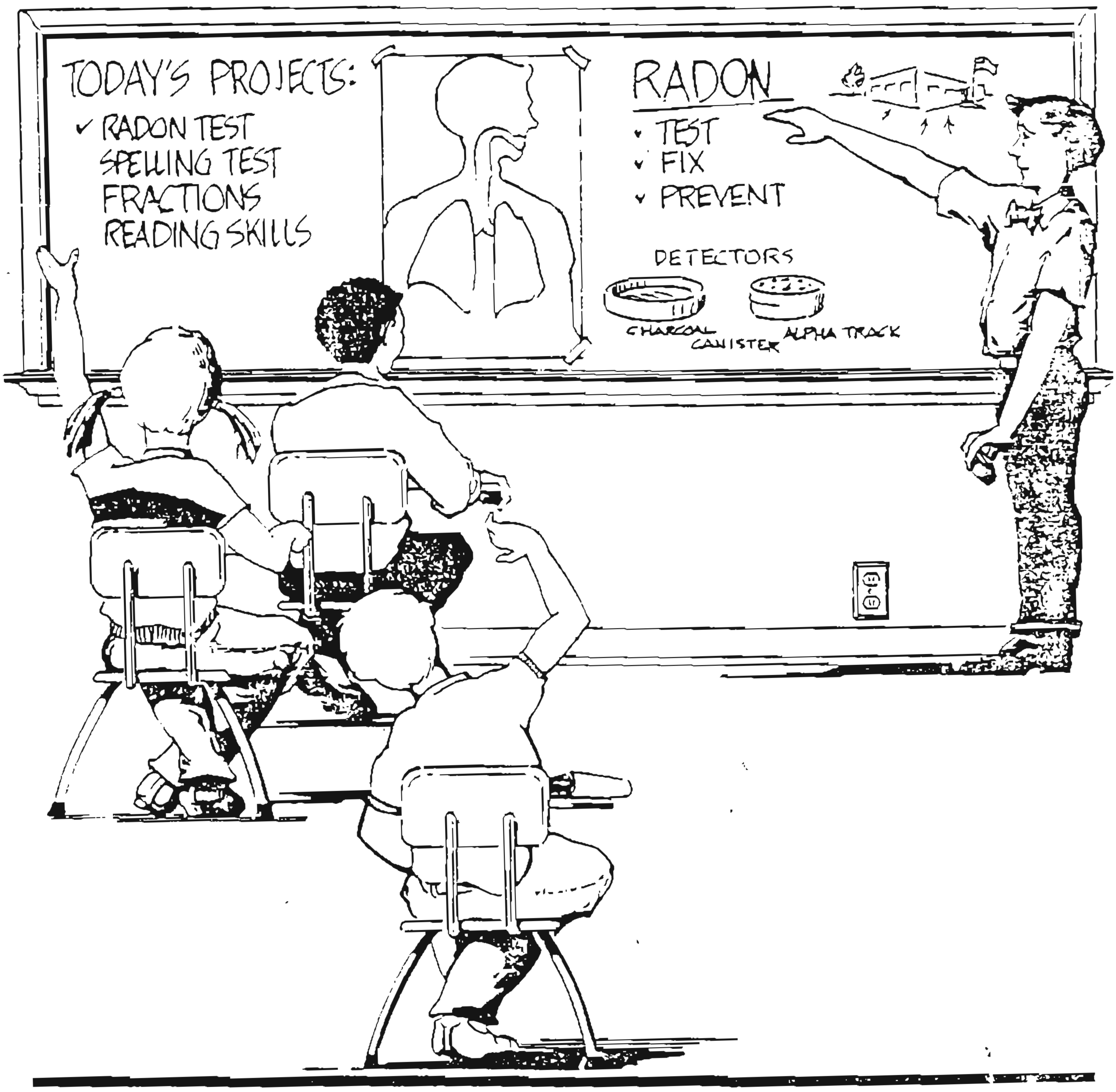
The historic leadership message abides: The best way to achieve excellence and equity in the public schools, in the more than 15,000 school districts across our immense and diverse nation, is through the local school board—an integral part of the enduring American institution of representative, participative, and accountable governance of public elementary and secondary education for more than 200 years. □

United States Environmental Protection Agency
Office of Radiation Programs Washington D.C. 20460
EPA 520/1-89-010
March 1989

EPA

RADON MEASUREMENTS IN SCHOOLS

An Interim Report



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RADON MEASUREMENTS IN SCHOOLS

- AN INTERIM REPORT -

March 1989

U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

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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 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

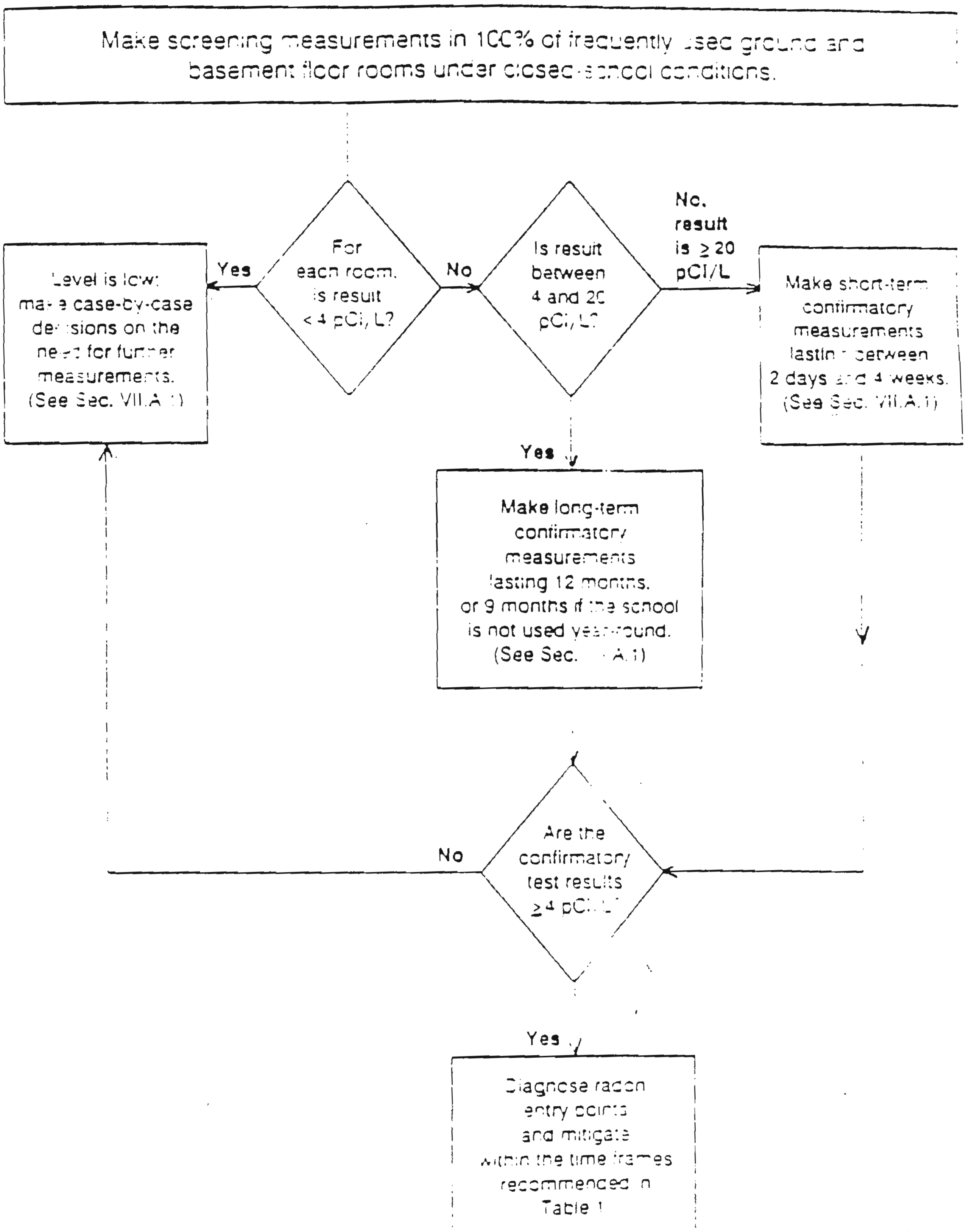

FIGURE 2

Screening Measurement Guidance: Three-Month, Winter Measurement Option

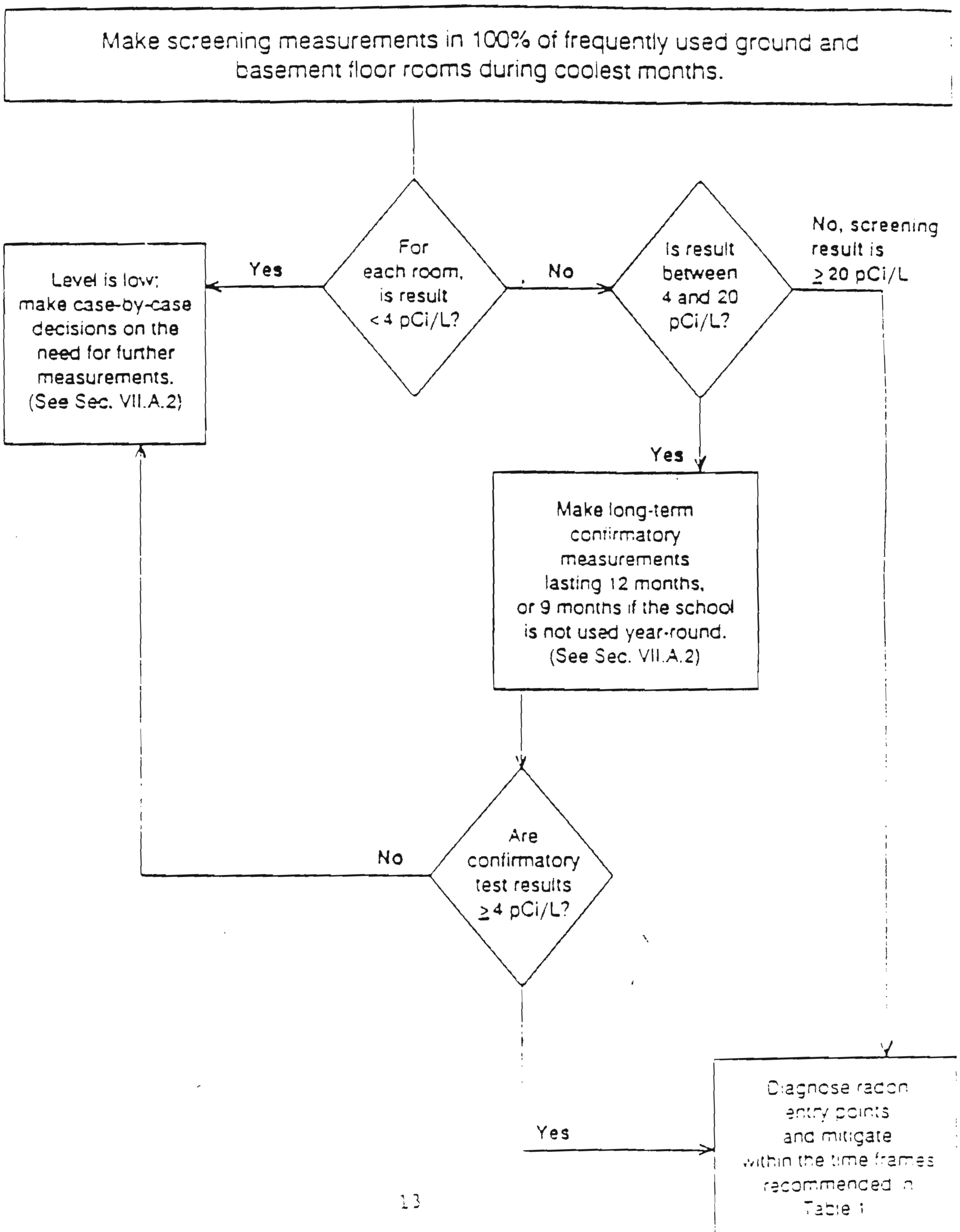

TABLE 1

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 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-520-1-8 -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.

- 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 [illegible] 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:

- 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. 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

APPENDIX A:

PROTOCOLS FOR USING TWO RADON MEASUREMENT DEVICES 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.

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.

- 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.

- 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.

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.

FISCAL NOTE
BUREAU OF BUDGET & MANAGEMENT RESEARCH

BBMR-F7

l No. 1127

Date Received 2/7/90

ndatory Bill Yes / / No X /

Date Reviewed 2/12/90

artment/Agency Affected: Government of Guam

artment/Agency Head: Joseph F. Ada

al Fiscal Year Appropriation: $481,165,316

l Title (concise): AN ACT TO ESTABLISH A TASK FORCE TO CONDUCT A STUDY TO DETERMINE THE EXTENT OF RADON CONTAMINATION IN THE SCHOOL BUILDINGS ON GUAM AND TO DETERMINE THE NECESSARY MEASURES TO REDUCE RADON EXPOSURE.

ange in Law: None

ll Attempts to:

/ / Increase Program Funding
/ / Decrease Program Funding
/ / Reallocate Present Program Funding

Bill is for:

/ / Operations
/ / Capital Improvement
/X/ Other

FINANCIAL/PROGRAM IMPACT

Minimum Estimated Required Funds (For Five Years)

PROGRAM CATEGORIES	GENERAL FUND	FEDERAL	OTHER
xecutive Branch			
GRAND TOTAL	See Attachment		

ESTIMATED MULTI-YEAR FUND REQUIREMENTS

SOURCES	1st	2nd	3rd	4th	5th
eral Fund					
eral Fund					
er Fund					
RAND TOTAL	See Attachment				

ESTIMATED MULTI-YEAR REALIZED REVENUES

SOURCES	1st	2nd	3rd	4th	5th
eral Fund	N/A				
eral Fund					
er Fund					
RAND TOTAL					

ose S. Calvo
PROGRAM ANALYST

Date Review Terminated: 2/13/90

MICHAEL J. REIDY
DIRECTOR

MENTS:

COMMENTS ON BILL NO. 1127

This Bill proposes to establish a task force comprised of four (4) Director's or designee's of Guam Environmental Protection Agency, Education, Public Health and Social Services, and Public Works: and includes five (5) specialists as selected by abovementioned four (4) task force members. The purpose of this task force is to conduct a study to determine the extent of radon contamination in the school buildings on Guam and to determine the necessary measures to reduce radon exposure. Section 5 of the Bill appropriates the sum of $500,000 to fund radon testing and mitigation.

The fiscal impact of this Bill cannot be assessed due to insufficient information. However, information received from the Guam Environmental Protection Agency offered possible alternatives either through the hiring of an independent contractor or by utilizing government personnel in order to satisfy the intent of the Bill. In either case, funding will be required and to an extent will be provided by the appropriation contained in the Bill. However, it should be noted that the fiscal impact is incalculable at this time since no specific plan has been developed to address radon contamination. It should also be noted that the funding source to fund the proposed project was not identified.

MICHAEL J. REIDY

ATTENDANCE SHEET

TWENTIETH GUAM LEGISLATURE
COMMITTEE ON HEALTH, WELFARE, AND ECOLOGY

PUBLIC HEARING DATE: Feb. 13, 1990 ON Bill No. 1127

		INITIAL
1.	SPEAKER **SAN AGUSTIN**, JOE T	
2.	SENATOR **AGUON**, JOHN P.	
3.	SENATOR **ARRIOLA**, ELIZABETH P. **(M)**	
4.	SENATOR **DIERKING**, HERMINIA D. **(M)**	
5.	SENATOR **GUTIERREZ**, CARL T.C.	
6.	SENATOR **LUJAN**, PILAR C. **(M)**	[illegible]
7.	SENATOR **MAILLOUX**, GORDON **(M)**	
8.	SENATOR **NELSON**, TED S. **(M)**	
9.	SENATOR **PARKINSON**, DON	
10.	SENATOR **QUITUGUA**, FRANKLIN J.A.	
11.	SENATOR **REYES**, EDWARD D. **(M)**	
12.	SENATOR **SANTOS**, FRANK R.	
13.	SENATOR **BAMBA**, GEORGE J.	
14.	SENATOR **BROOKS**, DORIS F.	
15.	SENATOR **DUENAS**, EDDIE R.	
16.	SENATOR **ESPALDON**, ERNESTO **(M)**	
17.	SENATOR **MANIBUSAN**, MARILYN D.A. **(M)**	
18.	SENATOR **RUTH**, MARTHA C. **(M)**	[illegible]
19.	SENATOR **TANAKA**, TOMMY **(M)**	
20.	SENATOR **UNPINGCO**, TONY R. **(M)**	

ATTENDANCE SHEET

COMMITTEE ON HEALTH, WELFARE AND ECOLOGY

DATE: February 13, 1990

Bill No. 1127

NAME		TESTIMONY		AGENCY / INTEREST GROUP	COMMENT	
PRINT:	SIGN:	WRITTEN:	ORAL:		FAVOR:	AGAINST:
FRED M CASTRO	[signature]	✓	✓	Guam EPA	✓	
JAMES L. CANTO	[signature]		✓	" "	✓	
Vince Leon Guerrero for Anita A. Sukola	Vince Leon Guerrero	✓	✓	DOE	✓	

TWENTIETH GUAM LEGISLATURE
1989 (FIRST) Regular Session

Introduced

DEC 28 '89

Bill No. 1127 (LS)

Introduced by: M. Manibusan
M. C. RUTH
E. M. ESPALDON
A. R. Unpingco
E. P. Arriola

AN ACT TO ESTABLISH A TASK FORCE TO CONDUCT A STUDY TO DETERMINE THE EXTENT OF RADON CONTAMINATION IN THE SCHOOL BUILDINGS ON GUAM AND TO DETERMINE THE NECESSARY MEASURES TO REDUCE RADON EXPOSURE.

BE IT ENACTED BY THE PEOPLE OF THE TERRITORY OF GUAM:

Section 1. There is hereby established a Radon Testing and Mitigation Task Force to be composed as follows:

1. The Director of Guam Environmental Protection Agency or his designee.
2. The Director of Education or her designee.
3. The Director of Public Health and Social Services or her designee.
4. The Director of Public Works or his designee.
5. Specialists selected by the above four persons who have the necessary expertise to conduct the testing and assist in determining the measures to mitigate the radon contamination. Such specialists not to exceed five (5) persons.

Section 2. The "Task Force" shall be aware and take advantage of any federal programs which provide assistance.

Section 3. Not later than six months after the date of the enactment of this statute, the "Task Force" shall establish a program to test sample the Guam Schools. The testing shall be completed not later than one year after the date of this enactment.

Section 4. The "Task Force" shall after completion of the necessary testing prepare a report with recommendations for correcting contamination problems and submit the report to the Governor with information copy to the Legislature. This report shall be done in an expeditious manner and in no case later than six months after completing the testing.

Section 5. The sum of five hundred thousand dollars ($500,000) is hereby appropriated for funding this Radon Testing and Mitigation Task Force.

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