FILE CONTENTS FILE NAME HB 519 Dt Referred 2/15/88

#	Date In	Doc. Type	Date	DESCRIPTION Subject	From	Cop-ied	Init.
(1)	2/17/88	Bill	2/15/88	Bill			
(2)	3/2	Art.		"Article" Radon in AK"	Heidersdorf		
(3)	3/2	LTR.		Letter From Rep Davis Request	Rep Davis		
(4)	3/2	BRY CS		Budget BRY sheets	Forbes		
(5)	3/2	Booklet		Radon Reduction in New Construction	US EPA		
(6)	3/2	Booklet		A Home owner's Guide 2nd Ed	US EPA		
(7)	3/2	Booklet		A Citizen's Guide to Radon	US EPA.		
(8)	3/3	Bill Review					
(2.1)	3/4	Pkt		Alaska Radon Info from Sponsor			
(1.1a)	3/7/8	FN	3/7/8	DCRA 4 pgs			
(1.3)	3/7/8	PP	3/7/8	DCRA			
(1.2)	3/7	FN		HSS			
(1.4)	3/7	PP		HSS			
(1.1)	3/5	CS		Proposed CS			
~~(9)~~	~~3/7~~	~~[illegible]~~		~~Staff review~~			
(1.5)	3/7	Anal.		DEC Analysis.			
(9)	3/28	Art		Article on Radon			
(10)	[illegible]	[illegible]		[illegible]			
(11)	4/15	Booklet	4/1/88	Occupational Safety & Health (AK) Standards	AK Dept of Labor		
(12)	4/15	Study	4/15/88	Indoor Air Quality 11/16/87	US. E.P.A. Washington D.C.		
(13)	4/15	Article	4/15/88	Gen Principles of Resolution Indoor Air Complaints			
(14)	4/19	Article	4/19	General News Article Radon	Phil Carson	✓	
(1.2)	4/21	2nd CS		2nd Prop CS 5-1051 L			
(15)	4/22	Test.		Phil Loudon			
(16)		POM		Phil Loudon			
A	3/7/8	(Min)					
B	3/28/8	(Min)					
C	4/22/8	(Min)					

(#) = Distributed, all files (Ltr) = Master, Backup, Next Com. Files

File Contents

HB 519 - Radon Mitigation Loans to Homeowners

No.	Description
1.	Bill - HB 519
1.1.	Proposed CS (by Sponsor)
1.2a	2nd Proposed CS, 5-1851L, 3/31/88, Chenoweth
1.1a.	Fiscal Note with impact - DCRA
1.2	Fiscal Note (Zero) - HSS
1.3	Position Paper - DCRA
1.4	Position Paper - HSS
2.	Memo - Rep. Davis
2.1	Alaska Radon Information
3.	Article "Radon in Alaska"
4.	BRU Budget Sheet C-5
5.	Booklet - "Radon Reduction in New Construction"
6.	Booklet - "A Homeowner's Guide" 2nd Ed.
7.	Booklet - "A Citizen's Guide to Radon"
8.	Bill Review - Harrison (HCRA Staff)
9.	Article on Radon
10.	Memo - Davis response
11.	Booklet - Occupational Safety Standards
12.	Study - Indoor Air Quality
13.	Article - General principles - resolutions

HB519.FIL
4-21-88

STATE OF ALASKA
THE LEGISLATURE

LEGISLATIVE AFFAIRS AGENCY

LEGISLATIVE REFERENCE LIBRARY

POUCH Y · STATE CAPITOL
JUNEAU, ALASKA 99811
907-465-3800

May, 1988

Copies of minutes listed below were originally included in this file. The minutes are available on the STAIRS database CMPR. In order to save space copies of minutes have not been left in the files.

Mary Van Nimwegen

HC+RA 3-28-88 3:00 P.M.
4-22-88 3:00 P.M.
3-7-88 3:00 P.M.

THE SEAL OF THE STATE OF ALASKA

Official Business

COMMITTEE:

HOUSE COMMUNITY & REGIONAL AFFAIRS

DATE: Fri. April 22, 1988

SIGN-IN

Subject of meeting:

HB 519 Radon Mitigation Loans to Homeowners

HB 520 Approp: Radon Mitigation Loan Fund

HB 286 Creating the Rural Governance Council

NAME (PLS PRINT)	YOUR TITLE & ADDRESS	PHONE	REPRESENTING	BILL #	DO YOU WANT TO TESTIFY?
Scott Burgess	Juneau	6-1325	AML	HB 286	Yes
Jim Plagman	POBox BH	4750	DCRA	HB 286	yes

Official Business

COMMITTEE:

HOUSE COMMUNITY & REGIONAL AFFAIRS

DATE: Mon. Mar. 28, 1988

SIGN-IN

Subject of meeting:

HB 318 Energy Efficient Home Equity Fund
HB 319 APprop: AK Energy Efficient Home Program

HB 519 Radon Mitigation Loans to Homeowners
HB 520 Approp: Radon Mitigation Loan Fund

*HB 522 Planning Commissions

NAME (PLS PRINT)	YOUR TITLE & ADDRESS	PHONE	REPRESENTING	DO YOU WANT TO TESTIFY?
Mike Miller			Dist. 18	yes

THE SEAL OF THE STATE OF ALASKA

Official Business

COMMITTEE:

HOUSE COMMUNITY & REGIONAL AFFAIRS

DATE: Mon. Mar. 28, 1988

SIGN-IN

Subject of meeting:

HB 318 Energy Efficient Home Equity Fund
HB 319 APprop: AK Energy Efficient Home Program

HB 519 Radon Mitigation Loans to Homeowners
HB 520 Approp: Radon Mitigation Loan Fund

*HB 522 Planning Commissions

	NAME (PLS PRINT)	YOUR TITLE & ADDRESS	PHONE	REPRESENTING	DO YOU WANT TO TESTIFY?
	Scott Burgess	Juneau	6-1325	AML	Yes
HB 519	Katherine Reardon	HB 519			
520	Rep. Davis	520			
520	Rep. Miller				
522	Jim Plasman				

Alaska State Legislature

Representative Mike Davis District 19

P.O. Box V
Juneau, Alaska 99811
(907) 456-4930/4941

Interim Office:
P.O. Box 81435
Fairbanks, Alaska 99708
(907) 456-8161

TO: House Community & Regional Affairs Committee
FROM: Rep. Mike Davis
DATE: March 7, 1988
RE: HB 519 and HB 520, establishing a revolving loan fund for radon mitigation.

House Bill 519 establishes a revolving loan fund in the Department of Community and Regional Affairs for reduction of radon in homes.

Radon is a naturally occurring radioactive gas. The largest source of indoor radon is directly from the soil in areas where uranium deposits are high. Significant amounts of radon can enter and accumulate in homes, presenting a serious health threat to residents. The major known health effect of radon in the air is an increased risk of lung cancer. It is estimated that 5,000 to 20,000 lung cancer deaths annually can be attributed to radon.

Dangerous levels of radon have been recorded in several Alaskan communities. Effective techniques have been developed to reduce radon levels in homes. However, many Alaskans cannot afford to retrofit their houses. Some are reluctant to even test for radon, because they will not be able to pay for necessary modifications. House bill 519 will set up a small loan program for these homeowners.

This legislation authorizes the Dept. of Community and Regional Affairs to make market rate loans of up to $10,000 for radon mitigation. To be eligible, a homeowner must have applied for a loan from a bank or savings & loan, and been rejected. The homeowner is also required to submit a plan for the use of the money. The department may establish additional eligibility criteria and write regulations for the program.

The House of Representatives recognized the need for radon mitigation when it unanimously passed HJR 38, which calls for a joint state/federal effort to alleviate the radon gas problem in Alaska. House Bill 519 is a positive step in that direction.

LEGISLATIVE
SPONSOR: H C+RA — TC DATE/DAY: Monday March 7

Pub. Hear — Work Ses. — (Inv. Hear) ? — TIME: 3-4:30

LEGISLATIVE REFERENCE: HB 520 + ~~[illegible]~~ — JUNEAU ROOM: CA-603

SUBJECT: Radon Mitigation — BRIDGE: ~~DD#~~ 456-5076

[illegible] — # OF PORTS:

CONTACT: Katherine Martin — PH: 4941 / 4383 — DATE TAKEN/BY: [illegible] 3/3

****

TELECONFERENCE SITES:

LIO'S	LTC'S	VTS'S
Anchorage	Homer	See List on
Barrow *	Wrangell	Reverse Side
Bethel		
Delta Junction *		
Dillingham *		
(Fairbanks)	ALL LIO'S	
Glennallen *		
(Juneau)		
Ketchikan		
Kodiak	OTHER SITES WELCOME WITH PRIOR NOTIFICATION	
Kotzebue		
Mat-Su		
Nome		
Petersburg *		OFFNETS:
Sitka		
Soldotna		
Valdez *		

CHAIRING SITE: JNU

CHAIRPERSON: Rep. Springer

[ ] CONFORMS TO LEGISLATIVE COUNCIL POLICY 4/85

Martha [illegible] — 3/4/88

SIGNATURE OF SPONSOR/CONTACT PERSON — DATE

****

SPECIAL INSTRUCTIONS

No JNU MOD

They will use speakerphone. 2 people in FBX.

* SESSION ONLY

fw / CRA

Alaska State Legislature

Representative Mike Davis District 19

P.O. Box V
Juneau, Alaska 99811
(907) 456-4930/4941

Interim Office:
P.O. Box 81435
Fairbanks, Alaska 99708
(907) 456-8161

FEB 18 1988

TO: Rep. Heinrich Springer
Chairman, House Community & Regional Affairs
FROM: Rep. Mike Davis
DATE: February 17, 1988
RE: HB 519 and HB 520

I would like to request early scheduling of HB 519 and HB 520, establishing a revolving loan fund for radon mitigation.

While radon exposure is poses a serious threat to public health, many Alaskans cannot afford to install mitigation systems in their homes. HB 519 and HB 520 would provide loans of up to $10,000 to home owners to install air-to-air heat exchangers, vapor barriers and other mitigation mechanisms.

Official Business

COMMITTEE:

HOUSE COMMUNITY & REGIONAL AFFAIRS

DATE: Monday, March 7, 1988

Subject of meeting:

*HB 519 Radon Mitigation Loans to Homeowners

~~*HB 520 Approp: Radon Mitigation Loan Fund~~

SIGN-IN

NAME (PLS PRINT)	YOUR TITLE & ADDRESS	PHONE	REPRESENTING	DO YOU WANT TO TESTIFY?
Jim Plasman	Dep. Dir MRAD, Juneau	4750	DCRA	Yes
Rep. Davis	Sponsor. HB519 HB520			

(1.1) HB 519

5-1851B
Chenoweth
3/4/88

Original sponsors: Davis, Koponen and Ulmer

IN THE HOUSE

CS FOR HOUSE BILL NO. 519 ( )

IN THE LEGISLATURE OF THE STATE OF ALASKA

FIFTEENTH LEGISLATURE - SECOND SESSION

A BILL

For an Act entitled: "An Act establishing a revolving loan fund for radon mitigation; and providing for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

* Section 1. FINDINGS. The legislative finds that

(1) exposure to radon poses a serious threat to public health and is estimated to cause approximately 5,000 to 20,000 lung cancer deaths each year nationally;

(2) fourteen percent of the indoor radon measurements made by the state's divisions of geological and geophysical surveys and public health exceeded four picocuries, the level at which the Environmental Protection Agency recommends action be taken to reduce the level;

(3) environmental conditions in Alaska contribute to the health risk of radon, due to the long heating season, amount of time spent indoors, and pressure differentials caused by extreme indoor-outdoor temperature differentials;

(4) high levels of radon may decrease property values, making loans difficult to obtain and greatly hindering resale;

(5) techniques such as vapor barriers, air-to-air heat exchangers, and certain house pressurization strategies may be used to mitigate radon in homes;

(6) many Alaskans do not have the financial resources to install radon mitigation systems in their homes; and

(7) state response to the health threat posed by radon is essential and should continue at existing or expanded levels.

* Sec. 2. AS 44.47 is amended by adding new sections to read:

ARTICLE 11A. RADON MITIGATION REVOLVING LOAN FUND.

Sec. 44.47.650. RADON MITIGATION REVOLVING LOAN FUND. There is in the Department of Community and Regional Affairs the radon mitigation revolving loan fund to carry out the purposes of AS 44.47.650 - 44.47.658. The fund may not be used for any other purpose.

Sec. 44.47.652. POWERS AND DUTIES OF THE DEPARTMENT IN ADMINISTERING THE FUND. (a) The department may

(1) make loans to homeowners to mitigate the effects of radon on property used as the homeowner's place of residence;

(2) adopt regulations necessary to carry out the provisions of AS 44.47.650 - 44.47.658.

(b) The department shall

(1) determine by regulation eligibility for loans based on a measurement of radon within the borrower's residence; eligibility must be established based on a sliding scale that inversely relates the minimum measurement level to qualify for a loan to the length of the time period during which the radon measurement was taken;

(2) develop other eligibility standards for loans;

(3) adopt guidelines for the determination of loan terms.

(c) The department shall dispose of property acquired through default or foreclosure of a loan made under AS 44.47.650 - 44.47.658. Disposal shall be made in a manner that serves the best interests of the state, and may include the amortization of payments over a period of years.

Sec. 44.47.654. LOAN TERMS AND PAYMENTS. (a) A loan made by the department under AS 44.47.650 - 44.47.658 may not exceed $10,000.

(b) The duration for repayment of a loan may not exceed 10 years.

(c) The interest rate on a loan made by the department under AS 44.47.650 - 44.47.658 is the annual rate charged member banks for advances by the 12th Federal Reserve District on the day the loan is made.

(d) All principal and interest payments on loans under AS 44.-47.650 - 44.47.658 shall be paid into the radon mitigation revolving loan fund.

Sec. 44.47.656. ELIGIBILITY FOR LOANS. A homeowner is eligible for a loan under AS 44.47.650 - 44.47.658 if

(1) a measurement of the radon in the homeowner's residence exceeded the numbers of picocuries determined by program regulation under AS 44.47.652(b)(1);

(2) the homeowner has applied for a loan to mitigate the effects of radon from a state chartered or federally chartered lending institution, and the application has been rejected;

(3) the homeowner submits to the department a plan for the use of the loan funds that is approved by the commissioner; and

(4) the applicant meets additional eligibility standards established by the department under AS 44.47.652.

Sec. 44.47.658. SPECIAL ACCOUNT ESTABLISHED. (a) There is established as a special account within the radon mitigation revolving loan fund the foreclosure expense account. This account is established as a reserve from fund equity.

(b) The commissioner may expend money credited to the foreclosure expense account when necessary to protect the state's security interest in collateral on loans made under AS 44.47.650 - 44.47.658 or to defray expenses incurred during foreclosure proceedings after a default by an obligor.

* Sec. 3. This Act takes effect July 1, 1988.

(1.1a) HB 519

STATE OF ALASKA
1988 LEGISLATIVE SESSION

BILL VERSION : HB 519
PUBLISH DATE :

FISCAL NOTE

REQUEST:

Revision Date:
Title : Establishing a revolving loan fund for radon mitigation
Sponsor :
Requestor :

Agency Affected : Community & Regional Affairs
BRU : Housing Assistance

Components : Radon Mitigation Loan Fund

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
PERSONAL SERVICES		62.4	64.9	67.4	70.1	72.7
TRAVEL		8.0	8.0	8.0	8.0	8.0
CONTRACTUAL		6.0	6.0	6.0	6.0	6.0
SUPPLIES		.4	.4	.4	.4	.4
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING		76.8	79.3	81.8	84.5	87.1

CAPITAL						

REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND		76.7	79.3	81.8	84.5	87.1
FEDERAL FUNDS						
OTHER						
TOTAL						

POSITIONS:

FULL-TIME		1.0	1.0	1.0	1.0	1.0
PART-TIME		1.0	1.0	1.0	1.0	1.0
TEMPORARY						

ANALYSIS : (Attach a separate page if necessary)

See Attached Analysis

Prepared by : Carol Carroll [signature]
Division : Administrative Services
Phone : 465-4709
Date : 3/7/88

Approved by Commissioner : L. David G. Hoffman [signature]
Agency : Community and Regional Affairs
Date :

Distribution (by preparer) :
Legislative Finance
Legislative Sponsor
Requestor
Office of Management and Budget
Impacted Agency(ies)

FISCAL NOTE ANALYSIS

A. Assumptions

Enactment of this legislation will require the Department of Community and Regional Affairs to develop regulations, determine eligibility standards and adopt guidelines for loan terms. Also, the Department will be required to review applications for loans and coordinate a home visit to determine eligibility with other state agencies who are presently measuring radon levels in homes. Depending on the appropriation level an estimated 50 to 250 loan applications will need to be reviewed and processed.

B. Staff Requirements

In order to respond to the responsibilities enumerated above it will be necessary to establish a new Project Coordinator position in the Housing Assistance Section to develop regulations and oversee the loan application process. A part-time Clerk III position will be needed to assist the Project Coordinator.

Computation of Salary Costs

1.	Project Coordinator,	Range 18 Step A	
		Salary	$37.4
		Benefits	12.1
		Total	$49.5
2.	Clerk III, Part-time	Range 08 Step A	
		Salary	$ 9.8
		Benefits	3.1
		Total	12.9

3. Position costs

Travel in the amount of $8.0 is necessary for the Project Coordinator do on-site reviews and develop loan packages.

Contractual in the amount of $6.0 is necessary for mail, phone, advertising and printing.

Supplies in the amount of $.4 is required for routine office needs.

Position Title		No. of Positions	Range/Step	Barg. Unit
Project Coordinator		1.0	18 A	GGU
Time Status: Full-Time	Staff Months: 12.0	Location: Anchorage		Election District:

Type of Expenditure		Amount
1	2	3
Salary	37.4	
Benefits	12.1	
Premium Pay	-0-	
Other	-0-	
Total Personal Services		49.5
Travel		8.0
Contractual		5.0
Commodities		.2
Equipment		
Other		
Total Cost		62.7

Funding Source for Total Cost		
Federal Receipts	1002	
G. F. Match	1003	
General Fund	1004	62.7
GF Program Receipts	1005	
Other		

Justification

This position will develop regulations for eligibility standards and loan conditions for the proposed radon mitigation loan fund. In addition, this position will oversee program activity to include on-site reviews and processing of a loan.

Request For New Position

Agency: Community and Regional Affairs

BRU: Housing Assistance

Component: Radon Mitigation Loan Fund

Page 3 of 4

Revised Date

FY 89

Position Title	No. of Positions	Range/Step	Barg. Unit
Clerk III	.5	08 A	GGU

Time Status	Staff Months	Location	Election District
Part-Time	6.0	Anchorage	

Type of Expenditure		Amount
1	2	3
Salary	9.8	
Benefits	3.1	
Premium Pay	-0-	
Other	-0-	
Total Personal Services		12.9
Travel		-0-
Contractual		1.0
Commodities		.2
Equipment		
Other		
Total Cost		14.1

Funding Source for Total Cost		
Federal Receipts	1002	
G. F. Match	1003	
General Fund	1004	14.1
GF Program Receipts	1005	
Other		

Justification

This position will assist the project coordinator with necessary loan processing paperwork, regulation preparation and various clerical duties associated with the project.

Request For New Position

Agency: Community and Regional Affairs

BRU: Housing Assistance

Component: Radon Mitigation Loan Fund

Page 4 of 4

Revised Date

FY 89

(1.2) HB 519

STATE OF ALASKA
1988 LEGISLATIVE SESSION

BILL VERSION: HB 519
PUBLISH DATE:

FISCAL NOTE

REQUEST:

Revision Date: 2/15/88
Title: An Act establishing a revolving loan fund for radon . . .
Sponsor: Davis et al.
Requestor:

Agency Affected: Health & Social Services
BRU: State Health Services
Components: Lab Services

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
PERSONAL SERVICES						
TRAVEL						
CONTRACTUAL						
SUPPLIES						
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	-0-	-0-	-0-	-0-	-0-	-0-
CAPITAL						
REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND						
FEDERAL FUNDS						
OTHER						
TOTAL	-0-	-0-	-0-	-0-	-0-	-0-

POSITIONS:

FULL-TIME						
PART-TIME						
TEMPORARY						

ANALYSIS: (Attach a separate page if necessary)

The enactment of HB 519 would have no direct fiscal impact on the Department of Health and Social Services.

Prepared by: Elizabeth Ward, Director [signature] Phone: 465-3090
Division: Public Health Date: 3-3-88

Approved by Commissioner: [signature] Date: 3/7/88
Agency: Department of Health & Social Services

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)

(1.3) HB 519

STATE OF ALASKA

DEPT. OF COMMUNITY & REGIONAL AFFAIRS

OFFICE OF THE COMMISSIONER

STEVE COWPER, GOVERNOR

☐ *P.O. BOX B*
JUNEAU, ALASKA 99811-2100
PHONE: (907) 465-4700

☐ *949 E. 36TH AVENUE, SUITE 400*
ANCHORAGE, ALASKA 99508-4302
PHONE: (907) 563-1073

March 7, 1988

POSITION PAPER

RE: House Bill 519: "An Act Establishing A Revolving Loan Fund for Radon Mitigation"

SPONSOR: Representative Davis, et. al.

Program Effects of Bill

House Bill 519 would create in the Department of Community and Regional Affairs a revolving loan fund to finance radon mitigation measures for Alaskans whose homes' measurement of radon exceed six picocuries per liter and who cannot secure financing from commercial banks.

Comments

The Department strongly supports steps to mitigate radon where its occurrence exceeds safety limits. Radon is a serious health and indoor air quality issue with which this country is just coming to grips. High radon levels are being discovered in the Fairbanks area, and the extent of the problem is not currently fully known. The State of Alaska clearly has a role in addressing this health threat.

Fortunately, there exist alternatives to address this problem. Many of the technologies used in energy-efficient construction, properly installed vapor barriers, proper ventilation, and air-to-air heat exchangers have proven effective in mitigating high radon levels.

The Department has been very active in increasing public awareness of radon and other indoor air quality concerns. We have sponsored two successful statewide indoor air quality conferences, funded the Alaska Craftsman Home Training Program which teaches builders how to construct radon-free homes, and are currently working with the Alaska Lung Association and the University of Alaska in developing factsheets and a video program on radon and indoor air quality.

The Department, however, does not have a position on this legislation. While it supports continued research and education efforts on the issue as well as mitigation efforts, it questions whether the State should create a new loan fund in light of the current revenue situation.

for David G. Hoffman
Commissioner

21-P1LH

(1.4) HB 519

Position Paper

HB 519

For an Act entitled: "An Act establishing a revolving loan fund for radon mitigation; and providing for an effective date."

HB 519 establishes a revolving loan fund for radon mitigation in private homes. The Department of Community and Regional Affairs is to administer this fund, making loans to homeowners who meet specific eligibility standards. That department is also required to adopt regulations necessary to carry out provisions of the fund under guidelines established in HB 519.

Comments and Recommendations

1. Under legislative findings on page one, reference is made to the Environmental Protection Agency (EPA) remedial action level of six picocuries per liter of radon gas concentration. The EPA remedial action level is four picocuries per liter.

2. HB 519 specifies that a homeowner be eligible for a loan if the measurement of radon concentration exceeds six picocuries per liter. It is recommended that the EPA action level be used as the baseline and that eligibility for loans be based on different radon gas level measurements made in the home, depending upon the duration of the measurements. The EPA health risk estimates are based on annual averages with occupancy in the home for 75% of the time and an exposure period of 70 years. It is known that the concentration levels vary with the season of the year and associated ventilation rate changes in the home. Consequently grab-samples, or measurements made over short time periods, may not reflect an average condition. For example, it has been shown that on the average, a wintertime basement screening measurement overestimates the first floor annual average by a factor of three. Also, a three-month wintertime first floor measurement overestimates an annual first floor measurement by

a factor of two. For this reason, we recommend that paragraph (1) of Section 44.47.656, Eligibility For Loans, be reworded as follows:

(1) A measurement of the radon gas concentration in the homeowner's residence exceeds the following:

(a) 4 picocuries per liter for a yearlong measurement; or

(b) 6 picocuries per liter averaged over a minimum measurement period of three months; or

(c) 8 picocuries per liter for a measurement period of less than three months.

In addition, we recommend that the following two paragraphs be added to Section 44.47.656.

(2) Measurements of radon gas concentration must be made in a living area of the homeowner's residence.

(3) Measurements must be performed by companies having successfully passed the Radon Measurement Proficiency Program of the EPA.

Paragraph (2) has been added to insure that measurements are not obtained from crawl spaces, root cellars, etc., which may be appreciably higher than those found in other areas of the home. Radon measurements in these areas do not provide information on which to evaluate health risks. The department has had difficulty making evaluations in a number of instances where homeowners have not followed the recommended guidelines to make measurements in living areas. It is very important that this be required. If not, a high percentage of homes will qualify for loans when the concentration of radon gas does not exceed the eligibility level in living areas. Paragraph (3) insures that the radon measurement is made by a company that has demonstrated a capability for accurately measuring radon levels.

Position

With the changes suggested above, the Department of Health and Social Services supports passage of HB 519.

Recommended by: Elizabeth Ward
Elizabeth Ward, M.N.
Director
Division of Public Health

Date: March 3, 1988

Approved by: Myra M. Munson
Myra M. Munson
Commissioner
Department of Health and Social Services

Date: March 7, 1988

POSITION PAPER/Department of Health & Social Services

(1.5) HB 519

MAR - 4 1988

STATE OF ALASKA

OFFICE OF THE GOVERNOR

BILL ANALYSIS

DEPARTMENT	DIVISION	BILL NUMBER	SPONSOR
DEC	Environmental Quality	HB 519	Davis, Koponen, Ulmer

SHORT TITLE OF BILL

An act establishing a revolving loan fund for radon mitigation

DEPARTMENT POSITION

The Department supports the intent of the bill.

PREPARED BY	DATE	COMMISSIONER'S SIGNATURE	DATE
Amy D. Kyle	3/2/88		3/4/88

SUMMARY

OTHER AGENCIES AFFECTED BY BILL	CONSTITUENT GROUP(S) AFFECTED BY BILL
DCRA	

ORGANIZATIONAL SUPPORT FOR BILL	ORGANIZATIONAL OPPOSITION TO BILL

FISCAL IMPACT: ☒ NONE ☐ FISCAL NOTE ATTACHED

BACKGROUND/LEGISLATIVE INTENT

Radon contamination of homes and public facilities has been documented in Alaska. This can cause high levels of radiation and lead to lung cancer. It is a serious health concern.

ANALYSIS OF BILL/PROGRAM EFFECTS

The bill would provide a mechanism to assist homeowners to fund improvements needed to solve radon contamination problems.

The Department has no position on the issue of funding.

AMENDMENTS PROPOSED

PLEASE ATTACH A SEPARATE SHEET FOR ADDITIONAL COMMENTS OR ANALYSIS.

01-009 (Rev. 12/83)

THE FOLLOWING DOCUMENT(S) MAY NOT FILM LEGIBLY BECAUSE OF POOR QUALITY OF THE ORIGINAL.

TELECONFERENCE ON RADON GAS

HB 519 & HB 520

TESTIMONY OF PHILIP LOUDON, NORTECH INC.

229 3rd Street (in Graehl)

Fairbanks, Alaska 99701

(907) 451-8378, 456-8378

March 7, 1988

Today I am speaking as a principal of a newly formed engineering and technical services firm named Nortech. Nortech is a direct result of the recent radon findings in the Fairbanks area. Involved in Nortech with myself, is John Hargeshiemer, a professional engineer with experience in civil, chemical and environmental engineering.

Our involvement with radon gas in the Fairbanks area consists of providing testing, analysis and mitigation services for building owners that have been impacted by this substance. We have currently distributed over three hundred activated carbon, short term radon monitors and we maintain the largest private data base of information on the frequency and quantities of radon gas found in Alaska. We also own continuous radon monitoring (CRM) equipment and distribute products dealing with home measurement of radon. We are presently working on our fourteenth mitigation system design.

Our customers have been homeowners and small businesses, though we have provided testing services for governments and institutions. In every case, the impact of finding greatly elevated levels of radon gas has proven to be difficult financially, emotionally draining and in some cases mentally debilitating, to those with the misfortune to have discovered it.

We are aware of many households that cannot financially afford any amount of mitigation expense. One client of ours who is blind and dependent upon social security, is confronted daily with living in a radon environment that he cannot financially deal with. He is dependent upon friends and neighbors to remove him from his home that contains levels of radon gas above the mine closure level established by the Nuclear Regulatory Commission. The NRC has established cumulative dosage limits for miners exposed to radon gas during a 40 hour work week. This person remains exposed to radon far more than forty hours a week and desperately needs help in mitigating his problem.

Some of our clients have not taken steps toward mitigating their radon problems because other financial burdens have forced them to expend their savings first. In several cases they and their children live, play and sleep in homes that contain an equivalent lung cancer risk as smoking two and three packs of cigarettes per day (using the EPA AVERAGE risk assessment). This is disconcerting, but the EPA has set the risk.... we only measure and inform our clients of the reality of their individual situation and what they may do about it. To what extent they carry out our recommendations is their responsibility.

Human exposure to radon gas is clearly the greatest natural radiation threat to modern man. Where other toxic substances such as dioxin, PCB's, benzene, etc. are con[illegible] safe at risk levels of one death in one million, the AVERAGE U.S. home, not Alaskan home, contains amounts of radon gas at risk levels of around 4,000 deaths per million. I distinguish the difference between the AVERAGE U.S. home and the AVERAGE Alaskan home for very important reasons.

The EPA has defined four conditions that must exist for a building to contain a quantity of radon gas:

1) Radium must be present in the soil.
2) The soil porosity must facilitate movement of the gas.
3) The building must have entry points, cracks and holes.
4) A pressure difference must exist between the soil and the building interior.

It is quite apparent that all of these conditions exist with surprising regularity in the Fairbanks area. Without trying to alarm, or create a sensation, I feel compelled to focus your attention on the differences between the EPA risk factors and our Alaskan reality. In reviewing the risk assessment formulas used by the U.S. Environmental Protection Agency (EPA) to determine harm from exposure to radon gas, we find that a lifetime risk requires a 75 per cent exposure rate. This is to say that the AVERAGE individual must be exposed to the substance for seventy-five percent of their lives, from cradle to grave. The significance of this becomes clear when we apply this same exposure rate to the Fairbanks population.

In order to fit the wide and varying environmental and lifestyle factors found across the United States population, the EPA has based their risk calculations on an AVERAGE that does not include our long inhospitable winters. These winters are what cause us to remain inside our homes longer than residents in Iowa, Pennsylvania, or Colorado... or wherever this AVERAGE U.S. climate exists.

Example: In order to limit exposure to household radon gas at the 75% level, one is required to remain away from the home for an average of 42 hours each week over a period of 40 to 70 years (EPA literature calculates exposure to radon for these two exposure periods). While this may happen with some working persons and outdoor life-styles, if we are to define the AVERAGE Fairbanks resident we must include a wide variety of social profiles among which are homemakers, pre-school and school aged children, the elderly, and the infirm. These are the ones most at risk as they are the least able to access the world outside the home, and they increase considerably the AVERAGE exposure time for the AVERAGE Fairbanks resident.

In fact, many Fairbanks residents are indoors more than 90% of the time, especially during our long and cold winter heating season. Even at this seemingly high percentage of indoor presence an average of 2.4 hours a day must be spent outside the residence, every week, every year.

Not only are Alaskans exposed to indoor environments more on a daily basis because of their cold climate, but their gross exposure is greater due the fact that Alaskan winters are longer in duration than the EPA AVERAGE winter.

Cold weather also affects the entry rate of radon gas and is another reason that we have such highly elevated levels in Fairbanks. As the difference in temperatures between our homes and the outside air become extreme, the pressure driven flow of soil gas containing radon increases accordingly. As the warm moist air leaves our homes at the upper portion of our buildings (hot air rises) it is replaced with cool air coming into the lower portions of the building, some of which is soil gas containing radon.

So, the colder it gets - the greater the soil gas entry rate - the higher the radon levels - the more time we spend inside.

Because of the above mentioned reasons, we feel that the true health risk to residents in the Fairbanks area is likely to be between 15-30% greater than that defined within the EPA radon risk assessment. Unfortunately, at this time no hard data is available to document such an increased threat.

To define the severity of radon levels being found in the Fairbanks area. I would like to bring attention to the findings of a ten state study performed by the U.S. EPA. In testing many thousands of buildings in ten lower forty-eight states during the winter of 1986-87, the highest level of radon was found to be 180 pCi/l in a house in

Alabama. The highest confirmed level in the Fairbanks area is 500 pCi/l with only 5% of our total area homes being tested. We have identified many homes beyond 200 pCi/l, and levels between 20 and 100 pCi/l are a common occurrence. We have results of above 4 pCi/l from Second Avenue, Shannon Park, Dale Road, and North Pole. These elevated levels from the valley indicate a need for community-wide involvement in testing for radon and not just in the hill-side developments.

We need to better understand the relationship between radon gas and northern residents, but first we should recognize that we have a serious problem in the Fairbanks area, and perhaps elsewhere in Alaska. We strongly recommend that you set in place the mechanism that will assist in providing relief for our residents from the financial burden imposed upon them by radon gas.

Thank you for this opportunity to testify on the important issues raised in House Bill [illegible] and 520.

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Our recommendations for developing a structured approach to handling the radon problem in Fairbanks are:

1) Assess the extent of the problem through use of short term screening tests on an area-wide basis.

2) Develop state and federal funding support programs.

3) Begin an extensive and intensive research program directed at defining what mitigation systems work best in cold climates.

4) Develop a financial support program for residents demonstrating a need for continued assistance in measuring and diagnosis.

5) Disseminate useful information to the public with emphasis on the need to know about their exposure.

6) Develop citizen confidence in their test results, increase the general awareness about the types of tests and the individuals performing the testing.

   A) Establish testing protocol.

   B) Insure Quality Assurance of personnel through a certification program.

   C) Disperse brochures and informative literature.

   D) Publicize research and demonstration programs.

   E) Create procedure documents for arctic applications by delineating what works locally and what doesn't e.g., ventilating a crawlspace may not apply to cold climate construction due to freezing of mechanical systems.

7

#2.1 HB 519

PRELIMINARY SUMMARY OF ALASKAN RADON DATA

(Heidersdorf, December, 1987)

Detectors processed 331
Detectors in process 125
Communities sampled 50

Radon	<4 pCi/l	270
"	5-8 pCi/l	18
"	9-20 pCi/l	19
"	>20 pCi/l	11

Percent of detectors registering radon concentrations exceeding 4 pCi/l: .... 48 ÷ 331 = 14.5%

DISCLAIMER: Sample base still very small, with inadequate statewide coverage and early attention to Fairbanks hotspot.

CURRENTLY RECOGNIZED ALASKAN HOUSEHOLD RADON HOTSPOTS OR POTENTIAL ANOMALIES

(DGGS and DHSS data as of December 1987)

Area or District	Range of Radon Concentrations Exceeding 4 pCi/l	
Fairbanks (67)	5-800	(24)
Denali Park-Healy Area (77)	5-125	(24)
Circle Hot Springs (8)	5-31	(4)
Manley Hot Springs (3)	9-20	(1)
Northway (3)	9-20	(1)
Delta Junction (3)	5-8	(1)
Tok (3)	9-20	(1)
Seward (1)	5-8	(1)
Kodiak (13)	5-8	(1)

Results of EPA 1986-1987 Ten State Indoor Radon Survey

ESTIMATED PERCENT OF HOUSES WITH SCREENING LEVELS GREATER THAN 4pCi/l OF RADON

Colorado	39 %
Wisconsin	27
Wyoming	26
Kansas	21
Connecticut	19
Rhode Island	19
Kentucky	17
Tennessee	16
Michigan	9
Alabama	6
Alaska*	14

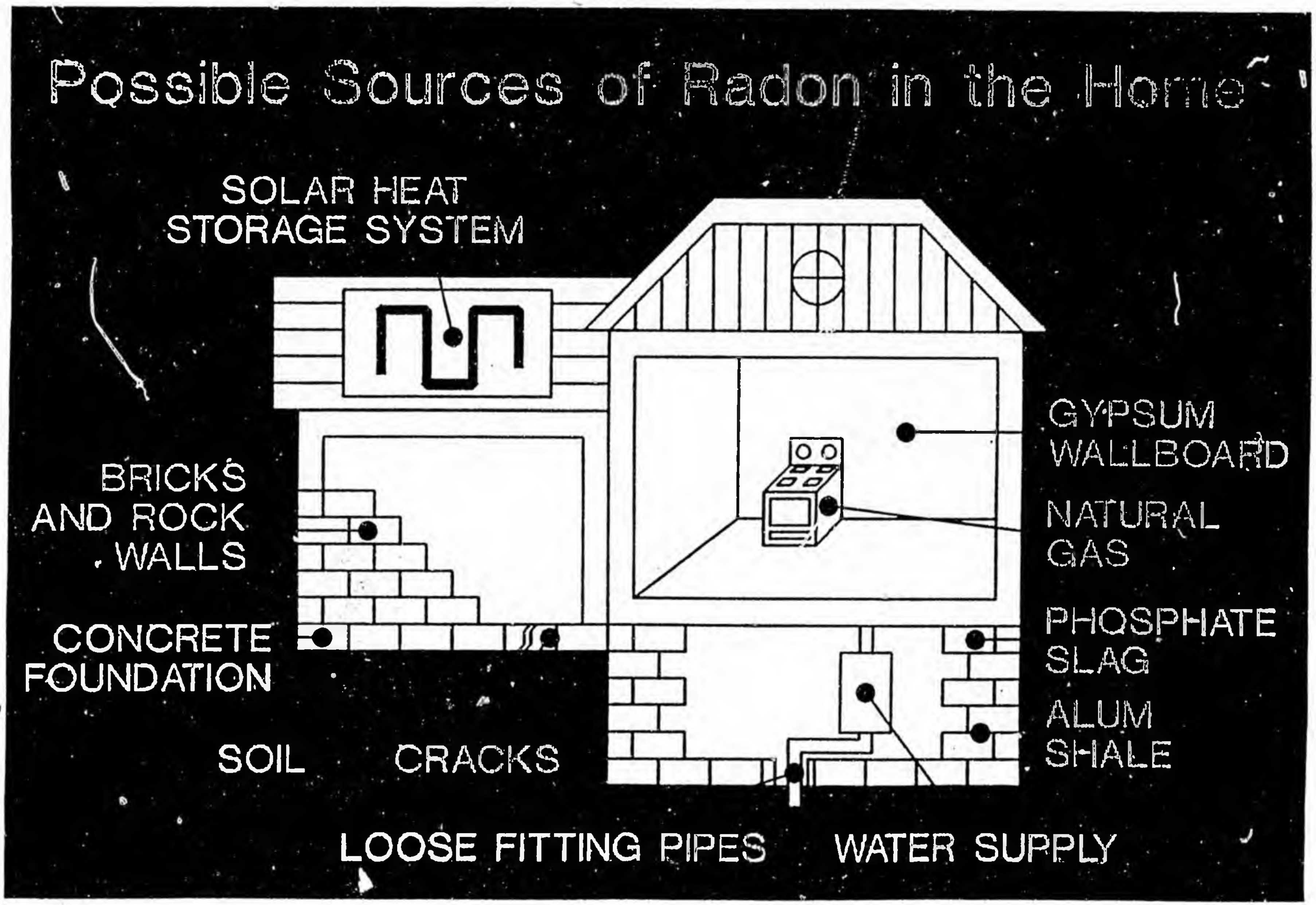
*Not representative sample

(From Heidersdorf, 1987)

RADON RISK EVALUATION CHART

pCi/l	WL	Estimated number of LUNG CANCER DEATHS due to exposure (out of 1000)	Comparable exposure levels		Comparable risk
200	1	440 - 770	1000 times average outdoor level		More than 60 times non-smoker risk
100	0.5	270 - 630	100 times average outdoor level		4 pack-a-day smoker
40	0.2	120 -380			20,000 chest x-rays per year
20	0.1	60 - 210	100 times average outdoor level		2 pack-a-day smoker
10	0.05	30 - 120	10 times average outdoor level		1 pack-a-day smoker
4	0.02	13 - 50			5 times non-smoker risk
2	0.01	7 - 30	10 times average outdoor level		200 chest x-rays per year
1	0.005	3 - 13	Average indoor level		Non-smoker risk of dying of lung cancer
0.02	0.001	1 - 3	Average outdoor level		20 chest x-rays per year

(Modified from U.S. EPA Report #OPA-86-004)


Possible Sources of Radon in the Home
SOLAR HEAT STORAGE SYSTEM
BRICKS AND ROCK WALLS
CONCRETE FOUNDATION
SOIL
CRACKS
GYPSUM WALLBOARD
NATURAL GAS
PHOSPHATE SLAG
ALUM SHALE
LOOSE FITTING PIPES
WATER SUPPLY

RADON IN ALASKAN HOMES

by

Sidney D. Heidersdorf
Radiological Physicist
Division of Public Health
Department of Health and Social Services
September 1, 1987

SUMMARY

This report presents the results of 246 tests for radon in Alaska homes and public facilities. Approximately 70 additional radon detectors are in Alaskan homes at the present time. In addition to the results from the Department of Health and Social Services monitoring program data have been compiled from tests conducted by a number of other State and Federal agencies, and companies providing the service. Seventeen percent of the homes monitored had levels which exceeded the EPA recommended guideline of 4 pCi/l in air. Ten percent of the homes exceeded the remedial action level of 8 pCi/l recommended by the National Council of Radiation Protection and Measurements. The levels ranged from normal background to a high of 383 pCi/l in air. Eight homes exceeded 20 pCi/l. With one exception (Mt. McKinley area) all homes exceeding 20 pCi/l were in the Fairbanks area. Radon in water is not a significant factor in the elevated levels found in the homes in the Fairbanks area.

Overall, the data show a general picture of low radon levels in Southeast Alaska and along the coastline, with higher levels in interior Alaska. In the Fairbanks area, conditions exist for a potentially serious health problem in a small percentage of homes, with 7 of the 54 homes monitored exceeding 20 pCi/l. The problem appears to exist principally for homes in the surrounding hills. The Mt. McKinley area also shows elevated radon concentrations with one home exceeding 20 pCi/l.

It is recommended that individuals living in the Fairbanks and Mt McKinley areas have their homes monitored because of the pattern of elevated radon concentration seen in the two areas.

Recommendations are also given to homeowners following receipt of monitoring results.

RADON IN ALASKAN HOMES

by

Sidney D. Heidersdorf
Radiological Physicist
Division of Public Health
Department of Health and Social Services

September 1, 1987

INTRODUCTION

In recent years, residential exposure to indoor radon has been given considerable attention nationally. Much of the public's interest and concern about radon has been generated by discovery of exceptionally high concentrations of radon gas in homes in an area known as the Reading Prong. This is a uranium rich area that extends through Pennsylvania and into parts of New Jersey and New York. It now appears likely that radon in homes will be one of the nation's most significant radiological health problems to arise in many years.

This report summarizes radon monitoring data for the State of Alaska obtained by the Department of Health & Social Services through its home radon monitoring program. Also included is data compiled from other sources including State and Federal agencies, companies providing monitoring services in Alaska and individuals.

BACKGROUND

Radon is a radioactive gas produced naturally through a series of radioactive transformations originating with uranium 238 which is found in trace quantities throughout the earth's crust. In some areas the uranium deposits are of higher concentrations and consequently produce more radon. Because of the very long radiological half-life of uranium the production of radon within the earth remains essentially constant and may be found in minute concentrations almost everywhere on earth. It is colorless, odorless and chemically inert. Because radon is not chemically reactive it is free to permeate through rock fractures and underground fissures and eventually emanate from the earth at the surface as soil gas.

Under certain conditions significant amounts of radon can infiltrate and accumulate in homes presenting a health threat to residents. Radon enters homes from several sources. The largest source of indoor radon is directly from the soil. Depending upon where and how the home is built radon can enter as soil gas through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints and other tiny cracks or pores found in walls. Groundwater is considered the largest of all secondary sources of radon. It enters a home through the domestic water supply and is released into the home when the water is used in the kitchen or bathroom. Other sources of radon are the materials used in the construction of the home, for example stone which contains large quantities of minerals. In general, water and building materials are not considered major sources of indoor radon.

Radon can be found in high concentrations in soil and rocks containing uranium, granite and phosphates. However, this in itself does not mean that the homes in that area will have high levels. In order for a home to have a radon problem at least four conditions must exist: 1) radon must be present in the soil in sufficient quantity, 2) the soil must be permeable, 3) the structure must have openings below ground level and, 4) inside pressure in the home must be less than the outside pressure. It is possible that homes situated away from areas of known concentrations of uranium may have high concentrations of radon because of the geological discontinuities through which radon gas may travel.

While radon source strength is the most important factor, home ventilation has obvious effects. Energy efficient measures in Alaska homes where the number of air exchanges per day is reduced may increase the concentration of radon, since these homes are designed to keep heated air from escaping. It is also known that radon levels in the same home may vary appreciably with time. Studies have documented both diurnal and seasonal variations. Because of the many variables involved it is extremely difficult, if not impossible, to predict which homes will have high concentrations of radon. The only way of knowing what concentration exists in a specific home is to actually measure the level.

Tests normally should be carried out over a period of two to three months in an effort to average the results since health risks are related to the average level, not the peak.

HEALTH EFFECTS

The major known health effect associated with exposure to radon in air is an increased risk of developing lung cancer. The American Cancer Society estimates that approximately 136,000 people will die of lung cancer in 1986. Of that numbe. has been estimated by experts in radiation bioeffects that between 5 and 20 thousand of these lung cancer deaths may be attributed to radon. As with other carcinogenic agents there is some uncertainty as to the actual degree of risk involved.

Despite the uncertainties surrounding the risk estimates for radon, it is generally accepted that the greater the exposure to radon the greater the risk for developing cancer at some time in the future. Therefore, the actual risk for an individual developing cancer depends upon the average radon concentration in the individual's home and the length of exposure. Reducing either of these factors will reduce the risk. Also, the time between exposure and the onset of the disease may be many years since lung cancer usually does not occur until people are 45 or older. Lung cancer has other causes and presently lung cancer caused by radon cannot be differentiated from cancer caused by smoking or any other agent. Therefore, it is impossible to attribute a specific case of lung cancer to radon exposure.

The health risks for radon in water include the risk of stomach cancer following ingestion and lung cancer as a result of inhalation of the radon gas which escapes from the water when it is aerated and used in the home. Generally the risk from ingestion of radon in water is small compared to the risk from inhalation, and the primary concern about radon in water is its contribution to the air concentration when water is used in the home.

EXPOSURE GUIDANCE

There are two remedial action levels proposed for general population exposure to radon in air. The U. S. Environmental Protection Agency (EPA) has adopted a radon concentration level of 4 picocuries per liter (pCi/l) of air as the guidance level above which home owners are advised to give consideration for corrective action. (A picocurie is one trillionth of a curie, a common unit of radioactivity). The National Council on Radiation Protection and Measurements (NCRP) recommends 8 pCi/l as a remedial action level above which steps should be taken to reduce exposure. The NCRP is a nonprofit corporation chartered by Congress in 1964 to develop and disseminate in the public interest information and recommendations about protection against radiation. The difference in the two standards simply reflects the uncertainty of the risk estimates as well as the fact that it is a judgement call. Present departmental policy is to inform homeowners of risk estimates and leave decisions regarding action up to the homeowner. By any standard, a home which exceeds 20 pCi/l of radon in air should be a candidate for remedial action to reduce levels. Those in the range from 4 - 20 pCi/l call for less urgent steps which might include further follow-up evaluation or action within a few years, especially if the levels are at the upper end of this range.

Four picocuries per liter is approximately twenty times the average outdoor level which is a part of our natural radiation background. A remedial action level should not be considered as a division between safe and harmful levels but simply a level which is achievable for residential structures while still not representing an unacceptable risk in view of the incidence of lung cancer to the general population from other causes. According to EPA estimates a 4 pCi/l exposure represents approximately 1 chance in 100 of an individual developing lung cancer for a lifetime of exposure. This is roughly the same as the normal incidence of lung cancer for non-smokers in the general population.

Radon risk estimates for lung cancer are based on epidemiological studies of underground uranium miners. The data for this population group are quite good making it more reliable than those studies which rely solely upon animal data. However, estimates of the health risk for low doses of radiation cannot be obtained directly. They can only be estimated statistically from cancer data observed at high doses by extrapolation down into the low dose region where cancer data are not available. In this process it is assumed that the risks associated with low doses are proportional to those observed at high doses. In development of the risk estimates for the general population it is assumed that an individual is exposed to a given concentration of radon over a lifetime of seventy years while spending approximately 75% of the time in the home.

There are no State, Federal or NCRP guidelines for radon concentrations in domestic water supplies similar to the EPA recommended guide for radon in ambient air. The EPA is presently considering the establishment of a level for radon in water but has not yet done so. With regard to risk estimates for radon in water per lifetime of exposure, it is estimated that there is one chance in 1,000 for a health effect at a concentration level of 10,000 pCi/l of radon in water, and one chance in 10,000 for a concentration of 1,000 pCi/l. This can be compared to the EPA risk level of one chance in 100 of getting lung cancer for a lifetime exposure (70 years) at a 4 pCi/l concentration of radon in air. In general, levels of radon in the air in a home are much more critical than the levels found in the domestic water supply.

In considering the data presented here, it is very important that the guidelines for <u>air</u> not be confused with levels found in <u>water</u>. As a rule of thumb, for normal water usage and household characteristics, one can assume that it will take about 10,000 pCi/l of radon in water to result in an air concentration of one pCi/l.

ALASKA RADON MONITORING

In the fall of 1985 the Department placed radon detectors in a few selected homes in various locations throughout the State. In 1986 this was repeated in additional homes. This effort included 17 homes in 11 locations. Radon concentrations in five homes exceeded the EPA guideline of 4 pCi/l, with a maximum level detected of 18 pCi/l. Beginning in late 1986 the Department began to offer a state-wide home radon monitoring service using the alpha-track method of detection. The detectors were provided to residents upon request for a fee of $30.00. The recommended monitoring period for the detectors was 3 months. In addition to the results reported here the Department has approximately 70 alpha-track detectors in Alaskan homes at the present time.

Data presented in this report came from a number of other sources as well. Within the past two years, the Department of Transportation and Public Facilities

(DOT/PF) and the Arctic Environmental Information Data Center also conducted small scale studies. In addition, the DOT/PF sponsored an evaluation of 37 public facilities through studies of a graduate student at the Unive ity of Alaska, Fairbanks. More recently additional air data has been gathered through the efforts of DOT/PF research staff, the Department of Natural Resources, the Cooperative Extension Service and other University of Alaska personnel. The results of a separate study by the National Park Service of housing at Mt. McKinley are also included. Finally, some radon in air data have been obtained directly from companies providing a monitoring service to homeowners. The total number of radon results from all sources listed above is 246.

In addition to the air monitoring, this report includes results of monitoring radon in water for 26 homes in the Fairbanks area. This effort was undertaken because of a concern over the possibility that radon in water was significantly contributing to elevated air concentrations found in some Fairbanks homes. At the request of the Department of Health and Social Services these samples were collected by personnel from the Departments of Environmental Conservation and Natural Resources. Many of the samples came from homes with high radon in air concentrations.

RESULTS

Table 1 summarizes the 246 radon in air results by detector type and four concentration ranges. This is a compilation from all sources listed above. Activated charcoal method of measurement represents monitoring periods of a few days to one week. The alpha-track method in most cases represents a monitoring period of 3 months. No differentiation is made between the winter or summer months, however there is reason to believe that the winter months represent conditions promoting the highest levels.

RADON IN AIR OF FAIRBANKS HOMES
(results by detector type)

Detector Type	Total Number	pCi/l: 4 or less	5 - 8	9 - 20	21+
Charcoal	105	77	13	11	4
Alpha-track	141	127	3	7	4
TOTALS	246	204	16	18	8
% of TOTAL:		83	7	7	3

(From Heidersdorf, 1987)

The above data includes the alpha-track results from a DOT/PF sponsored study of 37 public facilities across the State. For more detail Appendix 1 summarizes all data by location, number of results and concentration range. Monitoring results have been rounded to the nearest whole number for grouping into ranges. For example: 4.4 pCi/l has been reported to the 4 or less column, whereas 4.6 pCi/l would be reported in the 5 - 8 column.

The highest level for a public facility was a school at 5.2 pCi/l. All other results for public facilities were 4 or below. Results for the 209 homes ranged from background levels to a high of 383 pCi/l of air. Three homes had levels above 100 pCi/l. They were all in the Fairbanks area with levels of 383, 200 and 112 pCi/l. Approximately 10% of the homes exceeded the NCRP action level of 8 pCi/l. Seventeen % exceed the EPA guideline of 4 pCi/l. With only two exceptions, (one home each in Homer and Anchorage) all homes exceeding the 8 pCi/l limit are in Interior Alaska. For comparison purposes, Appendix II presents the results of the EPA 1986 - 1987 ten state indoor radon survey with the estimated percent of homes with levels greater that 4 pCi/l. The reader is cautioned that the results for Alaska presented here cannot be considered as representative of all Alaska homes in general.

Overall, the data show a general picture of low radon levels in Southeast Alaska and along the coastline, with higher levels in interior Alaska. It appears that interior Alaska deserves special attention. For example, in the Fairbanks area, conditions exist for a potentially serious health problem in a small percentage of homes, with 7 of the 54 homes monitored exceeding 20 pCi/l. The problem appears to exist principally for homes in the surrounding hills. The Mt. McKinley area also shows elevated radon concentrations with one home exceeding 20 pCi/l.

Table 2 summarizes the results for water samples from 26 homes in the Fairbanks area. Many of these homes were selected because of higher than normal radon in air concentrations.

Radon Concentration in Water (pCi/l)
(26 Fairbanks Homes)

pCi/l		Number
< 1,000		2
1,000 - 2,000		7
2,000 - 4,000		9
3,000 - 4,000		3
4,000 - 5,000		3
5,000 - 6,000		1
6,000 - 7,000		1
	TOTAL	26

(From Heidersdorf, 1987)

Results range from a low of 200 pCi/l to the highest level reported of 6476 pCi/l of radon in water. The water results show no correlation with radon in air levels measured in the homes thereby verifying that radon in water does not contribute significantly to the elevated air levels found in Fairbanks homes. This is not unexpected since a level of 10,000 pCi/l of radon in water is needed to produce a 1 pCi/l radon concentration in air.

There is nothing unusual about the levels found in the 26 homes in the Fairbanks area. Results from radon surveys nationally show that approximately 40% of the public water supplies in the U. S. have radon concentrations of 500 pCi/l, 10% have radon concentrations of 1,000 pCi/l, and 10% have levels of 5,000 pCi/l.

The Fairbanks air and water data are not necessarily representative of the typical home in the Fairbanks area since they were not randomly selected. Many were selected because of their locations in the surrounding hills. In addition it is important to remember that levels in one home cannot be used to predict levels in adjacent homes. However it is not unreasonable to suspect that areas which have yielded high results offer the greatest potential for neighboring houses with high levels. Also, one cannot assume that areas which have only low levels reported to date do not have outliers or neighborhood pockets with high radon concentrations. Only the actual measurement of the levels in a specific home can determine that.

RECOMMENDATIONS

Individuals living in interior Alaska, especially those in the Mt. McKinley and Fairbanks areas should have their homes monitored. In the Fairbanks area the potential for high radon appears to be greatest in the surrounding hills. This recommendation is directed specifically toward the Fairbanks and the Mt. McKinley areas because of the high levels observed in these two locations. It does not mean such levels could not be found elsewhere.

Recommendations for other areas may be forthcoming as additional data becomes available which indicates the need for expanding the scope of monitoring. The above recommendation is not intended to discourage homeowners in other areas of the State from having their homes monitored, since sporadic elevated levels have been detected in other interior Alaska locations such as Circle Hot Springs, Delta Junction, Manley Hot Springs, Northway, Tok and Palmer.

The following is recommended for individuals who have obtained monitoring results for their home:

1) Individuals with results of 20 pCi/l or higher based on charcoal analysis should carry out a 3-month evaluation of their home using the alpha-track detector.

2) Individuals with levels of 20 pCi/l and above using the alpha-track detector should take steps to reduce the levels in their homes. Follow-up monitoring should be conducted to verify effectiveness of reduction methods.

3) Individuals with alpha-track results ranging from 4 to 20 pCi/l should give serious consideration to reducing their levels to the extent possible, especially if the levels are at the upper end of the range.

4) Individuals with charcoal or alpha-track results below 4 pCi/l need take no action if the measurement was made with the house closed up prior to and during the testing period.

ALASKA RADON RESULTS
(All data through 8/20/87)

	Location	Number	Concentration of radon, picocuries per liter of air (pCi/l) 4 or less	5-8	9-20	20 +
1	Anchorage	39	38		1	
2	Arctic Circle H.S.	1		1		
3	Barrow	1	1			
4	Bethel	1	1			
5	Bettles	1	1			
6	Craig	1	1			
7	Deadhorse	1	1			
8	Delta Junction	3	2	1		
9	Dillingham	1	1			
10	Douglas	3	3			
11	Eagle	1	1			
12	Eagle River	10	10			
13	Fairbanks	54	33	7	7	7
14	Fort Yukon	1	1			
15	Galena	1	1			
16	Glenallen	1	1			
17	Haines	5	5			
18	Healy	1	1			
19	Homer	4	3		1	
20	Hope	1	1			
21	Juneau	23	23			
22	Kasilof	1	1			
23	Kenai	1	1			
24	Ketchikan	4	4			
25	King Salmon	1	1			
26	Klawock	1	1			
27	Kodiak	3	3			
28	Kotzebue	2	2			
29	Manley Hot Springs	3	2		1	
30	McGrath	1	1			
31	McKinley Park	41	29	6	5	1
32	Nenana	1	1			
33	Nome	1	1			
34	North Pole	2	2			
35	Northway	3	2		1	
36	Palmer	6	5		1	
37	Pedro Bay	1	1			
38	St. Mary's	1	1			
39	Seward	1		1		
40	Skagway	1	1			
41	Soldotna	4	4			
42	Sterling	1	1			
43	Tanacross	1	1			
44	Tok	2	1		1	
45	Unakleet	1	1			
46	Valdez	2	2			
47	Wales	1	1			
48	Wasilla	5	5			
	TOTALS	246	204	16	18	8

(From Heidersdorf, 1987)

Results of EPA 1986-1987 Ten State Indoor Radon Survey

ESTIMATED PERCENT OF HOUSES WITH SCREENING LEVELS GREATER THAN 4 pCi/l OF RADON

Colorado	39%
Wisconsin	27
Wyoming	26
Kansas	21
Connecticut	19
Rhode Island	19
Kentucky	17
Tennessee	16
Michigan	9
Alabama	6
Alaska (not representative sample)	17

(From Heidersdorf, 1987)

RADON INFORMATION PACKET

PROVIDED BY

COOPERATIVE EXTENSION SERVICE
ENERGY AND BUILDING SPECIALIST

NOVEMBER 1987

Alaskans
Meeting
Economic
Challenge

IN CONTROL

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF ALASKA

RICHARD SEIFERT
EXTENSION ENERGY SPECIALIST

207-D Eielson Building
Cooperative Extension Service
University of Alaska
Fairbanks, Alaska 99775-5200
U.S.A.

Phone (907) 474-7201

Radon Tests for Alaska
by Richard Seifert

In an effort to speed up radon research, New Shelter magazine, in conjunction with Air-Chek and Alpha Energy Labs, has agreed to coordinate a national radon survey. The goal is to create a national database on radon levels in homes and at the same time offer homeowners a discount on radon testers. This provides a chance for the average homeowner to test the radon levels in his home for a minimum cost and still contribute to a national study.

Test kits, normally $20 each, will cost survey participants $11.95. A questionnaire in the test kit will help to compile data on tested homes and locations. All names and addresses will be kept in the strictest confidence, which of course they should be if you must pay to participate! Please note that it has taken me more than two weeks to receive my kit, but I am told by the Air-Chek people that they will accept phone orders and ship them the same day for an additional $3 fee. Their phone number is (704) 891-5892. They also advise shipping the kits back to them first class--special handling at a minimum--because they have about a 12-day lifetime before analysis once the four-day exposure time is completed. If too much time elapses before the test is complete, the devices are difficult to read, so they must be sent back promptly.

To join in the testing and the survey, send your name, address and check of $11.95 to Air-Chek, P.O. Box 2000-NS, Penrose, NC 28766. After receiving the testing device, it is kept in the home for four days, and then returned to Air-Chek in the envelope provided. They'll process the results and advise the participant of the radon level in the home within 10 days. The survey findings will be published in a future issue of New Shelter magazine.

Do the first ($12) test initially. If this test shows greater than 10 pC/l, we recommend a three month test, which is available from CES. The following press release gives the details on this test!

Press Release

RADON TEST KITS NOW AVAILABLE THROUGH COOPERATIVE EXTENSION SERVICE, UAF

As a result of the recent concerns about radon levels in some of the areas in Fairbanks, the Cooperative Extension Service has entered into an agreement with the State Health Radiologists office in Juneau to make 3-month radon test kits available at the Fairbanks office of the Cooperative Extension Service.

These badges are a second-tier test. That means you should test first with a $12 three-day test kit to find out if you have a problem. The next step if you have a problem would be to buy one of these three-month test kits from the Cooperative Extension Service in Fairbanks. They cost $30, the same as they cost from the Juneau office.

It was felt that it would be useful to have them in Fairbanks since a larger part of the radon problems happen to be in the Fairbanks area. For information in obtaining one of these badges, please call Rich Seifert at the Cooperative Extension Service office 474-7201 weekdays 9 a.m. to 5 p.m.

-30-

RADON PROOFING IN NEW CONSTRUCTION

The best protection against the event of high radon levels in a home which has normal soil contact is to build it with radon-proof construction techniques. These include:

a. A sub-pad vapor barrier below the basement pad, sealed to all perforations of the pad with watertight seals, and tabbed around the perimeter of the pad to enable easy attachment to a wall vapor barrier.

b. Use of glas-clad dense fiberglass below grade insulation around the walls of the basement. This allows air movement and therefore radon escapement along the walls.

c. Use of a layer of below-pad gravel which is vented by perforated pipe around the perimeter and placed in the gravel. This allows for escape of radon from below the pad, and the system could even be negatively pressurized if necessary to remove radon from beneath the pad.

d. The supply of fresh air to the basement with an air-to-air heat recovery ventilation system is a normal requirement of an ACHP home which can be used to provide the basement ventilation.

e. Certification of the radon levels in the house can be provided through testing and subsequent disclosure of the test results in the sales agreement of the ACHP home.

Also available is a publication from the US EPA entitled "Radon Reduction in New Construction -- An Interim Guide," which is free for the asking at CES (474-7201).

United States Environmental Protection Agency

Office of Air and Radiation

U.S. Department Of Health and Human Services

Centers for Disease Control

August 1986

OPA-86-004

A Citizen's Guide To Radon

What It Is And What To Do About It

PHONE # 1-800-AIR-CHEK
or # 1-800-CK-RADON

Insertion of the above logo & phone number DOES NOT INFER endorsement by any of the above agencies.
This is a reprint of the EPA's Booklet furnished compliments of Air Chek. (Because of space limitations approximately 5% of the original material has been deleted.)

What is radon?

Radon is a radioactive gas which occurs in nature. You cannot see it, smell it, or taste it.

Where does radon come from?

Radon comes from the natural breakdown (radioactive decay) of uranium. Radon can be found in high concentrations in soils and rocks containing uranium, granite, shale, phosphate and pitchblende. Radon may also be found in soils contaminated with certain types of industrial wastes, such as the byproducts from uranium or phosphate mining.

In outdoor air, radon is diluted to such low concentrations that it is usually nothing to worry about. However, once inside an enclosed space (such as a home) radon can accumulate. Indoor levels depend both on a building's construction and the concentration of radon in the underlying soil.

How does radon affect me?

The only known health effect associated with exposure to elevated levels of radon is an increased risk of developing lung cancer. Not everyone exposed to elevated levels of radon will develop lung cancer, and the time between exposure and the onset of the disease may be many years.

Scientists estimate that from about 5,000 to about 20,000 lung cancer deaths a year in the United States may be attributed to radon. (The American Cancer Society expects that about 130,000 people will die of lung cancer in 1986. The Surgeon General attributes around 85 percent of all lung cancer deaths to smoking.)

Your risk of developing lung cancer from exposure to radon depends upon the concentration of radon and the length of time you are exposed. Exposure to a slightly elevated radon level for a long time may present a greater risk of developing lung cancer than exposure to a significantly elevated level for a short time. In general, your risk increases as the level of radon and the length of exposure increase.

How certain are scientists of the risks?

With exposure to radon, as with other pollutants, there is some uncertainty* about the amount of health risk. Radon risk estimates are based on scientific studies of miners exposed to varying levels of radon in their work underground. *Consequently, scientists are considerably more certain of the risk estimates for radon than they are of those risk estimates which rely solely on studies of animals.*

To account for the uncertainty in the risk estimates for radon, scientists generally express the risks associated with exposure to a particular level as a *range* of numbers. (The risk estimates given in this booklet are based on the advice of EPA's Science Advisory Board, an independent group of scientists established to advise EPA on various scientific matters.)

Despite some uncertainty in the risk estimates for radon, it is widely believed that **the greater your exposure to radon, the greater your risk of developing lung cancer.**

*How does radon cause lung cancer?

Radon, itself, naturally breaks down and forms radioactive decay products. As you breathe, the radon decay products can become trapped in your lungs. As these decay products break down further, they release small bursts of energy which can damage lung tissue and lead to lung cancer.

How is radon detected?

Since you cannot see or smell radon special equipment is needed to detect it. The two most popular, passive commercially-available radon detectors are the charcoal canister and the more expensive, slower, alpha track detector. Both of these devices are exposed to the air in your home for a specified period of time and sent to a laboratory for analysis.

Charcoal Canisters
Test Period: 1 to 4 days

How can I get a radon detector?

Homeowners in some areas are being provided with detectors by their state or local government. In many areas, private firms offer radon testing. Your state radiation protection office may be able to provide you with information on the availability of detection devices or services.

*Other ongoing studies may show a more conclusive relationship between Radon 220 (THRON) and cancer in other body tissue.

How should radon detectors be used?

Obtaining a useful estimate of the radon level in your home may require that several detectors be used to make measurements in different areas. Following the steps below should provide the information needed as you decide whether or not further action is advisable. (In making radon measurements, you should be sure to follow the instructions of the manufacturer as to the proper exposure period for the particular device you are using.)

Step One: The screening measurement

The first step you should take is to have a short-term "screening" measurement made to give you an idea of the highest radon level in your home. Thus, you can find out quickly and inexpensively whether or not you have a potential radon problem.

The screening measurement should be made in the lowest livable area of your home (the basement, if you have one). All windows and doors should be closed for at least 12 hours prior to the start of the test, and kept closed as much as possible throughout the testing period. This is necessary to keep the radon level relatively constant throughout the testing period. Because of the need to keep the windows closed as much as possible, we recommend that you make short-term radon measurements during the cool months of the year.

Step Two: Determining the need for further measurements

In most cases, one screening measurement is not a reliable measure of the *average* radon level to which you and your family are exposed. Since radon levels can vary greatly from season to season as well as from room to room, the screening measurement only serves to indicate the *potential* for a radon problem. Depending upon the result of your screening measurement, you may need to have follow-up measurements made to give you a better idea of the average radon level in your home.

The following guidance may be useful to you in determining the urgency of your need for follow-up measurements.

If your screening measurement result is **greater than about 1.0 WL or greater than about 200 pCi/l**, you should perform follow-up measurements as soon as possible. Expose the detectors for no more than one week. Doors and windows should be closed as much as possible during testing. You should also consider taking actions (see page 13) to immediately reduce the radon levels in your home.

If your screening measurement result is **about 0.1 WL to about 1.0 WL or about 20 pCi/l to about 200 pCi/l**, perform follow-up measurements. Expose detectors for no more than three months. Doors and windows should be closed as much as possible during testing.

If your screening measurement result is **about 0.02 WL to about 0.1 WL or about 4 pCi/l to about 20 pCi/l**, perform follow-up measurements. Expose detectors for one year, or make measurements of no more than one week duration during each of the four seasons.

If your screening measurement result is **less than about 0.02 WL or less than about 4 pCi/l**, follow-up measurements are probably not required. If the screening measurement was made with the house closed up prior to and during the testing period, there is relatively little chance that the radon concentration in your home will be greater than 0.02 WL or 4 pCi/l as an annual average.

Step Three: The follow-up measurement

Follow-up measurements will provide you with a relatively good estimate of the *average radon concentration* to which you and your family are exposed. **We strongly recommend that you make follow-up measurements before you make any final decisions about whether to undertake major efforts to permanently correct the problem.**

Follow-up measurements should be made in at least two lived-in areas of your home. If your home has lived-in areas on more than one floor, you should make measurements in a room on each of the floors. An example is to take a measurement in the living room on the first floor and another in a second-floor bedroom. *The results of the follow-up measurements should be averaged together.*

What do my test results mean?

The results of your follow-up measurements provide you with an idea of the average concentration throughout your home. The actual risk you face depends upon the amount of time you are exposed to this concentration.

The figures on the facing page illustrate the number of lung cancer deaths, out of a group of 100 people, that scientists would attribute to exposure to specific levels of indoor radon. The first three figures assume that these 100 individuals spent 75 percent of their time in the dwelling for 70 years. The numbers below each picture indicate what scientists consider to be a reasonable range of estimates of lung cancer deaths that could be attributed to the radon exposure. This is in addition to the number of lung cancer deaths attributed to other causes. (On average, about four people out of a hundred die of lung cancer from all causes combined.) The pictures represent the midpoint of the ranges.

How quickly should I take action?

In considering whether and how quickly to take action based on your test results, you may find the following guidelines useful. EPA believes that you should try to permanently reduce your radon levels as much as possible. Based on currently available information, EPA believes that levels in most homes can be reduced to about 0.02 WL (4 pCi/l).

If your results are about 1.0 WL or higher, or about 200 pCi/l or higher:
Exposures in this range are among the highest observed in homes. Residents should undertake action to reduce levels as far below 1.0 WL (200 pCi/l) as possible. We recommend that you take action within several weeks. If this is not possible, you should determine, in consultation with appropriate state or local health or radiation protection officials, if temporary relocation is appropriate until the levels can be reduced.

If your results are about 0.1 to about 1.0 WL, or about 20 to about 200 pCi/l:
Exposures in this range are considered greatly above average for residential structures. You should undertake action to reduce levels as far below 0.1 WL (20 pCi/l) as possible. We recommend that you take action within several months.

If your results are about 0.02 to about 0.1 WL, or about 4 pCi/l to about 20 pCi/l:
Exposures in this range are considered above average for residential structures. You should undertake action to lower levels to about 0.02 WL (4 pCi/l) or below. We recommend that you take action within a few years, sooner if levels are at the upper end of this range.

If your results are about 0.02 WL or lower, or about 4 pCi/l or lower:
Exposures in this range are considered average or slightly above average for residential structures. Although exposures in this range do present some risk of lung cancer, reductions of levels this low may be diffcult, and sometimes impossible, to achieve.

Remember: There is increasing urgency for action at higher concentrations of radon. The higher the radon level in your home, the faster you should take action to reduce your exposure. If you find elevated radon concentrations in your home, you should take the relatively easy, short-term actions described on the back page. See: How can I reduce my risk to Radon?

Are there other factors I should consider?

Most of the risk information given in this pamphlet, as well as the recommendations for taking corrective action, are based on the general case. Your individual living patterns could influence your assessment of your risk and your decisions about the need for further action. Your answers to the following questions may help you evaluate your personal risk.

- Does anyone smoke in your home? Scientific evidence indicates that smoking may increase the risk of exposure to radon. In addition, smoking significantly increases your overall risk of lung cancer.

- Do you have children living at home? Although there are no studies of children exposed to radon to determine whether they are more sensitive than adults, some scientific studies of other types of radiation exposure indicate that children may be more sensitive. Consequently, children could be more at risk than adults from exposure to radon.

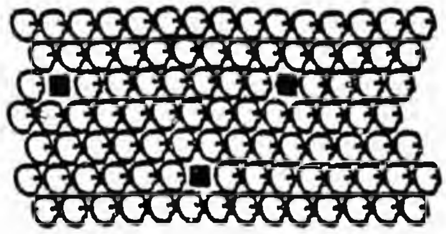
- How much time does any family member spend at home? The risk estimates given in this pamphlet assume that 75 percent of a person's time is spent at home. If you or your family spend more or less time at home, you should take this into consideration.

- Does anyone sleep in your basement? Since radon concentrations tend to be greater on the lower levels of a home, a person who sleeps in the basement is likely to face a greater risk than a person who sleeps in a second-floor bedroom.

- How long will you live in your home? The risk estimates in this booklet are based on the assumption that you will be exposed to the radon level found in your home for roughly 70 years. As you evaluate your potential risk, therefore, you might consider the total amount of time you expect to live in your home. But remember: other houses you have lived in—or will live in—may have the same or higher radon levels.

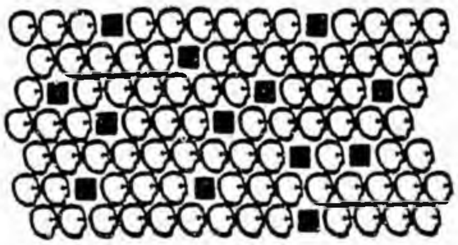
Lung Cancer Deaths Associated With Exposure To Various Radon Levels Over 70 Years

WL = 0.02
pCi/l = 4



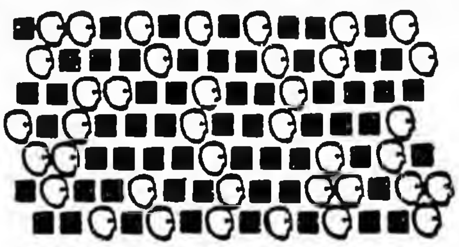
Between 1 and 5 out of 100

WL = 0.1
pCi/l = 20



Between 6 and 21 out of 100

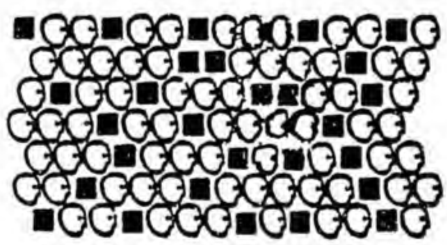
WL = 1.0
pCi/l = 200



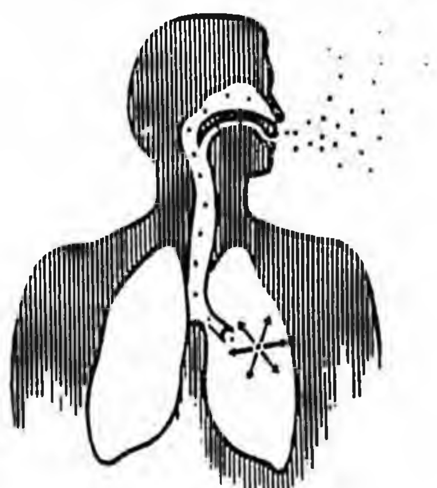
Between 44 and 77 out of 100

If these same 100 individuals had lived only 10 years (instead of 70) in houses with radon levels of about 1.0 WL, the number of lung cancer deaths expected would be:

WL = 1.0
pCi/l = 200



Between 14 and 42 out of 100



How does radon get into a home?

Radon is a gas which can move through small spaces in the soil and rock on which a house is built. Radon can seep into a home through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints, and tiny cracks or pores in hollow-block walls.

Radon also can enter water within private wells and be released into a home when the water is used. Usually, radon is not a problem with large community water supplies, where it would likely be released into the outside air before the water reaches a home. (For more information concerning radon in water, contact your state's radiation protection office.)

In some unusual situations, radon may be released from the materials used in the construction of a home. For example, this may be a problem if a house has a large stone fireplace or has a solar heating system in which heat is stored in large beds of stone. *In general, however, building materials are not a major source of indoor radon.*

How can I reduce my risk from radon?

Your risk of lung cancer from exposure to radon depends upon the amount of radon entering your home and the length of time it remains in your living areas. Listed below are some actions you might take to immediately reduce your risk from radon. These actions can be done quickly and with minimum expense in most cases.

- Stop smoking and discourage smoking in your home. By doing so, you should reduce your family's overrall chance of developing lung cancer, as well as reducing your family's risk from radon exposure.
- Spend less time in areas with higher concentrations of radon, such as the basement.
- Whenever practical, open all windows and turn on fans to increase the air flow into and through the house. This is especially important in the basement.
- If your home has a crawl space beneath, keep the crawl-space vents on all sides of the house fully open all year.

While the above actions will help reduce your risk from radon, they generally do not offer a long-term solution. You can find more information about permanent, cost-effective solutions to a radon problem in the EPA publication, *Radon Reduction Methods: A Homeowner's Guide*. A copy of this booklet may be obtained from your state radiation protection office or from your EPA regional office. *(AIR CHEK has a limited supply of reprints of this booklet.)*

When did radon become a problem?

Radon has always been present in the air. Concern about elevated indoor concentrations first arose in the late 1960's when homes were found in the West that had been built with materials contaminated by waste from uranium mines. Since then, cases of high indoor radon levels resulting from industrial activities have been found in many parts of the country. We have only recently become aware, however, that houses in various parts of the U.S. may have high indoor radon levels caused by *natural* deposits of uranium in the soil on which they are built.

Does every home have a problem?

No, most houses in this country are not likely to have a radon problem; but relatively few houses do have highly elevated levels. *The dilemma is that, right now, no one knows which houses have a problem and which do not.* You may wish to call your state radiation protection office to find out if any high levels have been discovered in your area.

Many states, as well as the federal government, are sponsoring work to identify areas of the community which are likely to have indoor problems. *However, early results from this work are inconclusive. If you are concerned that you may have an indoor radon problem, you should consider having your home tested.*

Radon Risk Evaluation Chart

pCi/l	WL	Estimated number of lung cancer deaths due to radon exposure (out of 1000)	Comparable exposure levels	Comparable risk
200	1	440—770	1000 times average outdoor level	More than 60 times non-smoker risk
100	0.5	270—630	100 times average indoor level	4 pack-a-day smoker
40	0.2	120—380		20,000 chest x-rays per year
20	0.1	60—210	100 times average outdoor level	2 pack-a-day smoker
10	0.05	30—120	10 times average indoor level	1 pack-a-day smoker
4	0.02	13—50		5 times non-smoker risk
2	0.01	7—30	10 times average outdoor level	200 chest x-rays per year
1	0.005	3—13	Average indoor level	Non-smoker risk of dying from lung cancer
0.2	0.001	1—3	Average outdoor level	20 chest x-rays per year

Sources of Information

If you would like further information or explanation on any of the points mentioned in this booklet, you should contact your state radiation protection office.

If you have difficulty locating this office, you may call your EPA regional office listed to the right. They will be happy to provide you with the name, address, and telephone number for your appropriate state contact.

EPA Regional Offices

EPA Region 1
Room 2203
JFK Federal Building
Boston, MA 02203
(617) 223-4845

EPA Region 2
26 Federal Plaza
New York, NY 10278
(212) 264-2515

EPA Region 3
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-8320

EPA Region 4
345 Courtland Street, NE
Atlanta, GA 30365
(404) 881-3776

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

EPA Region 6
1201 Elm Street
Dallas, TX 75270
(214) 767-2630

EPA Region 7
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2803

EPA Region 8
Suite 1300
One Denver Place
999 18th Street
Denver, CO 80202
(303) 283-1710

EPA Region 9
215 Fremont Street
San Francisco, CA 94105
(415) 974-8076

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

RADON CONCERNS IN ALASKA

by R.D. Seifert

I chose the title of this article very carefully because I am trying very hard not to be an alarmist. The reasons for this will become evident as I describe what radon is and how it affects the indoor environment in Alaska. Radon is a colorless, odorless gas which is a natural by-product of uranium decay in most soils. It can be found in especially high concentrations in soils and rocks containing uranium such as uranium mine tailings, granite, shales, phosphate or pitchblende. Radon can also be found in certain soils contaminated with industrial wastes such as the by-products from uranium mining or phosphate mining.

Normally, in outdoor air, radon is diluted to such a low concentration that it is nothing to worry about. It's the indoor, enclosed spaces that can accumulate radon which are of concern. Indoor levels depend both on the construction of the building and the concentration of radon in the underlying soil. Because I am the energy and building specialist with Cooperative Extension at the University of Alaska-Fairbanks, I have investigated the presence and movement of radon in Alaskan buildings.

Back in mid-1986, I tried to encourage people to test for radon in buildings by participating in a national radon survey. This survey was organized through Rodale's New Shelter magazine. People were encouraged to buy a test kit for approximately $12, expose it in their homes, and then send it to a laboratory for analysis. They would be informed of the radon level in their house.

Broad awareness that radon could pose a health problem only developed recently. Actually, radon has been an indoor air quality issue for 20 or 30 years, and it has been affecting our lives for millennia. However, attention to radon emerged from studying energy efficient homes, and was first thought to be a problem because buildings were becoming more tight. Therefore, any pollutants which entered the indoor building environment probably remained longer, and possibly posed a greater risk to the occupants of the building. However, this has generally been debunked by a paper from the buildings group at the University of California-Berkeley. Headed by Doctor Nero, this group generally characterized the sources and environmental influences on radon transport, and found that really the most important factor for determining radon concentration in buildings was the source of the emissions in the soil beneath the building.

This was also brought home by the striking and sensational reporting of a radon problem by the U.S. press. The little community of Boyertown, Pennsylvania, became famous for its high radon concentrations when one of its citizens, who worked at the Limerick Nuclear Power Plant in Pennsylvania, suddenly came into work several days in a row with his badge exposed and hotter (in a radiation sense) than when he left the plant. This was of great concern to the radiation physicists working here, and they eventually determined that his house was extremely radon-rich: several thousand times the recommended limit for exposure.

As a result of that incident and much attention to the problem of radon in the indoor environment, many subsequent events have occurred. The Environmental Protection Agency has issued a publication entitled Citizen's Guide to Radon, describing what radon is and what to do about it. They also published an additional pamphlet called Radon Reduction Methods, a homeowner's guide to what to do as a result of high radon levels in the home. (In the public interest, I might add that I have copies of these two publications in my office. Most of the items I refer to in this article are available for public perusal. They can be obtained by calling my office in Fairbanks, Alaska, (907) 474-7201.)

The radon problem has become important enough in Pennsylvania that it is now law that when a property is sold through a real estate agent, that agent must have the owner sign a disclosure statement on radon. This disclosure statement poses the question, "Have you ever had the building tested for radon?" If you have, you must state when the test was done and what the results were. On the contrary side, if you have not tested, you must say so and sign a statement saying that you do not know what the radon level is in the home. Obviously, this is intended to discourage people from unloading radon "problem" houses onto unsuspecting purchasers in Pennsylvania. It is worth noting this particular bit of law, because I predict that in 5 years this necessity to dis-

Richard D. Seifert is the energy and building specialist with the Cooperative Extension Service at the University of Alaska-Fairbanks.

close the radon levels in the home will be the law nationwide, including Alaska.

In Alaska, we have now had two simultaneous radon surveys proceeding for about eight months, since I first made public the radon tests from both Alaska and the National Radon Survey. Generally, the results have not been alarming. In most cases, the houses are below four picoCuries/liter, which is the recommended limit for long-term exposure given by the Environmental Protection Agency. This is an acceptable level of radiation exposure, but it is often difficult to reduce levels below this amount. However, there have been several houses, notably in the Fairbanks area, where high levels 20-50 picoCuries/liter) have been encountered over the winter period. There does not seem to be any pattern or predictability to these yet, because there are only about three or four instances where high levels of radon have been detected. However, there have been enough instances to cause me to conduct further research into the problem.

My first research effort was to review the geology of the Fairbanks area. I wanted to find out whether, in fact, we have any suspect geologies that might increase radon levels in homes. Paul Metz of the University's mining and engineering department was my first contact. Metz is experienced in the bedrock geology of the Fairbanks area and, in fact, showed me research indicating that there was a very slight enrichment of uranium in the mineralized areas north of Fairbanks, in the Cleary sequence and in the areas around Gilmore Dome. This is interesting but not conclusive in any way. However, there is enough uranium to provide a source of radon in the area.

Taking this research further, I encountered an excellent paper by a professor from the University of North Carolina, Harry E. LeGrande. His paper is entitled, "Radon and Radium Emanations from Fractured Crystalline Rocks - A Conceptual Hydrogeological Model." LeGrande discusses the movement, transport and generation of radon from soil to air and to buildings in a very lucid and detailed presentation. He gives the following conditions which could lead to high radon concentrations.

1. Granite and associated rocks with normal or above-normal amounts of uranium.

2. Normal interconnecting fracture patterns of weathered rock.

3. A thin mantle of relatively impermeable clay soil.

4. Repeated cycles of recharge of a fluctuating water table in the fracture zone or in the overlying weathered rock.

5. Indentation of buildings into soil and rock materials.

6. Building construction allowing relatively easy inflow of air from the subsoil and rock.

Just a casual assessment of the buildings and geology in the Fairbanks area easily identified five of these six factors. The only one we are not certain of is number 4. However, repeated cycles of recharge of a fluctuating water table in the fracture zone may not be an issue for that portion of the radon emanation of soils which is airborne.

LeGrande's paper also makes this point: there is a key factor in how deeply the soil is penetrated, and what elements of the soil and rock are penetrated by a basement which could lead to a radon problem. The factor that needs to be understood about underground airborne radon is its mobilization from what is normally a mineral (uranium) to a gas. It is the gas phase of radon which makes it a problem. As soon as radon is formed in the decay of radium (which itself has decayed from uranium), it suddenly has the ability to become airborne. The amount of air entrapped in the pockets and zones of porous soil above bedrock is very critical to the amount of radon which becomes released in the air.

We believe the following happens. There is a characteristic soil regime in the Fairbanks area which results from aeolian silt deposits. The silts are normally deep (60 feet) near the base of a hill. As one moves up the slope of the hill, the silts and topsoil get shallower and shallower until--at the top of the slope, near the crest of the hill--there is almost no soil at all, and fractured bedrock reaches the surface. This suggests that the construction of a basement on a hillside, where soil and fractured bedrock are intercepted in the excavation for the basement, may lead to a very high probability of radon penetration into a building. At least the availability of radon should be suspected at these sites.

Postulation of how radon moves in the soil is an interesting issue. It may be seasonally affected by the additional overlying layer of frozen soil which could make the permeability of the frozen layer very minimal, leading one to hypothesize that great seasonal variations in the concentration of radon in basements at certain elevations and under certain conditions could occur. Seasonal frost at the soil surface may enhance winter transport of radon into buildings because the soil surface is impermeable, leaving basements as the easiest exit point of radon to the atmosphere. In fact, most of the known sites where high radon concentrations exist are, indeed, sites that have these characteristics. The homes have basements that intercept the soil bedrock, and penetrate the fractured bedrock area and the overlying soil, and they are near the crest of hills. So indications are that this hypothetical mechanism for the release of radon to buildings is, in fact, a good candidate for understanding why some houses have radon and others nearby may not.

Perhaps the most important thing we can say at this time about radon is that there are very easy and relatively inexpensive methods to prevent radon penetration into a newly constructed building. Because radon has to come in through leaks in the basement and pretty much through that mechanism alone, sealing the basement is the key to solving the problem. I have, through my work, developed a list of radon-proofing building techniques for new construction.

1. If a concrete pad is to be used, as in a typical basement, then it is recommended that a subpad polyethylene vapor barrier be placed below the basement pad, sealed to all perforations of the pad with a watertight seal. Allow a tab around the perimeter of the pad to enable easy attachment to a wall vapor barrier. The tab around the perimeter of the pad should be at least 6 inches above the expansion joint at the base of the pad next to the concrete footing of the basement to allow for easy attachment to the wall vapor barrier.

2. Use of Glas-Clad dense fiberglass below grade insulation around the walls of your basement can allow air movement and, therefore, radon escapement along the outside walls. Unfortunately, this product is not readily available in the Fairbanks area and, to my knowledge, is not available elsewhere in Alaska. It is available in Canada and is used quite frequently there. We need to bring it into our market.

3. Use of a layer of below-pad gravel which is vented by a perforated pipe around the perimeter. This allows radon to escape from below the pad. The system could even be negatively pressurized by pumping it, if necessary, to remove radon from beneath the pad. This is not absolutely essential, but it is good building practice. Such a system provides a very good stop-gap method for areas where there is cause for concern about eventual radon problems.

4. The supply of fresh air to the basement with an air-to-air heat recovery ventilation system is a normal requirement of a well-built home today, and it can also be used to provide the basement ventilation after sealing against radon.

These recommendations, by the way, have been made an integral part of the new Alaskan Craftsman Home specifications, which the Cooperative Extension Service is also promoting at this time.

So far I have talked a great deal about where radon comes from, what it does, what it is and how to prevent it from being a health problem. The only known health affect associated with exposure to elevated levels of radon is an increased risk of developing lung cancer. Of course, not everyone exposed to elevated levels of radon will develop lung cancer. The time between exposure and the onset of the disease may be many years. According to the EPA publication, "A Citizen's Guide to Radon," scientists estimate that from about 5,000 to 20,000 lung cancer deaths a year in the United States may be attributed to radon. The American Cancer Society, on the other hand, estimates that about 130,000 people died of lung cancer in 1986, but about 85% of these lung cancer deaths relate to smoking. There is also some evidence of a synergistic effect of smoking and radon. Risk increases with the level of radon and the number of cigarettes smoked, but risk increases geometrically. Thus, the risk associated with both smoking and radon is more than twice the sum of the two separate risks.

Radon risk estimates are based upon scientific studies of uranium miners exposed to varying levels of radon in their work underground. Consequently, scientists are considerably more certain of risk estimates for radon than they are of the risk estimates which rely solely on studies of animals. Despite some uncertainty in the risk estimates for radon, it is widely believed that increased exposure to radon increases the risk of developing lung cancer. As with many problems in health, air pollution and naturally occurring environmental factors, we never know enough about these problems early on to make accurate predictions of their effects on people. Because of this, I, along with several other associates at the Institute of Northern Engineering, University of Alaska-Fairbanks, have proposed research on radon, especially the transport mechanisms and sources of radon in the northern environment.

There have also been tests conducted by the Alaska Department of Transportation and Public Facilities to detect radon in public buildings. They have found that an overwhelming majority of the public buildings had very low radon levels (less than 1 picoCurie/liter) in 50 out of 56 buildings tested. However, it should be noted that most of the buildings they tested have very high levels of air exchange and ventilation. Therefore, such buildings would normally be expected to have diluted levels of radon. It is not the large, well-ventilated public buildings where most of the exposure will occur. It will be in home environments which are unsuspectingly built on sites where the potential exists for radon penetration.

Much of the research that needs to be done still remains. I would encourage everyone who reads this article to test their own home if they have reason to suspect their site. Let me give two danger signs of a potential radon problem in the home:

1. A full basement that was not built with an exterior polyethylene vapor barrier under the pad.

2. Basement excavation encountered weathered rock and/or bedrock under the existing basement. This is especially the case with homes built on hillsides at higher elevations in the Tanana Valley.

As I indicated earlier, the jury is still out and we need to know more about this problem. Hopefully, research will soon examine radon transport in Alaska. I would suggest all readers who are interested in testing to contact me for a packet of information on radon safety and health, and for information on where to obtain test kits for radon.

The following publications were used in this paper.

Radon Reduction Methods, a Homeowner's Guide, U.S. Environmental Protection Agency, Seattle, WA. Publication No. OPA-86-005. 1986.

Citizen's Guide to Radon, U.S. Environmental Protection Agency, Seattle, WA. Publication No. OPA-86-004. 1986.

LeGrande, Harry E. Radon and Radium Emanations from Fractured Crystalline Rocks - A Conceptual Hydrogeological Model. Vol. 25, No. 1, Groundwater, January-February 1987. pp. 59-69.

Nero, A.V., Jr., R.G. Sextro, S.M. Doyle, B.A. Moed, W.W. Nazaroff, K.L. Revzan, and M.B. Schwer. 1985. Characterizing the sources, ranges and environmental influences of radon 222 and its decay products. Science of the Environment, Elsevier Science Publishers, B.V. Amsterdam. 45:233-244.

(2) HB 519

Alaska State Legislature

Representative Mike Davis District 19

P.O. Box V
Juneau, Alaska 99811
(907) 456-4930/4941

Interim Office:
P.O. Box 81435
Fairbanks, Alaska 99708
(907) 456-8161

TO: Rep. Heinrich Springer
Chairman, House Community & Regional Affairs
FROM: Rep. Mike Davis
DATE: February 17, 1988
RE: HB 519 and HB 520

I would like to request early scheduling of HB 519 and HB 520, establishing a revolving loan fund for radon mitigation.

While radon exposure is poses a serious threat to public health, many Alaskans cannot afford to install mitigation systems in their homes. HB 519 and HB 520 would provide loans of up to $10,000 to home owners to install air-to-air heat exchangers, vapor barriers and other mitigation mechanisms.

INCREMENT/DECREMENT DESCRIPTION:

Provide operating funds to initiate a statewide Radon Screening Survey in conjunction with expected matching funds with DOE and EPA.

AGENCY CONTACT/PHONE NUMBER:
Robert B. Forbes 479-7625

CODE	EXPENDITURE BY OBJECT	AGENCY REQ.	GOV'S REQ.
100	Personal Services		
200	Travel		
300	Contractual Services	100.0	
400	Supplies		
500	Equipment		
600	Lands, Buildings, Etc.		
700	Grants, Claims, Etc.		
800	Miscellaneous		
	TOTAL	100.0	-0-
	I-A Transfer (NON-ADD)		
1002	Federal Receipts		
1003	General Fund Match		
1004	General Fund	100.0	
1005	Program Receipts/GF		
1007	I-A Receipts		

POSITION INFORMATION			
	PFT		
	PPT		
	Non Permanent		
	Staff Months	0	

/ / Enhance Existing Service Compared to FY 88

/X / New Service Compared to FY 88

/ / Continuation of FY 88 Service Level

/ / Formula Program

IMPACT FROM CAPITAL PROJECT (NAME) ____________

Chapter ______ SLA ______ Page/Line ______

DESCRIBE WHY THIS INCREMENT/DECREMENT IS NEEDED AND WHAT IT PURCHASES:

Radon (Rn^{222}) gas accumulation has long been known to be a serious health hazard in the uranium and phosphate mining industries and has resulted in significantly elevated incidence of lung cancer in miners. Since 1984, radon has assumed additional significance as a potentially serious health problem in residences and public buildings in some regions of the United States. EPA and public health officials postulate that radon may be the leading source of human exposure to naturally occurring background radiation. It may also be the leading cause of nonsmoking-related lung cancer that may account for from 5,000 to 20,000 cancer-related deaths per year in the United States.

At this time, more than 30 states throughout the U.S. have initiated programs to identify areas with high radon hazard potential and to deal with the complex health and legal aspects of the problem. DOE and EPA have established offices for the coordination of state radon-assistance programs.

Recent spot surveys by several state agencies (DOTPF, UAF, AEIDC, DHSS, DGGS) show that excessive radon concentrations occur in some Alaskan homes. Most recently, DGGS investigators recorded extremely high radon concentrations in several Fairbanks residences in hillside subdivisions; these concentrations rank among the highest yet measured in the United States (greater than 800 picocuries per liter). Considering that the EPA recommended maximum exposure level is 4 pCi/l, these concentrations indicate that household radon may be a serious health problem in Alaska and that a statewide radon survey program should be initiated as soon as possible.

The magnitude of the problem can be determined using careful and systematic orientation and screening surveys and correlating the results with meaningful geologic parameters. Through the development of geologic models for radon prediction, workers in other states have identified areas where the need for high-density household monitoring is greatest, thereby making the most efficient use of limited funding.

- - - Continued on following page - - -

C5 INCREMENT/DECREMENT REQUEST

Agency Priority ______ of ______

AGENCY Natural Resources

BRU Geological Management

COMPONENT Land and Public Safety

PROJECT Radon Screening

3137

Revised Date

FY 89

00102i

4

48519

(6/87)-c5

Currently, Alaska is one of the few states for which EPA has little or no information pertaining to radon potential or actual data from radon surveys of homes or public buildings. Limited data have been or are currently being gathered in local surveys of selected areas of the state. As yet, however, we do not have enough data to estimate the magnitude of the statewide radon problem. Presentation and discussions at a recent radon workshop in Reston, Virginia, dealt with geologic conditions that favor radon emanation and concentration in other regions of the United States. A comparison of those conditions to Alaskan geology makes it clear that it would be prudent to develop a multidisciplinary statewide survey program to determine the radon hazard potential throughout Alaska.

United States
Environmental Protection
Agency

Offices of
Air and Radiation and
Research and Development
Washington DC 20460

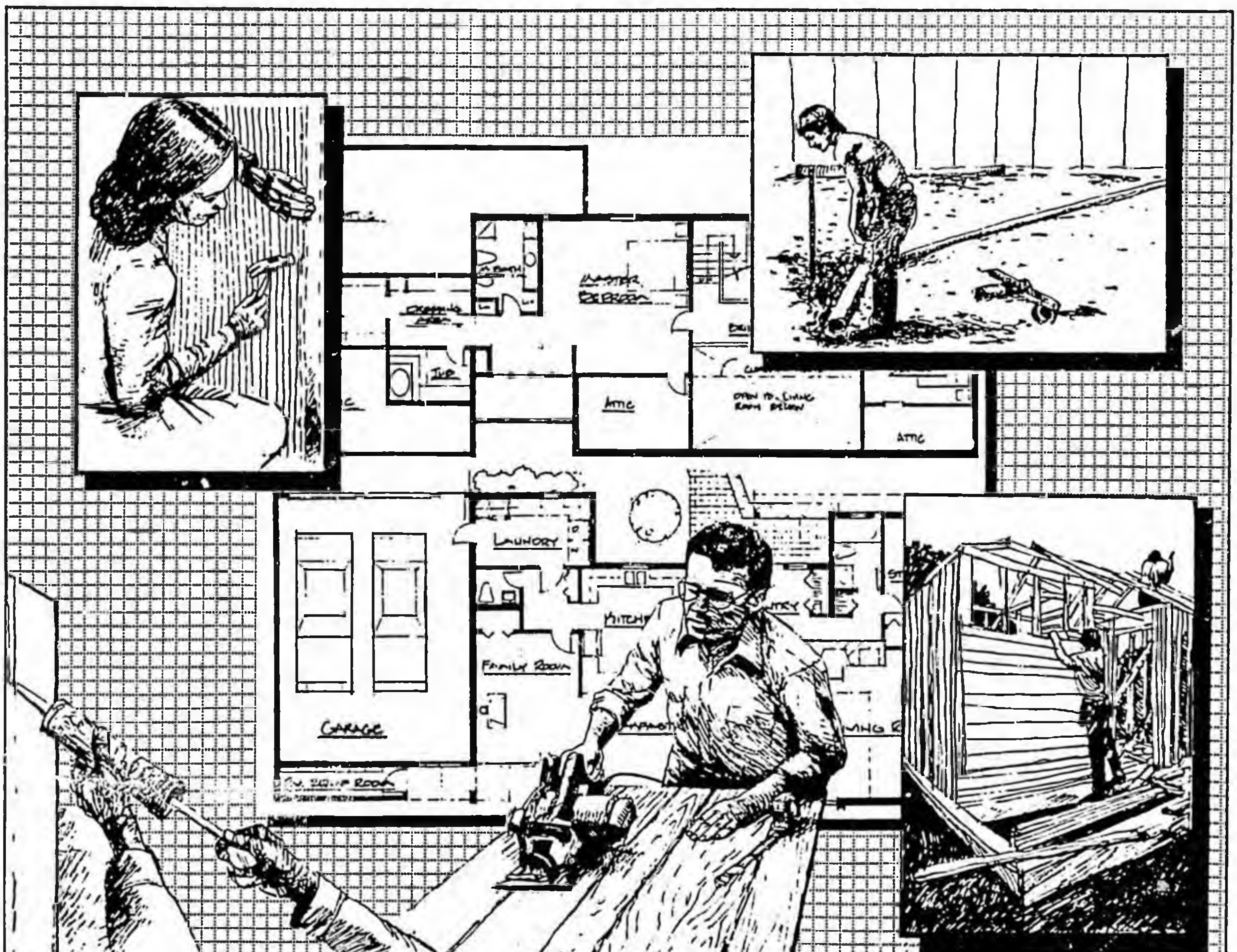
August 1987
OPA-87-009

EPA

NAHB
RESEARCH ®
FOUNDATION, INC.

Radon Reduction in New Construction

An Interim Guide



Comments on the information in this booklet should be addressed to:
Radon Division (ANR-464)
Office of Radiation Programs
U.S. Environmental Protection Agency
Washington, D.C. 20460

Introduction

The U.S. Environmental Protection Agency (EPA) is concerned about the increased risk of developing lung cancer faced by persons exposed to radon in their homes. Because many families already face the problem, early emphasis was placed on identifying the danger in existing homes and developing cost-effective methods to make such housing safer. Based on this early research, EPA published three documents in 1986: *A Citizen's Guide to Radon: What It Is and What To Do About It*, *Radon Reduction Methods: A Homeowner's Guide*, and a more detailed manual, *Radon Reduction Techniques for Detached Houses: Technical Guidance*. These documents were designed to help homeowners determine if they have a radon problem and to present information on how to reduce elevated radon levels in their homes.

This pamphlet is the next step in attempting to reduce the radon hazard in homes. It is designed to provide radon information for those involved in new construction and to introduce methods that can be used during construction to minimize radon entry and facilitate its removal after construction is complete. If there is concern about the potential for elevated indoor radon levels, it may be prudent to use these construction techniques in new homes. The "Techniques for Site Evaluation" section of this pamphlet outlines several methods for assessing the potential for elevated indoor radon levels. The decision to incorporate these construction techniques rests solely with the builder or homeowner.

In addition to extensive internal EPA review, this pamphlet has been developed in coordination with the National Association of Home Builders Research Foundation, Inc. (NAHB-RF) a not for profit organization, and other federal agencies including the Department of Energy (DOE), Housing and Urban Development (HUD), United States Geological Survey (USGS), and the National Bureau of Standards (NBS). It also reflects comments solicited from a broad spectrum of individual experts in home construction and related industries.

It is potentially more cost-effective to build a home that resists radon entry than to remedy a radon problem after construction. The construction methods suggested in this pamphlet represent current knowledge and experience gained primarily from radon reduction tests and demonstrations on existing homes. Field tests are underway to develop and refine the most cost-effective new-home construction techniques. After completion of these field tests, a more detailed "Technical Guidance" manual will be published to expand and revise, as necessary, the interim guidance presented in this pamphlet. Accordingly, *this Interim Guide should not be referenced in codes and standards documents.*

Radon Facts

Radon is a colorless, odorless, tasteless, radioactive gas that occurs naturally in soil gas, underground water, and outdoor air. It exists at various levels throughout the United States. Prolonged exposure to elevated concentrations of radon decay products has been associated with increases in the risk of lung cancer. An elevated concentration is defined as being at or above the EPA suggested guidelines of 4 pCi/l or 0.02 WL average annual exposure.* Although exposures below this level do present some risk of lung cancer, reductions to lower levels may be difficult, and sometimes impossible to achieve.

Soil gas entering homes through exposed soil in crawl spaces, through cracks and openings in slab-on-grade floors, and through below-grade walls and floors is the primary source of elevated radon levels (Figure 1). Radon in outside air is diluted to such low concentrations that it does not present a health hazard. In some small public and private well-water supplies, radon is a hazard primarily to the extent that it contributes to indoor radon gas concentrations. When water is heated and agitated (aerated), as in a shower or washing machine, it will give off small** quantities of radon.

Radon moves through the small spaces that exist in all soils. The speed of movement depends on the permeability of the soil and the presence of a driving force caused when the pressure inside a home is lower than the pressure outside or in the surrounding and underlying soil. A lower pressure inside a home may result from:

- Heated air rising, which causes a stack effect.
- Wind blowing past a home, which causes a down-wind draft or Venturi effect.
- Air being used by fireplaces and wood stoves, which causes a vacuum effect.
- Air being vented to the outside by clothes dryers and exhaust fans in bathrooms, kitchens, or attics, which also causes a vacuum effect.

In homes, where a partial vacuum exists, outdoor air and soil gas are driven into the home.

New Construction Principles

The facts just discussed form the basis for the following new-construction principles:

- Homes should be designed and constructed to minimize pathways for soil gas to enter.
- Homes should be designed and built to maintain a neutral pressure differential between indoors and outdoors.
- Features can also be incorporated during construction that will facilitate radon removal after completion of the home if prevention techniques prove to be inadequate.

The following techniques for site evaluation and construction are based on these principles.

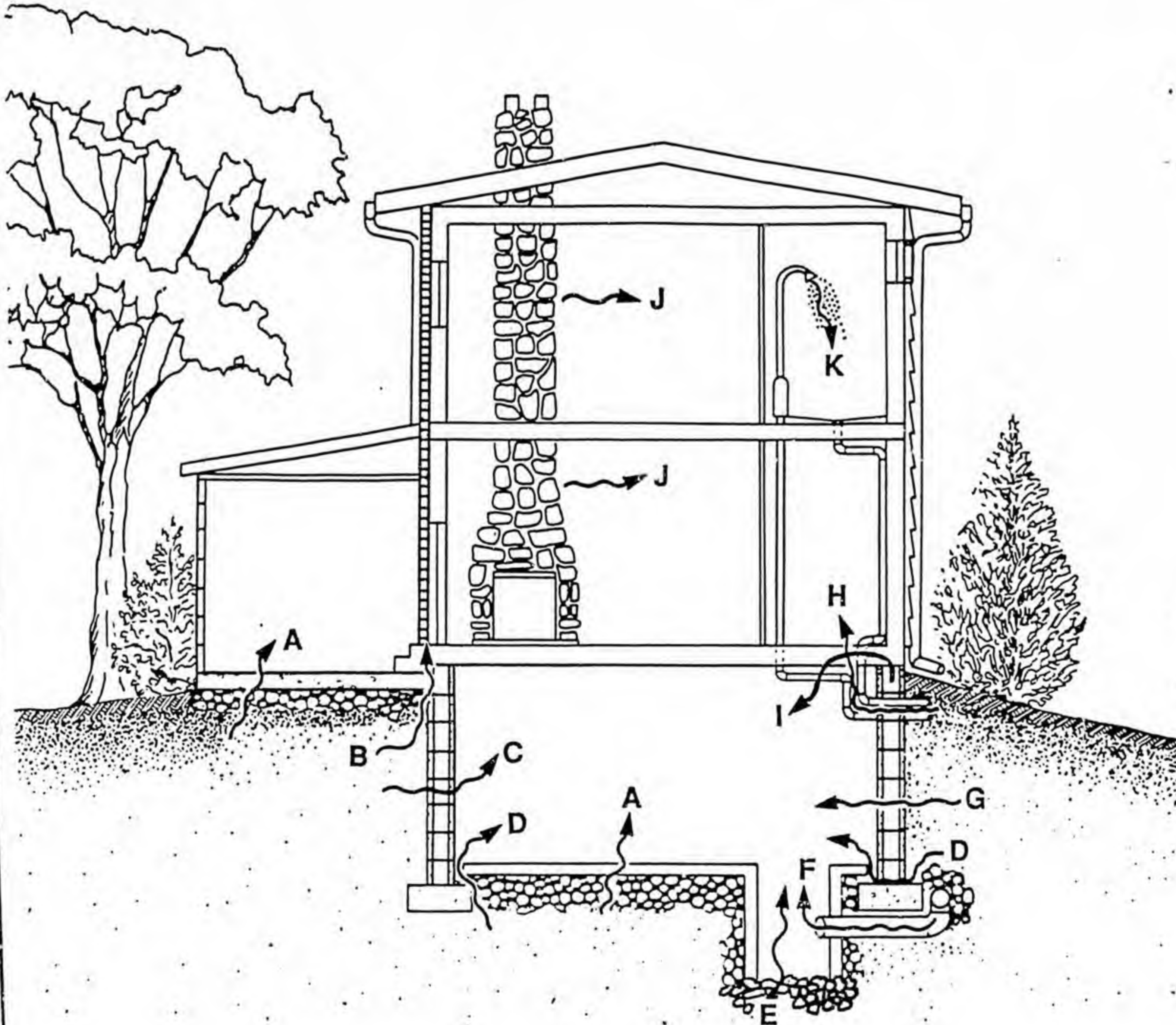
Techniques for Site Evaluation

The first step in building new radon-resistant homes is to determine, to the degree possible, the potential for radon problems at the building site. At this time, there are no standard soil tests or specific

---

** pCi/l, the abbreviation for pico Curies per liter, is used as a radiation unit of measure for radon. The prefix "pico" means a multiplication factor of 1 trillionth. A Curie is a commonly used measurement of radioactivity. WL, the abbreviation for Working Level, is used as a radiation unit of measure for the decay products of radon. The relationship between the two terms is generally 200 pCi/l = 1 WL.*

*** The generally accepted rule of thumb for emanation of radon gas from water is: 10,000 pCi/l of radon in water will normally produce a concentration of about 1 pCi/l of radon in indoor air.*



MAJOR RADON ENTRY ROUTES

A. Cracks in concrete slabs
B. Spaces behind brick veneer walls
   that rest on uncapped hollow-block foundation
C. Pores and cracks in concrete blocks
D. Floor-wall joints
E. Exposed soil, as in a sump
F. Weeping (drain) tile, if drained to open sump
G. Mortar joints
H. Loose fitting pipe penetrations
I. Open tops of block walls
J. Building materials such as some rock
K. Water (from some wells)

Figure 1

standards for correlating the results of soil tests at a building site with subsequent indoor radon levels. The variety of geological conditions in the United States will probably continue to preclude establishment of any all-inclusive, nationwide standards for such correlation. We can, however, estimate the radon potential at a building site based on factors other than soil tests. If the answer to any of the following questions is yes, radon problems might be anticipated and radon reduction features should be considered for inclusion in construction plans.

- Have existing homes in the same geologic area experienced elevated radon levels? ("Same geologic area" is defined as an area having similar rock and soil composition characteristics.) State or regional EPA offices may be able to assist in obtaining this information.
- What are the general characteristics of the soil? State and local geological or agricultural offices can normally help in providing answers to the following questions on soil:
  —Is the soil derived from underlying rock that normally contains above-average concentrations of uranium or radium, e.g., some granites, black shales, phosphates or phosphate limestones?
  —Is the permeability of the soil and underlying rock conducive to the flow of radon gas? Note that soil permeability (influenced by grain size, porosity, and moisture content) and the degree to which underlying and adjacent rock structures are stable or fractured can significantly affect the amount of radon that can flow toward and into a home.
- If the source of water to the site is going to be a local or onsite well, have excessive levels of radon been detected in other wells within the same geologic area? (Levels measured above 40,000 pCi/l of water could alone produce indoor radon concentrations of about 4 pCi/l or above. Such levels are considered excessive.) State or local health agencies, departments of natural resources, or environmental protection offices may be able to assist in providing this information. Testing well water for radon before the home is built could provide an additional indication of a potential radon problem. If excessive radon levels are confirmed, a granular activated-carbon filtration system or an aeration system might be designed into the plumbing plan.

Construction Techniques

Some of the radon prevention techniques discussed below are common building practices in many areas and, in any case, are less costly if accomplished during construction. Costs to retrofit existing homes with the same features would be significantly higher. Although these construction techniques do not require any fundamental changes in building design, there is a continuing need for quality control, supervision, and more careful attention to certain construction details. Construction techniques for minimizing radon entry can be grouped into two basic categories:

- Methods to reduce pathways for radon entry.
- Methods to reduce the vacuum effect of a home on surrounding and underlying soil.

Typically, the techniques in both categories are used in conjunction with each other.

Methods to Reduce Pathways for Radon Entry (Figure 2)

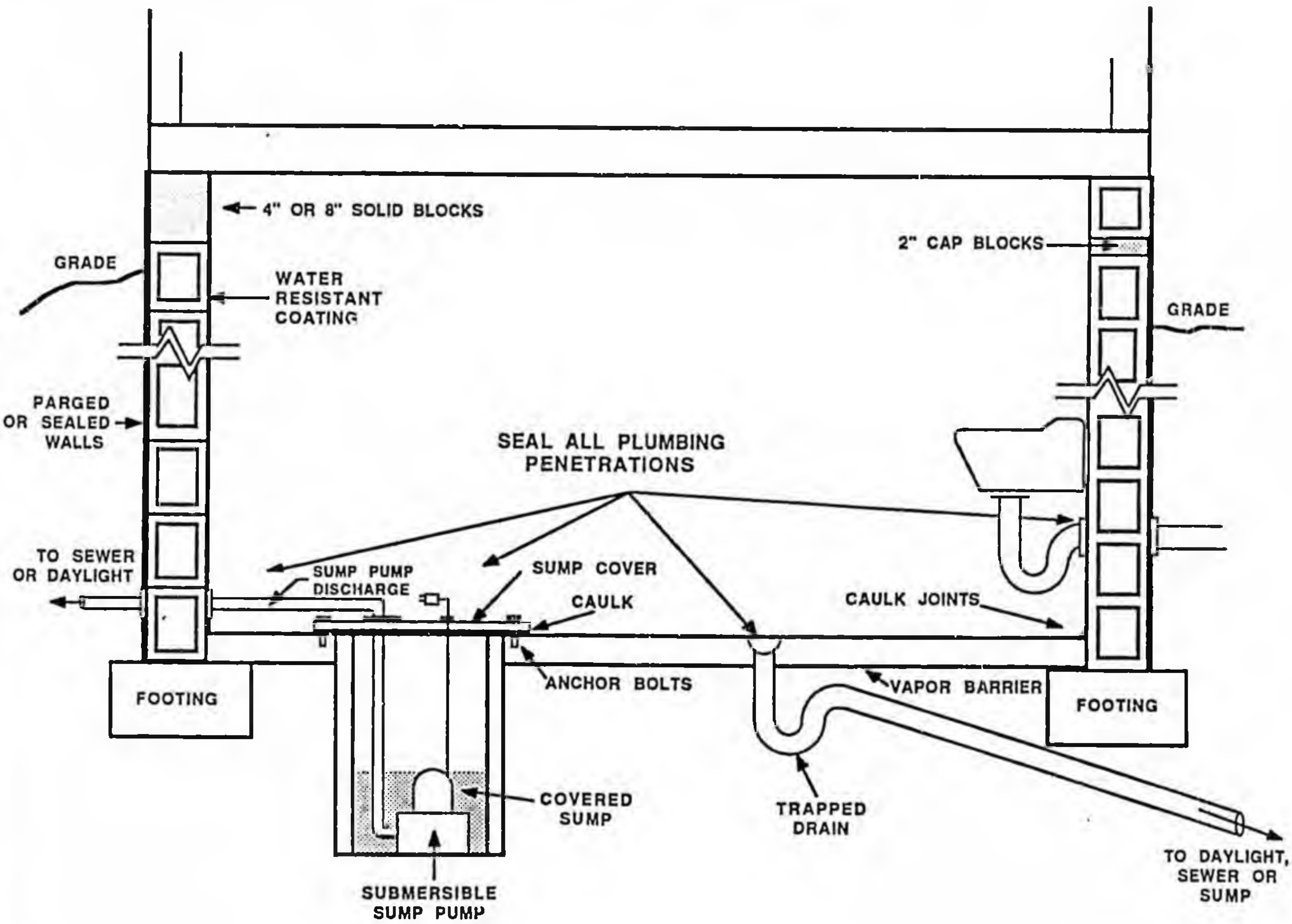
In Basement and Slab-on-Grade Construction:

- Place a 6-mil polyethylene vapor barrier under the slab. Overlap joints in the barrier 12 inches. Penetrations of the barrier by plumbing should be sealed or taped, and care should be taken to avoid puncturing the barrier when pouring the slab.
- To minimize shrinkage and cracks in slabs, use recommended water content in concrete mix and keep the slab covered and damp for several days after the pour.
- To help reduce major floor cracks, ensure that steel reinforcing mesh, if used, is imbedded in (and not under) the slab. Reducing major cracks in footings, block foundation, and poured-concrete walls will reduce the rate of radon entry. Radon can, however, enter homes through even the smallest of cracks in concrete slabs and walls if a driving pressure is applied to those surfaces.
- The most common radon-entry pathways are inside perimeter floor/wall joints and any control joints between separately poured slab sections. To reduce radon entry through these joints, install a common flexible expansion joint material around the perimeter of the slab and between any slab sections. After the slab has cured for several days, remove or depress the top 1/2 inch or so of this material and fill the gap with a good quality, non-cracking polyurethane or similar caulk. Similar techniques for sealing these joints may also be used.
- In some areas, basement slabs are poured with a French Drain channel around the slab perimeter. To be effective, this moisture control technique requires that the floor/wall joint be open to permit water to seep out into the sub-slab area. To reduce radon entry through such open joints, it may be necessary to install a perforated drain pipe loop under the slab, adjacent to the footing and imbedded in aggregate, and to tie this pipe into a sub-slab ventilation system to draw radon gas away from the French Drain joint (Figure 4). For additional information on water control techniques, refer to National Association of Home Builders (NAHB) publication *Basement Water Leakage: Causes, Prevention, and Correction.*
- When building slab-on-grade homes in warm climates, pour the foundation and slab as a single (monolithic) unit. If properly insulated below grade-level, shallow foundations and slabs can also be poured as a single unit in cold climates.
- Remove all grade stakes and screed boards and fill the holes as the slab is being finished. This will prevent future radon pathways through the slab, which might otherwise be created as imbedded wood eventually deteriorates.
- Carefully seal around all pipes and wires penetrating the slab, paying particular attention to bathtub, shower, and toilet openings around traps.
- Floor drains, if installed, should drain to daylight, a sewer, or to a sump with pump discharge. Floor drains should not be drained into a sump if such a pit will be used as part of a sub-slab ventilation system. Suction on the sump could be defeated by an open line to the floor drain.
- Sumps should be sealed at the top. In closed sumps used for sub-slab

ventilation systems, the continuous flow of moist air through the sump can cause rapid corrosion of exposed sump pump motors. For this reason, submersible-type sump pumps are recommended for closed-sump applications.

In Basement and Crawl space Construction:

- Seal or cap the tops of hollow-block foundation walls using one of the techniques shown in Figure 2.
- Carefully seal around any pipe or wire penetrations of below-grade walls.
- Exterior block walls should be parged and coated with high-quality vapor/water sealants or polyethelene films. For additional information on wall sealing, refer to NAHB publication *Basement Water Leakage: Causes, Prevention, and Correction.* Several new products for use on exterior walls are designed to provide an airway for soil gas to reach the surface outside the wall rather than being drawn through the wall. Similar materials may also be used in sub-slab ventilation applications.
- Interior surfaces of masonry foundations may be covered with a high-quality, water-resistant coating.
- Heating or air-conditioning ductwork that must be routed through a crawl space or beneath a slab should be properly taped or sealed. This is particularly important for return air ducting, which is under negative pressure. Due to difficulty in achieving permanent sealing of such ductwork, it may be advisable to redesign heating and ventilating systems to avoid ducting through sub-slab or crawl space areas, particularly in areas where elevated soil radon levels have been confirmed.
- Install air-tight seals on any doors or other openings between basements and adjoining crawl spaces.
- Seal around any ducting, pipe, or wire penetrations of walls between basements and adjoining crawl spaces, and close any openings between floor joists over the dividing wall.
- Place a 6-mil polyethelene vapor barrier on the soil in the crawl space. Use a 12-inch overlap and seal the seams between barrier sections. Seal edges to foundation walls.



METHODS TO REDUCE PATHWAYS FOR RADON ENTRY

Figure 2

Methods to Reduce the Vacuum Effect (Figure 3)

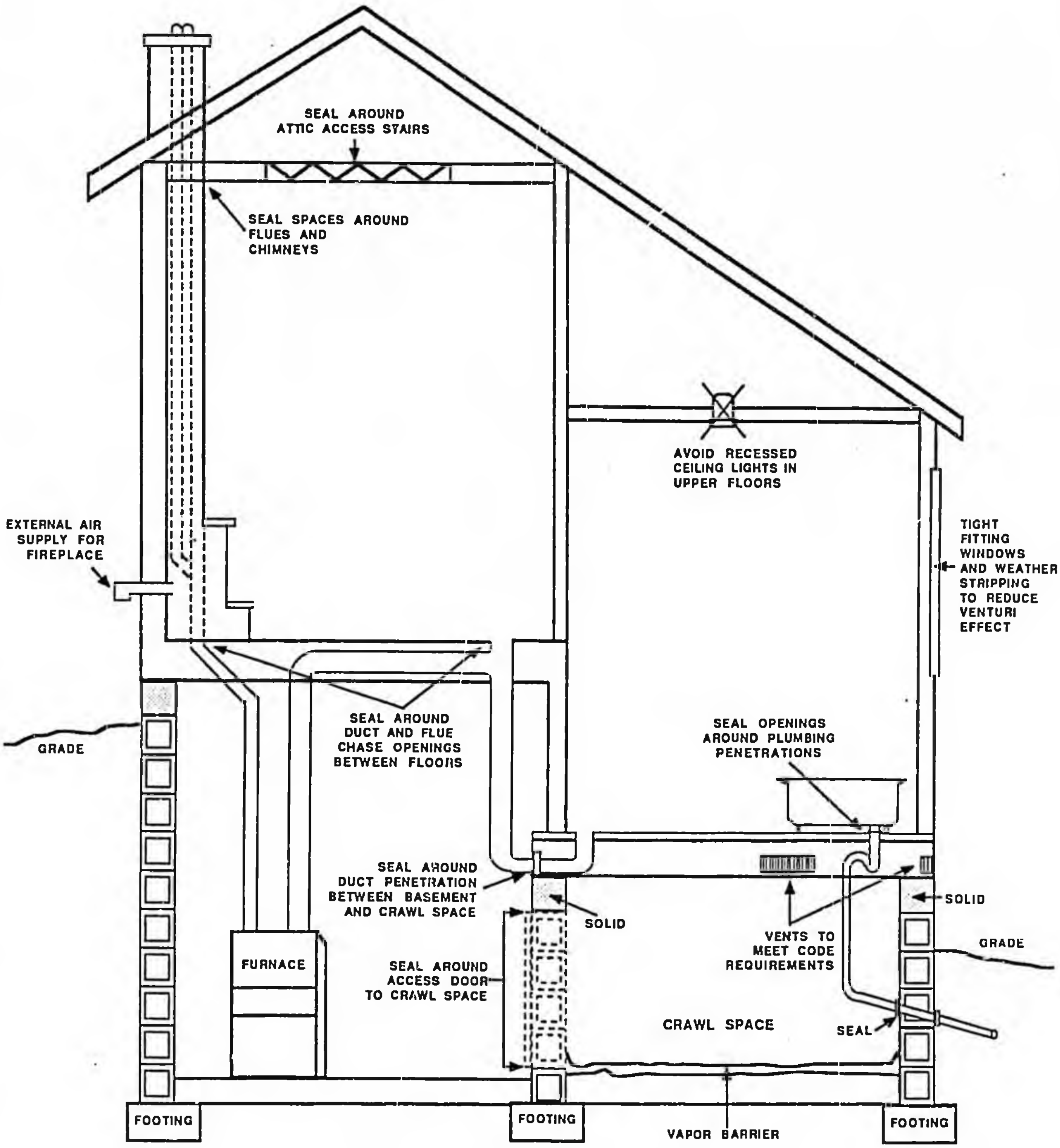
- Ensure that vents are installed in crawl space walls and are sized and located in accordance with local building practices. Adequate ventilation of crawl spaces is the best defense against radon entry in crawl space-type homes.
- Reduce air flow from the crawl space into living areas by closing and sealing any openings and penetrations of the floor over the crawlspace.
- To reduce the stack effect, close thermal bypasses such as spaces around chimney flues and plumbing chases. Attic access stairs should also be closed and sealed. (Note: Because of potential heat buildup, most codes prohibit insulating around recessed ceiling lights. Such lights should therefore be avoided in top-floor ceilings. As an alternative, use recessed ceiling lights designed to permit insulation or "hi-hat" covers and seal to minimize air leakage.)
- Install ducting to provide an external air supply for fireplace combustion.
- In areas frequently exposed to above-average winds, install extra weather sealing above the soil line to reduce depressurization caused by the Venturi effect. Such sealing will also save energy and reduce the stack effect.
- Air-to-air heat exchange systems are designed to increase ventilation and improve indoor air quality. They may also be adjusted to help neutralize any imbalance between indoor and outdoor air pressure and thus reduce the stack effect of the home. They should not, however, be relied upon as a stand-alone solution to radon reduction in new construction. (A slightly positive pressure, in the basement, may contribute to reducing radon flow into a home.)

Construction Methods That Will Facilitate Post-Construction Radon Removal (Figure 4)

Recognizing that radon prevention techniques may not always result in radon levels below the suggested guideline of 4 pCi/l average annual exposure, there are several additional construction techniques that can be used to facilitate any post-construction radon removal that may be required.

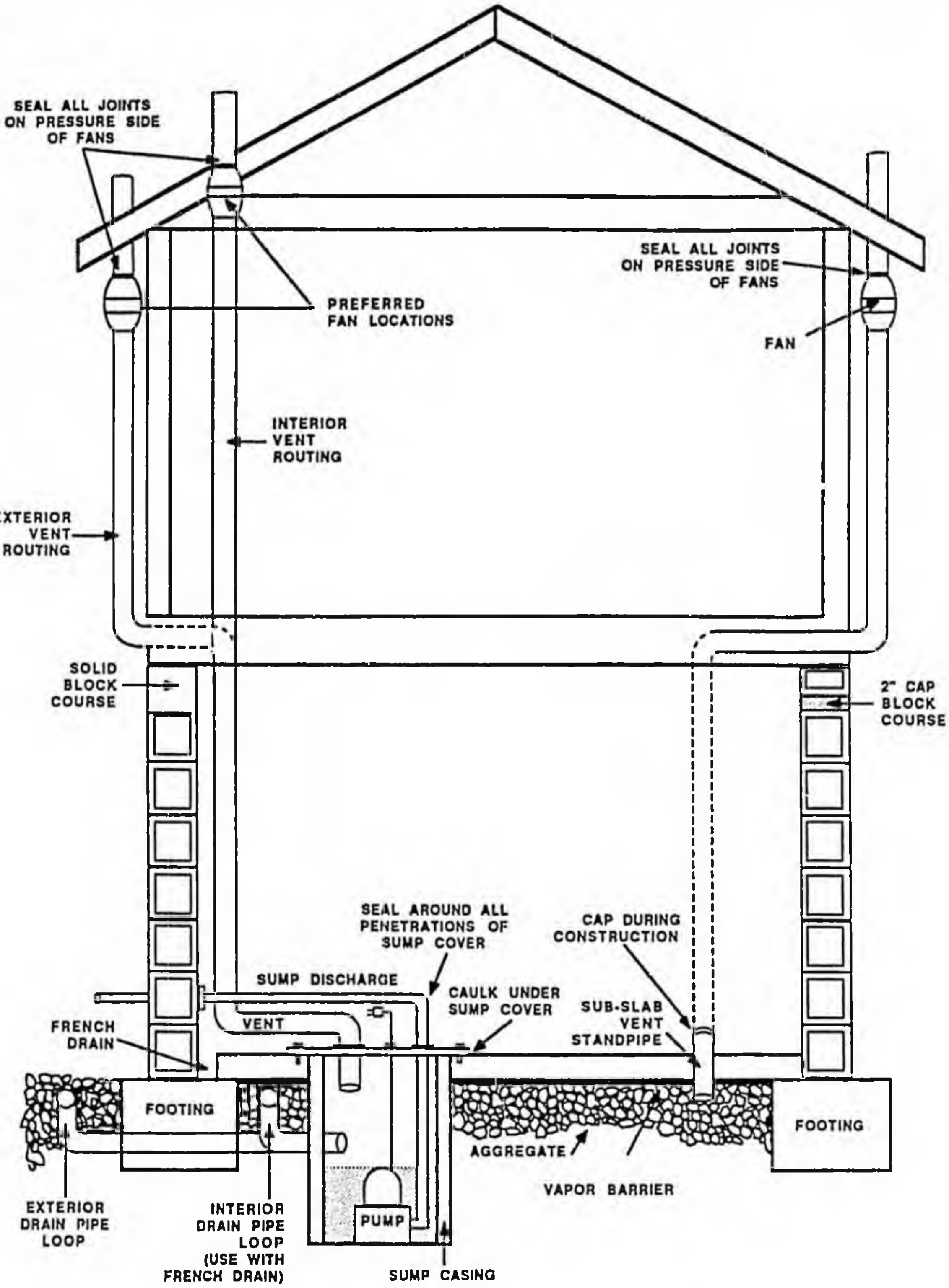
- Before pouring a slab, fill the entire sub-floor area with a layer (4 inches thick) of pea gravel or larger, clean aggregate to facilitate installation of a sub-slab ventilation system.
- Lay a continuous loop of perforated 4-inch diameter drain pipe around the inside perimeter of the foundation footing. Run the vent from this loop into the side of a closed sump that can, if necessary, be equipped with a fan-driven vent to the outside. In this configuration, the drain pipe loop can aid in water seepage control as well as radon reduction.
- As an alternative to the vented interior drain pipe loop, a similarly vented exterior loop can be laid outside the foundation footing.
- In areas where water seepage into below-grade spaces is not a problem and sump pumps are not installed, exterior or interior drain pipe loops can be stubbed-up outside the home or through the slab and can be available for use as sub-slab ventilation points if needed.
- The soil beneath a slab can also be ventilated using the following technique: Prior to pouring the slab, insert (in a vertical position) one or more short (12-inch) lengths of 4-inch minimum diameter PVC pipe into the sub-slab aggregate and cap the top end. After construction is complete, these standpipes can, if necessary, be uncapped and connected to one or more convection stacks or fan-driven vent pipes. When positioning these standpipes, choose locations permitting venting to the roof through already planned flue or plumbing chases, interior walls, or closets. In homes where flue or other chases are restricted in size or not easily accessible, it may be less expensive to go ahead—during the framing and rough-in plumbing/electric phase of construction—and complete the vent pipe hookup, temporarily terminating the vent in the attic along with an electric outlet for future fan installation. Experience has shown that in homes with higher radon levels—above 20 pCi/1—convection (passive) venting may not produce acceptable radon reductions. If lower radon levels are expected and passive venting is attempted, performance is improved by using a 6-inch diameter vent routed straight from the floor through the roof, with minimum bends.

  Drilling 4-inch holes through finished slabs for insertion of vent pipes is an alternative to this technique.
- To create the necessary convection flow, radon prevention techniques that involve passive venting normally require stacks that pass through the floors and roof. When active (fan-driven) systems are installed, venting through to the roof is still preferred. Recognizing, however, that active systems can be vented through the band joist or below-grade walls to the outside, it is considered advisable in such active systems to position the exit point of the vent pipe at or above the eave line of the roof and away from any doors or windows. This will preclude any possible recirculation of air containing concentrated radon gas back into the house.
- In homes where an active (fan-driven) sub-slab ventilation system has been installed, it may be necessary to provide make-up air to avoid back drafting.



METHODS TO REDUCE THE VACUUM EFFECT

Figure 3



METHODS TO FACILITATE POST-CONSTRUCTION RADON REMOVAL

Figure 4

The U.S. EPA and the NAHB-RF strive to provide accurate, complete, and useful information. However, neither EPA, nor NAHB-RF nor any other person contributing to or assisting in the preparation of this booklet—nor any person acting on behalf of any of these parties—makes any warranty, guarantee, or representation (express or implied) with respect to the usefulness or effectiveness of any information, method, or process disclosed in this material or assumes any liability for the use of—or for damages arising from the use of—any information, methods, or process disclosed in this material.

Source of Information

If you would like further information or explanation on any of the points mentioned in this booklet, you should contact your State radiation protection office or home builders association.

If you have difficulty locating these offices, you may call your EPA regional office listed below. They will be happy to provide you with the name, address, and telephone number of these contacts.

STATE-EPA REGION

Alabama-4
Alaska-10
Arizona-9
Arkansas-6
California-9
Colorado-8
Connecticut-1
Delaware-3
District of Columbia-3
Florida-4
Georgia-4
Hawaii-9

Idaho-10
Illinois-5
Indiana-5
Maryland-3
Massachusetts-1
Michigan-5
Minnesota-5
Mississippi-4
Missouri-7
Montana-8
Maine-1
New York-2
North Dakota-8

Oklahoma-6
Oregon-10
Ohio-5
Pensylvania-3
Rhode Island-1
Nebraska-7
South Carolina-4
Iowa-7
Nevada-9
South Dakota-8
Kansas-7
New Hampshire-1
Tennessee-4

Kentucky-4
New Jersey-2
Texas-6
Louisiana-6
New Mexico-6
Utah-8
North Carolina-4
Virginia-3
West Virginia-3
Washington-10
Wisconsin-5
Wyoming-8
Vermont-1

EPA REGIONAL OFFICES

EPA Region 1
Room 2203
JFK Federal Building
Boston, MA 02203
(617) 565-3234

EPA Region 2
26 Federal Plaza
New York, NY 10278
(212) 264-4418

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

EPA Region 4
345 Courtland Street, NE
Atlanta, GA 30365
(404) 347-2904

EPA Region 5
230 South Dearborne Street
Chicago, IL 60604
(312) 886-6175

EPA Region 6
1201 Elm Street
Dallas, TX 75270
(214) 655-7208

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

EPA Region 8
Suite 1300
One Denver Place
999 18th Street
Denver, CO 80202
(303) 293-1648

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

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

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGIONAL ORGANIZATION

☆ U. S. GOVERNMENT PRINTING OFFICE: 1987 716-002/60673

(6) HB519

United States
Environmental Protection
Agency

September 1987
OPA-87-010

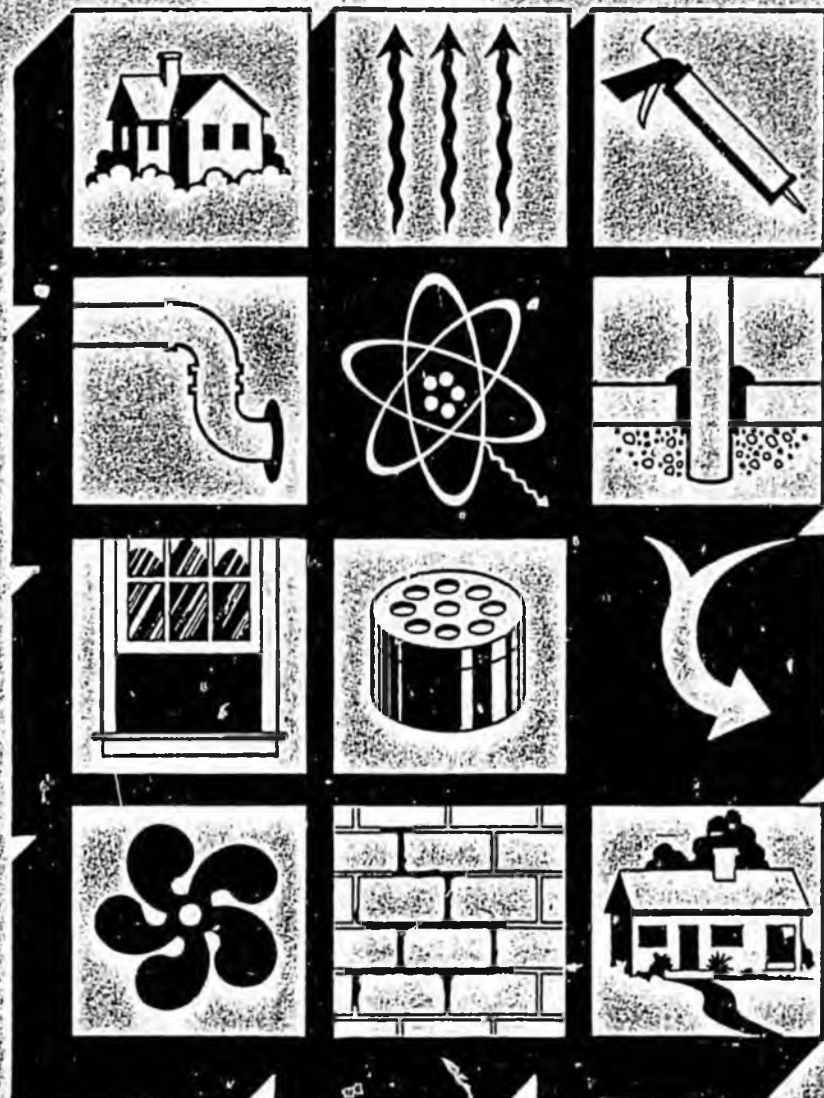
Research and Development

EPA

Radon Reduction Methods

A Homeowner's Guide

(Second Edition)



EPA Study

The U.S. Environmental Protection Agency (EPA) is studying the effectiveness of various ways to reduce high concentrations of radon in houses. While our work is far from complete, we have gained some information which may be of immediate use to homeowners. We are publishing this booklet to share what we have learned with those whose radon problems demand prompt action.

The booklet describes methods that have been tested successfully—by EPA and/or other research groups—on houses with high indoor radon levels. The information presented here is concerned primarily with radon which enters a house from the underlying soil. Additional information will be published as it becomes available.

Unique Problems

The first lesson to learn about radon reduction is this: No two houses are alike. Even houses that look the same have small differences in existing conditions that can affect radon entry and the design and effectiveness of reduction techniques. Underlying soils also vary greatly, even among houses which sit close together. These differences will affect the results obtainable from using the radon reduction methods described here.

General Information

This booklet is intended primarily for homeowners who already have had their homes tested for radon and have decided that they need to take some action to reduce radon levels. If you are uncertain of the meaning of such test results, or if you need general information about radon in houses, read the EPA booklet, *A Citizen's Guide to Radon: What It Is And What To Do About It* (OPA-86-004). To get a copy, contact your state radon program office (see list at the end of this booklet).

Performing screening and follow-up measurements prior to a decision to mitigate (that is, to reduce radon levels), is strongly encouraged. The results of follow-up measurements will enable the homeowner to make a well-informed decision about health risks and the need for remedial action. As mitigation often entails spending a significant amount of money, follow-up measurements should be reliable estimators of the actual maximum potential exposures of the occupants.

Using Contractors

Many radon remedies require the skilled services of a professional contractor who is experienced in radon reduction procedures. (EPA and the states are currently working to increase the number of experienced contractors.) Due to the skills required, do-it-yourself efforts are recommended only for homeowners with these special skills.

This booklet does not attempt to give the homeowner detailed instructions for corrective action. But, the information here should help you make informed decisions on what type of remedy is needed, and may assist you in evaluating proposals from contractors.

We cannot overemphasize the importance of carefully selecting a contractor and reviewing any proposal for radon reduction work at your house. Asking for business references and checking with your local Better Business Bureau or Chamber of Commerce will help you ensure that a contractor is reputable. Many states will provide lists of contractors doing radon mitigation work, and some states have certification programs for radon measurement and mitigation.

Getting a second opinion from another contractor or from one of your state's radiological health officials can help you decide if a proposal is reasonable. You should be certain to get a written estimate of costs which stipulates the work to be done. Because radon reduction work is so new, most contractors will not guarantee a reduction in radon levels.

A few contractors may be willing to guarantee a radon concentration of less than 4 pCi/L (picocuries per liter);

however, for a contractor to make this promise he should first thoroughly evaluate the potential for radon reduction methods to work in your home.

Technical Information

Those homeowners who are confident they have the tools, equipment, and skills to do the job themselves may want to read EPA's more detailed manual, *Radon Reduction Techniques for Detached Houses: Technical Guidance* (EPA/625/5-86/019). Single copies can be obtained by writing:

U.S. EPA
Center for Environmental Research Information
26 West St. Clair Street
Cincinnati, Ohio 45268

Methods

This booklet describes various methods which may reduce the level of radon in your house—either by preventing its entry or by replacing contaminated indoor air. Some of the methods are simple, some are complex, and some are much more expensive than others.

The effectiveness of any one method will depend upon the unique characteristics of each house, the level of radon, the routes of radon entry, and how thoroughly a job is done. No one can guarantee that these methods will work as they did in the test houses.

Sometimes a single method may be sufficient, but often—especially where levels are high—several methods will need to be combined to achieve acceptable results.

Mitigation Follow-up

Once an action (or combination of actions) has been performed, it is important that you have further testing done to determine the level to which radon has been reduced. Some states provide this service. If the radon levels have not been satisfactorily lowered, additional mitigation steps may be taken, and the testing process repeated. All tests should be performed in exactly the same manner as the test which confirmed the high radon levels in your house.

Due to the many factors affecting the performance of any reduction technique, a trial-and-error approach often will be necessary to achieve lasting radon reductions. If short-term testing indicates that radon has been reduced to an acceptable level, you may wish to test on a long-term basis.

Before Choosing a Radon Reduction Method

The selection of appropriate and cost-effective radon reduction techniques for a specific house depends on how well the source of the indoor radon problem is understood, how house characteristics affect radon entry rates, and how candidate radon reduction systems influence the radon entry process. Definition of these factors is possible through a series of diagnostic observations and measurements made before, during, and after radon reduction systems are installed.

Diagnostics begin with a house survey. This involves visual inspection to identify possible radon entry routes and any construction features which could influence the design of later radon reduction techniques. Diagnostics should also include an evaluation of the ease of soil gas movement underneath the concrete slab if sub-slab soil ventilation is a potential control option. If ventilation techniques are to be considered, the natural air infiltration rate also should be measured. The measurement of radon levels in well water is a good way to learn whether water is an important contributor to the airborne radon level. Similarly, measuring gamma levels inside and outside the house can help identify the possibility of building materials as a radon source.

As with radon reduction techniques, the skills needed to perform radon diagnostics are beyond the capabilities of most homeowners. Diagnostic methods are mentioned here only as supplemental information to assist homeowners when working with radon diagnosticians and mitigators.

New Construction

If you are planning to build a new home and are concerned about the potential for elevated indoor radon levels, you should consider measures to prevent radon entry into the house. It is typically less expensive to build a home that resists radon entry than to reduce a radon problem after construction.

A recent EPA document, *Radon Reduction in New Construction: An Interim Guide* (OPA-87-009), is available to assist home builders and others interested in potential radon prevention alternatives in new construction. The suggestions contained in this guide represent current knowledge and experience gained primarily from radon reduction tests and demonstrations on existing houses.

Until some of these techniques have actually been applied during the construction of new homes, the applicability, cost-effectiveness, radon-prevention effectiveness, and durability of the techniques cannot be fairly assessed. Ongoing EPA-sponsored field testing of radon prevention techniques in new construction should provide a better evaluation of radon prevention alternatives. The results of these studies will be published in future technical guidance documents.

Radon in Water

The potential concern with radon in water is the airborne radon released when water is used. The amount of radon that is given off from water depends on the amount in the water initially. The amount given off will increase as the temperature of the water increases and as the surface area exposed to air increases.

In the home, activities and appliances that spray or agitate heated water (showers, dishwashers, and clothes washers) create the largest release of waterborne radon. However, the level of radon in household water must be very high to significantly influence the overall level in the air within a house. As a rule of thumb, 10,000 pCi/L of radon in the incoming household water is equivalent to 1 pCi/L of radon in the indoor air.

In some areas, especially in the northeast and west, water from private wells or small community water systems can contain sufficient radon to contribute significantly to elevated levels within a house. Water from large community water supplies releases most of its radon before it reaches individual houses.

Two techniques can be considered to remove radon from water. The first requires either spraying water into a contained air space, introducing air bubbles into the water, or storing water in a tank until the radon has decayed. The second uses granular activated carbon (GAC) to remove radon from the water. The GAC method has been more widely tested and is more commonly used in individual homes. Radiation buildup in the unit itself may cause exposure and disposal problems.

For more detailed information on radon in water see the recent EPA booklet, *Removal of Radon From Household Water* (OPA-87-011).

Air Cleaners

The radon reduction methods discussed in this booklet concentrate on methods of removing radon gas or preventing radon gas from even entering the house. Since the radon health hazard is associated with the products of radon decay (which are chemically active), and not the radon itself (which is an inert gas), it is appropriate to ask whether it is feasible to remove the radon decay products without removing the radon gas itself.

Air cleaners are devices which either filter or electrostatically remove particles—such as dust or radon decay products—from the air. Air cleaners are commonly used to condition indoor air for a variety of health and comfort reasons, and there have been attempts to market air cleaners to reduce radon decay products. At this time, EPA does not endorse the use of air cleaners as a method of reducing radon decay products in indoor air because this technology has not been demonstrated to be effective in reducing the health risks associated with radon.

Although air cleaners will remove some of the radon decay products, many questions remain concerning the relative health effects of the decay products that are not removed and the potential impacts of the undiminished source of radon decay products. Until more is known, EPA believes that the available data do not warrant discontinuing the use of air cleaners already installed, nor can we suggest installing air cleaners to reduce your risk of exposure to radon and its decay products.

Some people also ask whether the radon gas itself can be removed from the indoor air. While some limited research has been done on using charcoal to filter the air, it appears that extremely large quantities of charcoal would be required. This is not yet a demonstrated or even clearly feasible approach.

Natural Ventilation

How It Works

Replaces radon-laden indoor air with outdoor air and neutralizes pressure. This is most often achieved by opening windows.

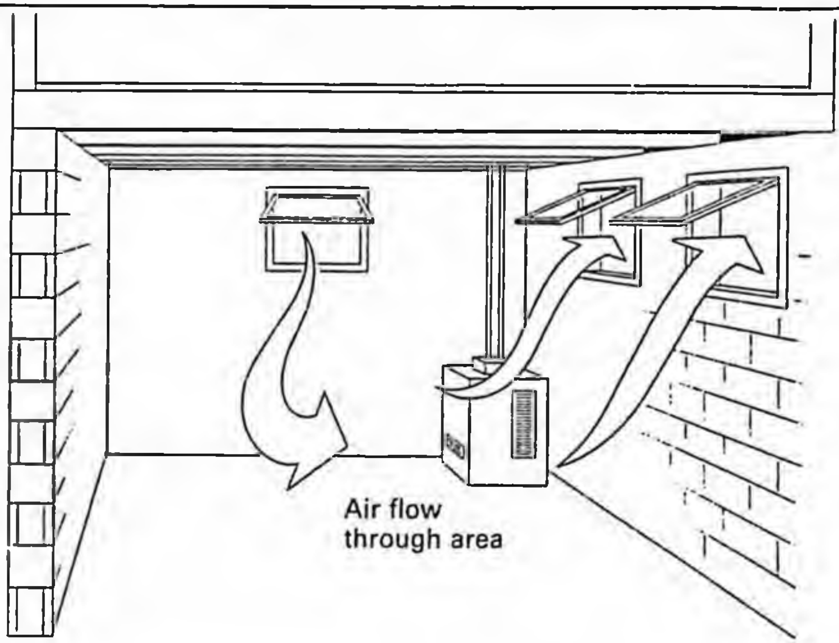
Some natural ventilation occurs in every house as air is drawn through tiny cracks and openings by temperature and pressure differences between indoor and outdoor air. In the average American house, outside air equal in volume to the inside air infiltrates about once every hour. In technical terms, this is called 1.0 ach (air changes per hour). Newer houses, which are generally "tighter," may have air exchange rates as low as 0.1 ach (one-tenth that of the average house). The rate in older houses, on the other hand, may be more than twice the average (2.0 ach).

Cost

There are no installation costs unless devices must be purchased to hold windows or vents in an open position, or to detect or prevent unauthorized entry through these openings.

Use of natural ventilation in cold weather will increase your heating costs substantially. For example, if you were to increase the air exchange rate to eight times its normal level in your basement and still maintain comfortable temperatures there, your annual house heating bill could be as much as three times greater than normal.

If you normally run an air conditioner in hot weather, your cooling costs will be similarly greater.



Reductions

The opening of windows, doors, and vents is a very effective, universally applicable radon reduction technique that can be readily implemented by the homeowner. If done properly, natural ventilation is consistently capable of high reductions, probably above 90 percent if a sufficient number of windows and vents is opened. High reductions result because natural ventilation both reduces the flow of soil gas into the house, by neutralizing the pressure difference between indoors and out, and dilutes any radon in the indoor air with outdoor air.

Limitations

The primary shortcoming of natural ventilation is that extreme weather makes this technique impractical year-round in most parts of the country, due to discomfort and/or increased heating and cooling costs. Open windows can also compromise the security of the house.

Procedure

You should ventilate the lowest level of your house, where it is in direct contact with the primary source of radon: the soil. If you have a basement or crawl space, that is the area to ventilate. (If you ventilate your basement, you may find it more economical or comfortable to close it off and limit its use.) If your house sits on a concrete slab, then your only choice is to ventilate the living area. Opening windows around all levels of your house (including the main living area) is recommended whenever outdoor conditions permit.

As noted earlier, radon is drawn into your house when the air pressure in the basement or lowest level is less than the air pressure in the surrounding soil. Therefore, it is imperative that any ventilation system does not further reduce the air pressure within your house and increase this "pull." To guard against this, be certain to open vents or windows equally on all sides of the house. Also, avoid the use of exhaust fans.

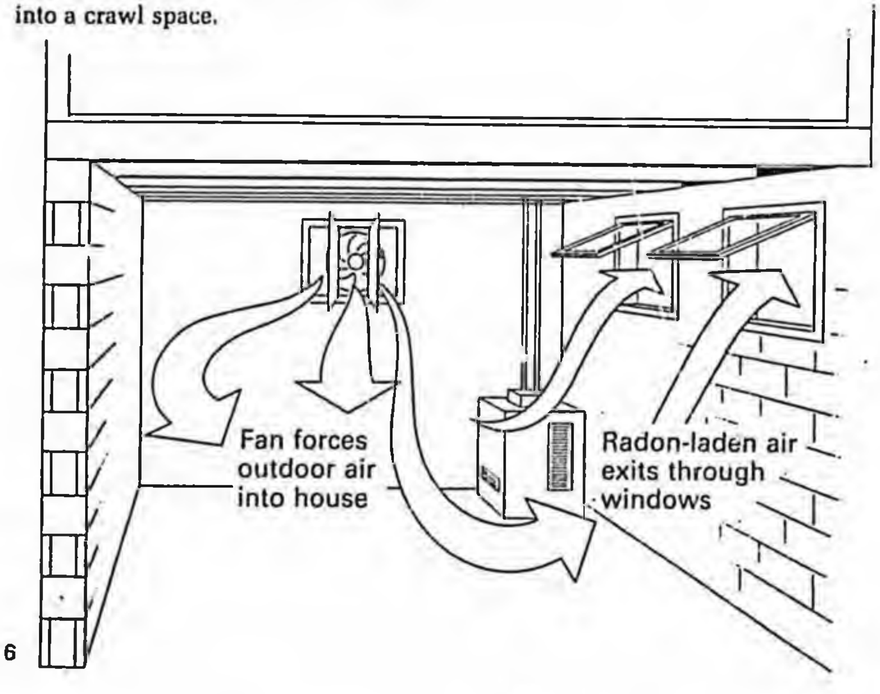
When ventilating unheated areas, be sure to take precautions to prevent pipes from freezing.

Forced Ventilation

How It Works

Replaces radon-laden indoor air with outdoor air and neutralizes pressure if the fan is big enough. Uses fans to maintain a desired air exchange rate independent of weather conditions. (Much of the information in the preceding section on "Natural Ventilation" is applicable to "Forced Ventilation" as well.)

Rather than relying on natural air movement, forced air fans can be used to provide a controlled amount of forced ventilation. For example, a fan could be installed to continuously blow fresh air into the house through the existing central forced-air heating, ducting, and supply registers with windows and doors remaining closed. Alternatively, fans could blow air into the house through protected intakes through the sides of the house, or could be mounted in windows. A fan could also be installed to blow outdoor air into a crawl space.



Cost

The installation costs for forced-air systems ranging from simple window fans to elaborate heating, ventilation, and air conditioning (HVAC) systems will range from $25 to as much as $1,000.

The additional cost of electricity for forced-air systems will vary depending upon the size of the fans, the number of fans used, and the amount of use. A single window fan can have electricity costs as low as $20 per year, while a central furnace fan may cost $275 a year to operate.

Use of forced ventilation throughout cold weather will substantially increase your heating costs. As with natural ventilation, if you were to increase the air exchange rate to eight times its normal level in your basement while maintaining comfortable temperatures there, your annual house heating bill could be as much as three times greater than normal.

If you normally have an air conditioner running in hot weather, your cooling costs will be similarly greater.

Reductions

As pointed out in the preceding section, "tight" houses with low air exchange rates are likely to benefit more from ventilation increases than are houses with high exchange rates. In a typical house, to achieve a 90-percent reduction of radon you will probably need a 500 to 1,000 cfm (cubic feet per minute) fan.

Limitations

Forced ventilation, like natural ventilation, can be employed in most houses, but, in many cases, the trade-off in decreased comfort and/or excessive heating or cooling costs may prove unacceptable. This approach may be useful as an interim measure with very high radon levels.

Procedure

You should ventilate the lowest level of your house. (Closing off and not using a basement may also be advisable.) Ventilating all levels is recommended whenever outdoor conditions permit. Air should be blown into the house and allowed to exit through windows or vents on adjacent or opposite sides. In many homes, blowing air in through an existing central furnace is quite practical. The use of an exhaust fan to pull air out of the house may decrease the interior air pressure and draw more radon inside. The use of whole-house fans is not recommended because they typically operate in the exhaust mode.

Air distribution and ventilation rates can be controlled by the sizing and location of fans and the use of louvered air deflectors. EPA's experience suggests that you should install two or three fans rated at twice the air moving capacity calculated to be needed for the desired increased ventilation.

When ventilating unheated areas, be sure to take precautions to prevent pipes from freezing.

Heat Recovery Ventilation (HRV)

How It works

Replaces radon-laden indoor air with outdoor air.

A device called a "heat recovery ventilator" (sometimes referred to as an "air-to-air heat exchanger") uses the heat in the air being exhausted to warm the incoming air. In an air-conditioned house in warm weather, the process is reversed: The air being exhausted is used to cool the incoming air. This saves between 50 and 80 percent of the warmth (or coolness) that would be lost in an equivalent ventilation system without the device.

Installation

Ducted units are designed, installed, and balanced by experienced heating/ventilation/air conditioning contractors. Wall-mounted units are generally less complex, and can sometimes be installed directly by the homeowner.

Cost

Installation costs (materials and labor) will range from $800 to $2,500 for ducted units and are roughly $400 for wall-mounted units.

The cost for electricity to operate one of the larger units with two 200-cfm fans is about $30 per year.

Using a heat recovery ventilator could save you 50 to 80 percent of the increase in heating and cooling costs that would result from achieving a comparable amount of ventilation without heat recovery.

Reductions

A radon reduction of 50 to 75 percent can be achieved in houses of typical size and infiltration rate, assuming between 200 and 400 cfm of HRV capacity. Reductions can be greater in tight houses. Reductions will vary throughout the house, depending on ducting configurations.

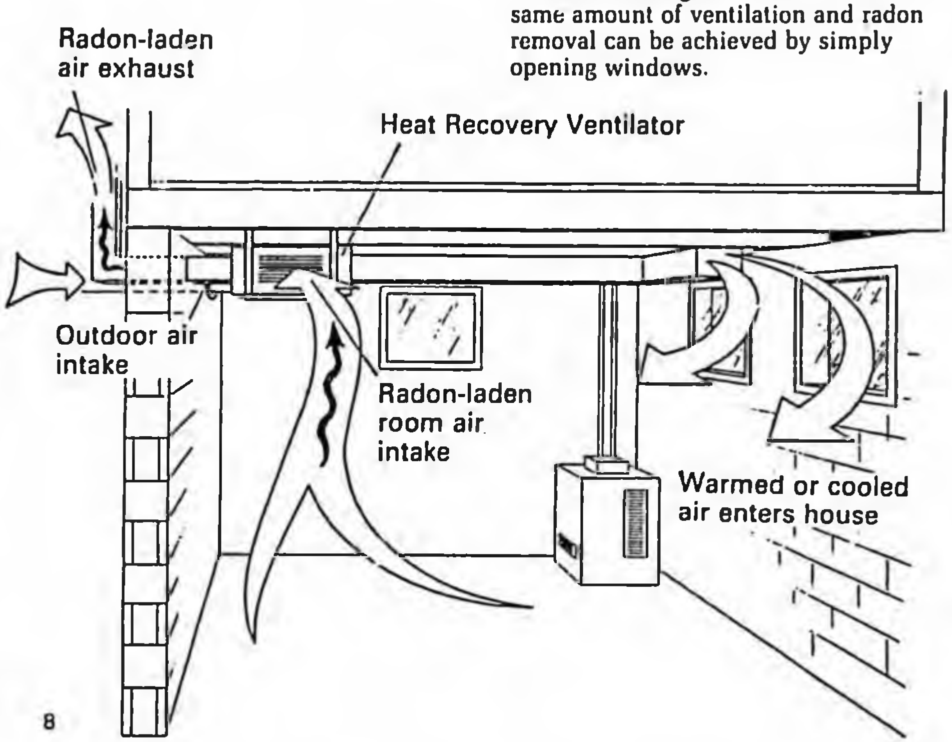
Limitations

The applicability of HRVs for radon reduction will likely be limited to situations where only moderate reductions are needed and where winters are cold. If an HRV is intended to serve as a stand-alone measure to achieve 4 pCi/L in a house of typical size and infiltration rate, the initial radon in the house could be no greater than 10 to 15 pCi/L. Greater reductions can be achieved in tight houses.

Procedure

To simplify the necessary ducting runs to different parts of the house, the heat recovery ventilator unit, consisting of the core and fans, can be located in an inconspicuous part of the house—such as an unfinished basement or utility room. Care must be taken to keep fresh air supply registers well-removed from return air withdrawal points, locating the radon-laden air returns in the basement or lowest level. It is crucial that the flow-rates in the fresh air intake duct and the radon-laden air exhaust duct be balanced. If more air is exhausted than is brought in, the house will become depressurized and even more radon may be drawn into the house. Be sure the balancing is done with no pressure difference between indoors and outdoors, since the unit will tend to maintain any pressure difference that exists when it is balanced.

Heat recovery ventilators are usually cost-effective only if operated during cold weather or in hot weather if the indoor versus outdoor temperature difference is large. At other times, the same amount of ventilation and radon removal can be achieved by simply opening windows.



Covering Exposed Earth

How It Works

Reduces the flow of radon into the house.

Exposed earth—in basement cold-rooms, storage areas, drain areas, sumps, and the like, as well as in crawl spaces—is often a major entry point for radon.

Installation

Requires installation by competent, experienced contractors or highly skilled homeowners.

Cost

Covering or sealing small areas (and ventilating covered air spaces as necessary) often costs under $100. Pouring a new slab would cost considerably more in a large unpaved area.

The annual cost for operating a fan would be about $30.

Reductions

Since radon can seep through any small opening, the degree of radon reduction achieved by sealing any particular area cannot be predicted. Effectively blocking a major entry point, however, should result in some reductions of the overall radon level in your house. In houses with marginal radon problems, covering exposed earth, along with sealing cracks and openings, may be a sufficient remedy.

Covering exposed earth is also likely to enhance the effectiveness of most other radon reduction methods, such as block-wall ventilation and sub-slab suction.

Limitations

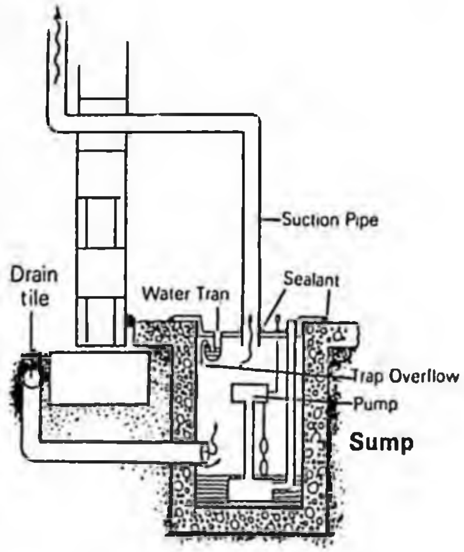
As a house settles and reacts to external and internal stresses, covered areas can open again. Therefore, periodic checking and maintenance are required.

Procedure

Any basement earthen floor should be excavated as necessary and a poured concrete floor installed. Before the concrete is poured, four inches of crushed stone should be placed over the earthen floor to permit easy radon reduction by sub-slab suction if needed at a later date. All joints must be carefully sealed. When the covering encloses an air space, such as that around a sump pump, a small fan should be installed to exhaust the air to the outside, preferably at roof level.

A crawl space connected to a basement can be covered, ventilated, and/or sealed off from the basement.

A crawl space not connected to a basement can be ventilated (as discussed in the section on natural ventilation), or the earthen floor can either be covered with a gas-proof liner (with passive vents to the outside) or covered with concrete.



Sealing Cracks and Openings

How It Works

Reduces the flow of radon into the house.

Radon is a gas that can pass through any opening in a floor or wall which touches the soil. It can enter your house through: openings around utility pipes, joints between basement floors and walls including perimeter (French) drains, other floor drains (especially those that discharge to dry wells), the holes in the top row of concrete blocks, and tiny cracks and openings (such as the pores in concrete blocks). Sealing such cracks and openings is often an important preliminary step when other methods are used. For houses with marginal radon problems, sealing alone may be sufficient.

In some houses, certain areas will be difficult, if not impossible, to seal without significant expense. These include: the top of block walls, the space between block walls and exterior brick veneer, and openings concealed by masonry fireplaces and chimneys.

Installation

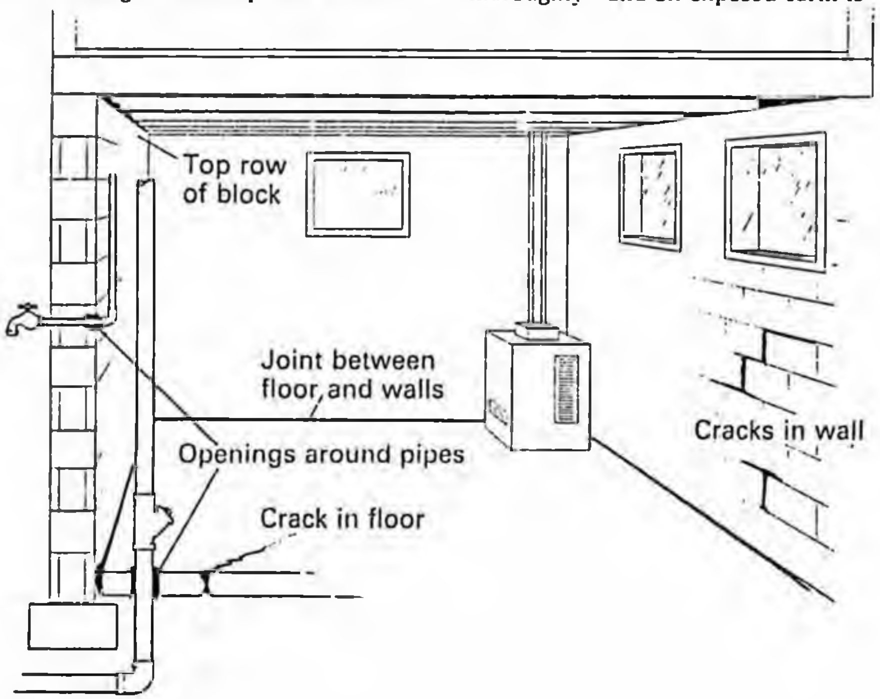
Since effective sealing generally requires meticulous surface preparation and carefully controlled application of appropriate substances, the work is often most effectively done by experienced and competent contractors or highly skilled homeowners.

Cost

Costs are highly variable. Do-it-yourself closure of accessible major entry points can be low in cost. Putting traps in drains and covering sumps can be low to moderate in cost. Applying membranes and coatings can be expensive.

Reductions

When sealing is used alone, you should expect only low to moderate reductions in radon levels. If sealing is done thoroughly—and all exposed earth is covered—reductions may be sufficient in some houses. Sealing is required for block-wall ventilation and some sub-slab suction systems to work effectively.



Limitations

It is very difficult to find all the cracks and openings in your house. This method may have little effect on radon entry unless nearly all the entry points are sealed. Furthermore, settling of the house and other stresses may create more cracks as time passes. Also, the openings in the top row of concrete blocks in a wall are often inaccessible or otherwise difficult to seal tightly. As a house settles and reacts to external and internal stresses, old seals can deteriorate and new cracks can appear. The aging process ultimately ends the ability of sealants to block out soil gases. Therefore, checking and maintenance are required at least yearly.

Procedure

If possible, the holes in the top row of concrete blocks in the basement walls should be sealed with mortar or urethane foam.

Seal wall and floor joints with flexible polyurethane membrane sealants.

Cracks and utility openings should be enlarged enough to allow filling with compatible, gas-proof, non-shrinking sealants.

A water trap should be installed in floor drains connecting to drainage or weeping-tile systems. Water traps allow water that collects on basement floors to drain away but greatly reduce or entirely eliminate entry of soil gas, including radon. Water traps must be kept filled with water to be effective.

Perimeter drains (French drains) should be filled with a urethane foam; however, some alternative plan for water drainage should be provided.

Porous walls (especially block walls) require the application of waterproof paint, cement, or epoxy to a carefully prepared surface.

Drain-Tile Suction

How It Works

Water is drained away from the foundation of some houses by perforated pipes called drain tiles. Drain tiles are rarely completely filled with water. If these drain tiles form a partial or continuous loop around the house, they may be used to pull radon from the surrounding soil and vent it away from the house.

Installation

Normally requires installation and testing by competent, experienced professionals. Some homeowners, however, might be able to install a drain-tile suction system themselves (particularly where work inside the house does not require removing concrete).

Cost

Installation costs (labor and materials) would be between $700 and $1,500 for an exterior drain system and between $800 and $2,500 for a system that drains into a sump. The actual cost will largely depend upon the amount and location of piping and the fan location. For simple exterior installations, the cost of materials (fan, plastic piping, and some incidentals) should not exceed $300.

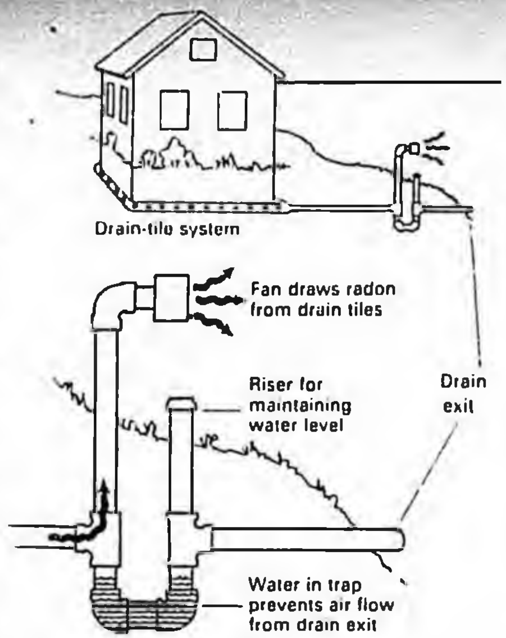
Operating costs should be roughly $30 per year for fan electricity and $100 per year for the heating penalty resulting from increased house ventilation.

Reductions

In some houses, the installation of a drain-tile suction system has resulted in radon reductions of over 99 percent.

Limitations

The primary disadvantage of drain-tile suction is that many houses will not



have complete drain-tile loops. Installation of drain tiles in houses that do not have them is sometimes not cost-effective. If some portion of the perimeter footing does not have drain tiles beside it or if the tiles are damaged or blocked, that portion of the perimeter might fail to be effectively treated. It is very difficult to determine how extensive the drain tiles are around a house. If drain tiles are likely to form a large portion of a complete loop, the advantages of the drain-tile suction approach may make it more cost-effective to try this approach first before attempting a more expensive technique.

Procedure

Water collected by drain tiles normally flows through a pipe to a drainage area away from the house or into a sump. Radon can be pulled from the soil beneath a house by attaching an exhaust fan to the collection pipe or to the sealed sump (see page 9).

To prevent outside air from being drawn from the end of the collection pipe, a water-filled trap should be installed in the pipe beyond the point where the fan is attached. This trap (similar to the trap beneath a kitchen sink) must be placed below the freeze line. The trap must be kept filled with water in order to be effective.

Sub-Slab Suction

How It Works

The lowest floor of most houses, other than those built over crawl spaces, consists of a concrete slab poured over the earth or on top of crushed rock (aggregate). Radon can be drawn from under the slab and vented away from the house.

Installation

Installation of a sub-slab suction system is not an easy "do-it-yourself" job, but some installations might be successfully completed by a homeowner with the necessary skills. A do-it-yourself installation might be most logically attempted when it is known that a good layer of aggregate underlies the slab.

Cost

Installation cost for a multiple-pipe, through-the-slab system would be about $900 to $2,500 if completed by a professional. Material costs for a fan, piping, and incidentals would be about $300. Typical operating costs would be roughly $30 per year for electricity and $100 per year for the heating penalty resulting from increased house ventilation.

Reductions

Installation of a sub-slab suction system can reduce indoor radon levels by 80 to 99 percent. In many cases, reductions of 95 to 99+ percent have been achieved when good permeability exists beneath the slab.

Limitations

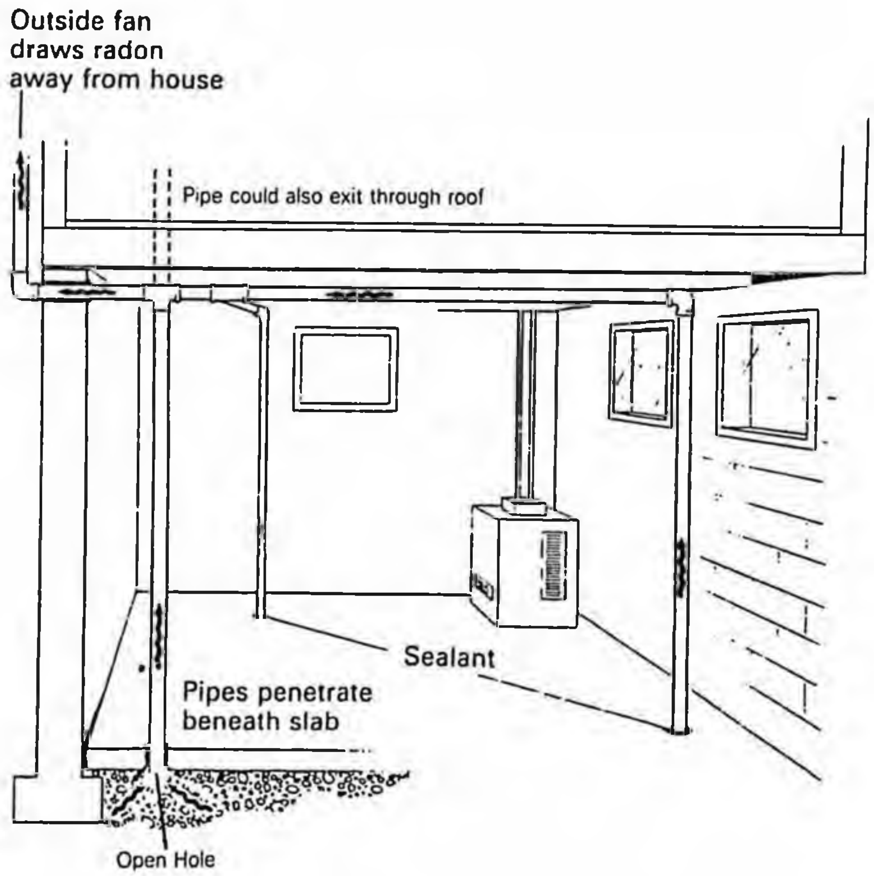
Sub-slab suction has been one of the most widely used and successful radon reduction techniques. It is most useful with foundations built on good aggregate or on highly permeable soil.

When permeability under the slab is not so good, sub-slab suction will often still be applicable. If permeability is less than desirable, more suction pipes might be needed. Positioning of the suction pipe also may become more important.

Sub-slab suction systems require both a fan capable of maintaining at least 0.5 to 1.0 inch pressure and closure of accessible openings in the slab.

Procedure

A fan is used to ventilate soil gas away from the foundation by means of individual pipes which are inserted into the region under the concrete slab. The pipes can be inserted vertically downward through the slab from inside the house, as illustrated, or can be inserted horizontally through a foundation wall at a level beneath the slab. This latter approach is more practical for slabs poured near the surface of the ground. Pipes should exhaust at roof level, away from windows and vents that could permit the gas to re-enter the house.



Block-Wall Ventilation

How it Works

Draws radon from the spaces within concrete block walls before it can enter the house ("wall suction") or blows air into block walls so that radon is prevented from entering the walls ("wall pressurization").

The concrete blocks used to construct many basement walls contain hollow spaces which are connected both horizontally and vertically. Radon from the soil—which enters the wall through joints or tiny pores and cracks—can travel through these connected spaces and enter the basement through similar openings on the interior side or through the openings in the top row of block.

Installation

Requires installation and testing by competent, experienced professionals or highly skilled homeowners.

Cost

The installation of a series of exhaust pipes in an unfinished basement would cost from $1,500 to $2,500. A baseboard collection system in a similar basement would cost about $2,000 or more to install.

Annual operating costs would typically be $30 to $60 for electricity and $200 to $400 for additional heating costs.

Reductions

Very effective (up to 99 percent radon reduction) in houses with good closure and sealing of all major wall openings. In other houses, radon reduction will be significantly less.

Limitations

Applicable only to houses with hollow block basement walls. Block-wall suction may not be successful if you cannot seal the top of the walls, the space between the walls and any exterior brick veneer, and openings that could be concealed by masonry fireplaces or chimneys. Noticeable cracks and openings should be sealed.

Block walls dividing the interior of a basement sometimes penetrate the floor and touch the underlying soil. Exhaust pipes must be installed in all such walls.

Procedure

There are two basic approaches to block-wall ventilation.

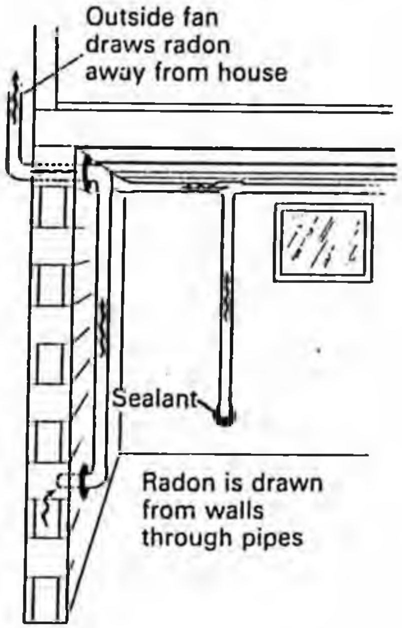
Although this method can be used for any radon level, it is best suited to levels above 0.2 WL (40 pCi/L). The easiest approach is to insert one or two pipes into each wall and use fans to draw radon out of the walls and vent it outdoors, or use fans to pressurize the walls to prevent radon entry. The other approach involves the installation of a sheet metal "baseboard" duct around the perimeter of the basement. Holes are drilled behind the duct into the hollow spaces within the blocks. This second approach produces more uniform ventilation and may be more pleasing in appearance.

In houses which have channel drains cast in the concrete floor next to the block walls, the baseboard approach should work particularly well, since it would ventilate the drains as well as the walls.

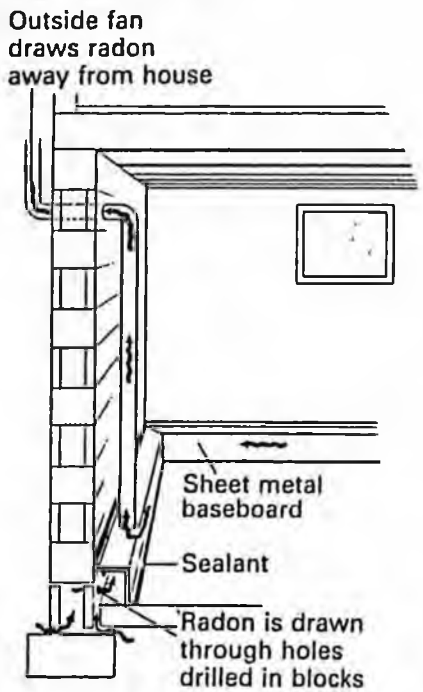
For either wall-ventilation approach to work, all major holes (especially the tops of the blocks) must be sealed. As we pointed out previously, this might be difficult—if not impossible—to do in certain places. (Both of the approaches are shown below in the "suction" mode.)

Pipes should exhaust at roof level away from windows and vents that could permit the gas to re-enter the house.

Pipe-in-wall approach



Baseboard approach



Prevention of House De-pressurization

How It Works

Reduces the amount of radon drawn into your house.

Some exhaust fans and combustion units (such as woodstoves and fireplaces) can lower the air pressure in your house by consuming air and/or exhausting it to the outside. The lower the air pressure in your house, compared to that in the soil, the more radon-laden air may be drawn inside from the underlying soil.

Installation

If exhaust fans must be used, slightly open windows near the fans. Likewise with windows near fireplaces, woodstoves, and other combustion units. Doing so will facilitate the flow of make-up air from outdoors. Install a permanent system to supply outdoor air to household combustion units. For central, forced-air heating and cooling systems, seal off any cold-air return registers that are located in the basement. This reduces leakage of basement air into ducts.

Close air-flow bypasses (openings through the floor between stories) to inhibit air movement up through the house. Close openings through the house shell on upper levels to reduce air outflow from the house.

Note: Many combustion units are designed to accept outside air, but for many others a modification is not only illegal but may be unsafe. Gas furnaces are a prime example. In this case, directing outdoor air to a point near the furnace or enclosing the furnace in a room that is vented outdoors are appropriate measures.

Cost

Some causes of depressurization can be eliminated by the homeowner with little cost.

Installation costs for providing supplemental air will vary greatly depending upon the type and location of the combustion unit being modified. For some, there may be a slight increase in operating cost due to the typically lower temperature of the air being heated.

Reductions

Because each situation is different, it is impossible to predict the reduction in radon levels that can be expected as a result of reducing sources of depressurization in a house. There have been a number of individual applications where radon reduction has been significant.

Limitations

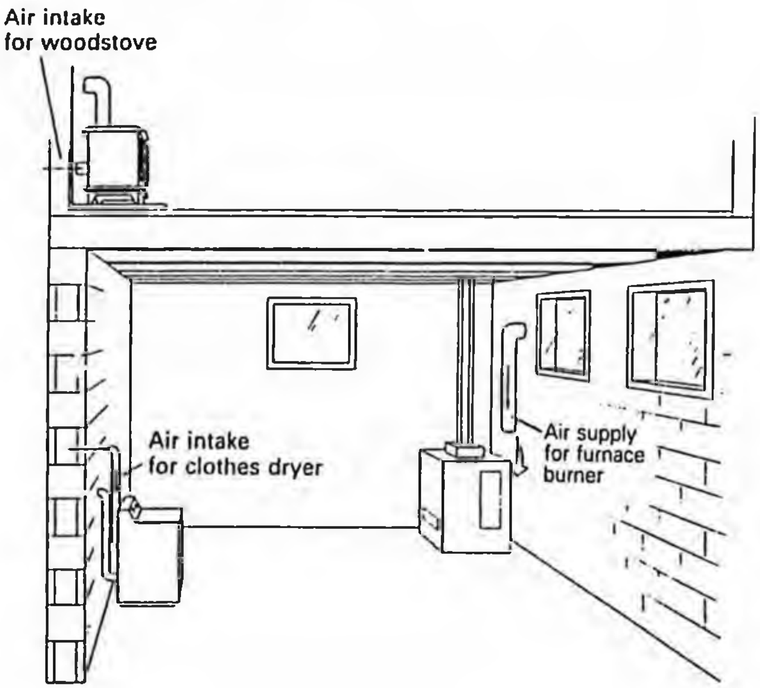
The effectiveness of depressurization reduction techniques for lowering radon levels will be time-dependent. For example, a technique aimed at reducing depressurization by an exhaust fan or a fireplace could have a significant impact when the appliance is being operated; however, the average annual effect will be lower if the appliance is operated for only a relatively small percentage of the year.

Procedure

Follow the procedures given under "Installation." When possible, avoid the use of exhaust fans or provide a route for outdoor air entry to compensate for exhausted house air.

Provide outdoor air in the vicinity of combustion units. Ductwork or piping can be run from any suitable exterior wall to the combustion unit. A manual or automatic damper should be placed in such ductwork to prevent entry of cold air when the stove or furnace is not in operation. Screen the outside end of ductwork to bar pests and debris.

Ensure that windows on the downwind side of the house are opened only when windows on the upwind side are also open.



House Pressurization

How it works

Maintains that part of the house which is in contact with the soil at a pressure higher than that of the air in the soil. This prevents soil gas—including radon—from entering the home. The most common application of this method is to blow upstairs air into the basement; however, in some homes, blowing upstairs air into a crawl space may also be applicable.

Installation

Requires installation by competent, experienced contractor or a careful and skilled homeowner.

Cost

Varies depending upon the work required to tighten the basement shell. Installation cost typically would be comparable to a simple wall ventilation system ($1,500-$2,500). Operating costs will include the electricity to run the fan (about $30 to $40 per year) and the heating penalty resulting from increased infiltration upstairs caused by the fan (as much as $400 to $500 per year).

Reductions

Initial results from a few basement pressurization applications indicate that radon reductions of 70 to 90 percent are possible.

Limitations

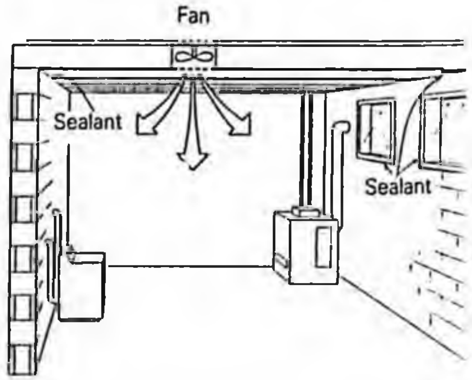
The application of this technique is strictly limited to houses with either basements or heated crawl spaces that are relatively tightly sealed from the living area. Care must be taken to prevent back-drafting of upstairs combustion units. Also, the performance of the system could be completely negated if homeowners open basement doors or windows.

Some homeowners may object to fan noise and vibration if the fan is mounted in the floor of living areas. To overcome that problem, the fan may be mounted on the basement floor and ducted to the living area.

This is one of the least-tested techniques. Structural effects and reliability are not well known.

Procedure

Tighten shell between the basement or crawl space and the upstairs and between the basement or crawl space and the outdoors. Blow upstairs air down in the basement or crawl space. If openings must be made in the upstairs floor, the openings should have a reasonable cross-section to avoid suffering a severe energy penalty.



Comparison of Features

Method	Installation Cost	Operating Cost	Maximum Possible Reductions*	Comments
Natural ventilation:				Useful immediate step to reduce high radon levels.
Basement or lowest floor	Minimal	High to very high	Up to 90+%	
Crawl space	Minimal	Moderate	Up to 90+%	
Forced ventilation:				More controlled than natural ventilation.
Basement or lowest floor	Low to moderate	Very high	Up to 90+%	
Crawl space	Low to moderate	Moderate	Up to 90+%	
Heat recovery ventilation				Air intake and exhaust must be equal. Also, expect lower radon reductions for houses with moderate to high air exchange rates.
Ducted	Moderate to high	Low to moderate	50-75%	
Wall mounted	Low to moderate	Low to moderate	No data available	
Covering exposed earth	Moderate to high	Low	Site specific	Required to make most other methods work.
Sealing cracks and openings	Minimal to high	Nominal	Site specific	Required to make most other method work.
Drain-tile suction	Moderate to high	Low	Up to 99+%	Works best when drain is continuous, unblocked loop.
Sub-slab suction	High	Low	Up to 99+%	Works best with good aggregate or highly permeable soil under slab.
Block-wall ventilation	High	Low	Up to 99+%	Applies to block-wall basements. Sub-slab suction may be needed to supplement.
Prevention of house depressurization	Low to moderate	Low	Site specific	May be required to make other methods work. May see seasonal impact.
House pressurization	Moderate to high	Moderate	Up to 90% (limited data)	Most cost-effective when basement is tightly sealed.

*These represent generally the best reductions that a single method can accomplish. You may get higher or lower reductions depending on the unique characteristics of your house. It is likely that reductions in your house will not be as great as those shown. Especially with high initial radon levels, several methods may have to be combined to achieve acceptable results.

Sources of Information

If you would like further information or explanation about any of the points mentioned in this booklet, you should contact your state radon program office listed at the end of this booklet.

If you have difficulty obtaining needed information, you may call your EPA regional office listed below. The radiation program staff will be happy to provide you with assistance.

EPA Regional Offices

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

EPA Region 2
(2AIR:RAD)
26 Federal Plaza
New York, NY 10278
(212) 264-4418

Region 3 (3AH14)
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-4084

EPA Region 4
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 347-2904

EPA Region 5 (5AR26)
230 South Dearborn Street
Chicago, IL 60604
(312) 886-6165

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

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

EPA Region 8
(8HWM-RP)
999 18th Street
One Denver Place, Suite 1300
Denver, CO 80202-2413
(303) 293-1648

EPA Region 9 (A-3)
215 Fremont Street
San Francisco, CA 94105
(415) 974-8378

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

State–EPA Region

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

State Radon Contacts

Alabama
Radiological Health Branch
Alabama Department of Public Health
State Office Building
Montgomery, AL 36130
(205) 261-5313

Alaska
Alaska Department of Health and Social Services
P.O. Box H-06F
Juneau, AK 99811-0613
(907) 465-3019

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

Arkansas
Division of Radiation Control and Emergency Management
Arkansas Department of Health
4815 W. Markham Street
Little Rock, AR 72205-3867
(501) 661-2301

California
Indoor Quality Program
California Department of Health Services
2151 Berkeley Way
Berkeley, CA 94704
(415) 540-2134

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

Connecticut
Connecticut Department of Health Services
Toxic Hazards Section
150 Washington Street
Hartford, CT 06106
(203) 566-8167

Delaware
Division of Public Health
Delaware Bureau of Environmental Health
P.O. Box 637
Dover, DE 19903
(302) 736-4731

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

Florida
Florida Office of Radiation Control
Building 18, Sunland Center
P.O. Box 15490
Orlando, FL 32858
(305) 297-2095

Georgia
Georgia Department of Natural Resources
Environmental Protection Division
205 Butler Street, SE
Floyd Towers East, Suite 1166
Atlanta, GA 30334
(404) 656-6905

Hawaii
Environmental Protection and Health Services Division
Hawaii Department of Health
591 Ala Moana Boulevard
Honolulu, HI 968[illegible]
(808) 548-4383

Idaho
Radiation Control Section
Idaho Department of Health and Welfare
Statehouse Mall
Boise, ID 83720
(208) 334-5879

Illinois
Illinois Department of Nuclear Safety
Office of Environmental Safety
1035 Outer Park Drive
Springfield, IL 62704
(217) 546-8100 or
(800) 225-1245 (in State)

Indiana
Division of Industrial Hygiene and Radiological Health
Indiana State Board of Health
1330 W. Michigan Street,
P.O. Box 1964
Indianapolis, IN 46206-1964
(317) 633-0153

Iowa
Bureau of Environmental Health
Iowa Department of Public Health
Lucas State Office Building
Des Moines, IA 50319-0075
(515) 281-7781

Kansas
Kansas Department of Health and Environment
Forbes Field, Building 321
Topeka, KS 66620-0110
(913) 862-9360 Ext. 288

Kentucky
Radiation Control Branch
Cabinet for Human Resources
275 East Main Street
Frankfort, KY 40621
(502) 564-3700

Louisiana
Louisiana Nuclear Energy Division
P.O. Box 14690
Baton Rouge, LA 70898-4690
(504) 925-4518

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

Maryland
Radiation Control
Department of the Environment
7th Floor Mailroom
201 W. Preston Street
Baltimore, MD 21201
(301) 333-3130 or (800) 872-3666

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

Michigan
Michigan Department of Public Health
Division of Radiological Health
3500 North Logan, P.O. Box 30035
Lansing, MI 48909
(517) 335-8190

Minnesota
Section of Radiation Control
Minnesota Department of Health
P.O. Box 9441
717 SE Delaware Street
Minneapolis, MN 55440
(612) 623-5350 or (800) 652-9747

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

Missouri
Bureau of Radiological Health
Missouri Deparment of Health
1730 E. Elm, P.O. Box 570
Jefferson City, MO 65102
(314) 751-6083

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

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

Nevada
Radiological Health Section
Health Division
Nevada Department of Human Resources
505 East King Street, Room 202
Carson City, NV 89710
(702) 885-5394

New Hampshire
New Hampshire Radiological Health Program
Health and Welfare Building
6 Hazen Drive
Concord, NH 03301-6527
(603) 271-4588

New Jersey
New Jersey Department of Environmental Protection
380 Scotch Road, CN-411
Trenton, NJ 08625
(609) 530-4000/4001 or
(800) 648-0394 (In State) or
(201) 879-2062 (N. NJ Radon Field Office)

New Mexico
Surveillance Monitoring Section
New Mexico Radiation Protection Bureau
P.O. Box 968
Santa Fe, NM 87504-0968
(505) 827-2957

New York
Bureau of Environmental Radiation Protection
New York State Health Department
Empire State Plaza, Corning Tower
Albany, NY 12237
(518) 473-3613 or
(800) 458-1158 (In State) or
(800) 342-3722 (NY Energy Research & Development Authority)

N. Carolina
Radiation Protection Section
North Carolina Department of Human Resources
701 Barbour Drive
Raleigh, NC 27603-2008
(919) 733-4283

N. Dakota
Division of Environmental Engineering
North Dakota State Department of Health & Consolidated Laboratories
Missouri Office Building
1200 Missouri Avenue, Room 304
P.O. Box 5520
Bismarck, ND 58502-5520
(701) 224-2348

Ohio
Radiological Health Program
Ohio Department of Health
1224 Kinnear Road
Columbus, OH 43212
(614) 481-5800 or
(800) 523-4439 (In Ohio only)

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

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

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

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

Rhode Island
Division of Occupational Health and Radiological Control
Rhode Island Department of Health
206 Cannon Bldg.
75 Davis Street
Providence, RI 02908
(401) 277-2438

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

S. Dakota
Office of Air Quality and Solid Waste
South Dakota Dept. of Water & Natural Resources
Joe Foss Building
Room 217
523 E. Capital
Pierre, SD 57501-3181
(605) 773-3153

Tennessee
Division of Air Pollution Control
Custom House
701 Broadway
Nashville, TN 37219-5403
(615) 741-4634

Texas
Bureau of Radiation Control
Texas Department of Health
1100 West 49th Street
Austin, TX 78756-3189
(512) 835-7000

Utah
Bureau of Radiation Control
Utah State Department of Health
State Health Department Building
P.O. Box 16690
Salt Lake City, UT 84116-0690
(801) 538-6734

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

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

Washington
Environmental Protection Section
Washington Office of Radiation Protection
Thurston AirDustrial Center
Building 5, LE-13
Olympia, WA 98504
(206) 753-5962

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

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

Wyoming
Radiological Health Services
Wyoming Department of Health and Social Services
Hathway Building
4th Floor
Cheyenne, WY 82002-0710
(307) 777-7956

EPA United States Environmental Protection Agency
Office of Air and Radiation

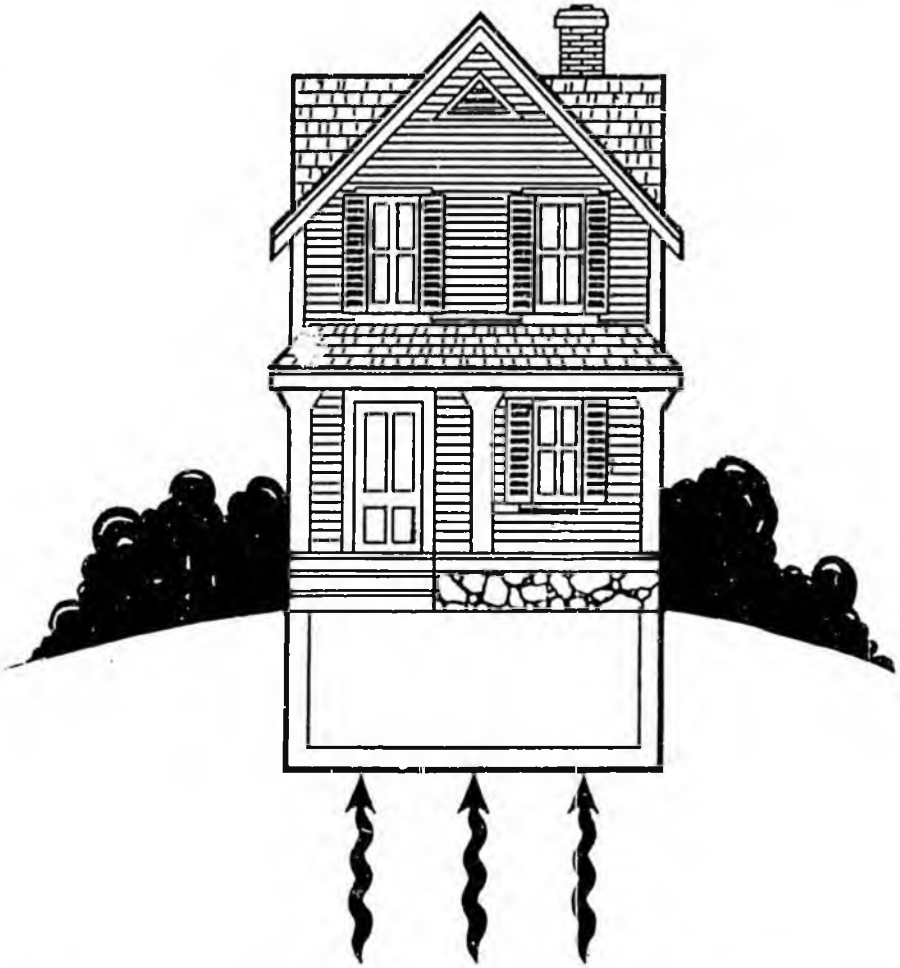
U.S. Department Of Health and Human Services
Centers for Disease Control

August 1986
OPA-86-004

HB 519

A Citizen's Guide To Radon

What It Is And What To Do About It



The U.S. Environmental Protection Agency and the U.S. Centers for Disease Control are concerned about the increased risk of developing lung cancer faced by persons exposed to above-average levels of radon in their homes. This pamphlet is a joint effort by EPA and CDC. Its purpose is to help readers to understand the radon problem and decide if they need to take action to reduce radon levels in their homes.

What is radon?

Radon is a radioactive gas which occurs in nature. You cannot see it, smell it, or taste it.

Where does radon come from?

Radon comes from the natural breakdown (radioactive decay) of uranium. Radon can be found in high concentrations in soils and rocks containing uranium, granite, shale, phosphate, and pitchblende. Radon may also be found in soils contaminated with certain types of industrial wastes, such as the byproducts from uranium or phosphate mining.

In outdoor air, radon is diluted to such low concentrations that it is usually nothing to worry about. However, once inside an enclosed space (such as a home) radon can accumulate. Indoor levels depend both on a building's construction and the concentration of radon in the underlying soil.

How does radon affect me?

The only known health effect associated with exposure to elevated levels of radon is an increased risk of developing lung cancer. Not everyone exposed to elevated levels of radon will develop lung cancer, and the time between exposure and the onset of the disease may be many years.

Scientists estimate that from about 5,000 to about 20,000 lung cancer deaths a year in the United States may be attributed to radon. (The American Cancer Society expects that about 130,000 people will die of lung cancer in 1986. The Surgeon General attributes around 85 percent of all lung cancer deaths to smoking.)

Your risk of developing lung cancer from exposure to radon depends upon the concentration of radon and the length of time you are exposed. Exposure to a slightly elevated radon level for a long time may present a greater risk of developing lung cancer than exposure to a significantly elevated level for a short time. In general, your risk increases as the level of radon and the length of exposure increase.

How certain are scientists of the risks?

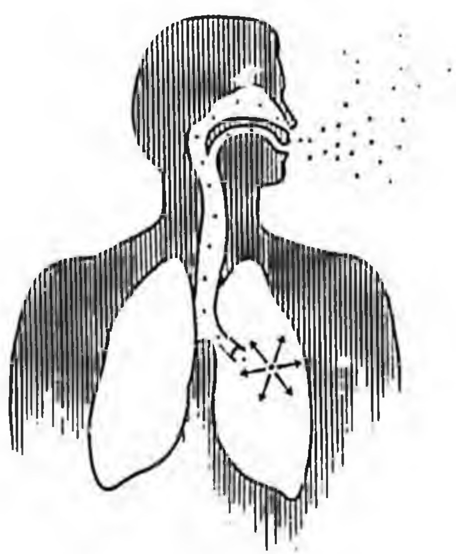
With exposure to radon, as with other pollutants, there is some uncertainty about the amount of health risk. Radon risk estimates are based on scientific studies of miners exposed to varying levels of radon in their work underground. Consequently, scientists are considerably more certain of the risk estimates for radon than they are of those risk estimates which rely solely on studies of animals.

To account for the uncertainty in the risk estimates for radon, scientists generally express the risks associated with exposure to a particular level as a *range* of numbers. (The risk estimates given in this booklet are based on the advice of EPA's Science Advisory Board, an independent group of scientists established to advise EPA on various scientific matters.)

Despite some uncertainty in the risk estimates for radon, it is widely believed that the greater your exposure to radon, the greater your risk of developing lung cancer.

How does radon cause lung cancer?

Radon, itself, naturally breaks down and forms radioactive decay products. As you breathe, the radon decay products can become trapped in your lungs. As these decay products break down further, they release small bursts of energy which can damage lung tissue and lead to lung cancer.



When did radon become a problem?

Radon has always been present in the air. Concern about elevated indoor concentrations first arose in the late 1960's when homes were found in the West that had been built with materials contaminated by waste from uranium mines. Since then, cases of high indoor radon levels resulting from industrial activities have been found in many parts of the country. We have only recently become aware, however, that houses in various parts of the U.S. may have high indoor radon levels caused by *natural* deposits of uranium in the soil on which they are built.

Does every home have a problem?

No, most houses in this country are not likely to have a radon problem; but relatively few houses do have highly elevated levels. The dilemma is that, right now, no one knows which houses have a problem and which do not. You may wish to call your state radiation protection office to find out if any high levels have been discovered in your area.

Many states, as well as the federal government, are sponsoring work to identify areas of the country which are likely to have indoor radon problems. However, early results from this work are inconclusive. If you are concerned that you may have an indoor radon problem, you should consider having your home tested.

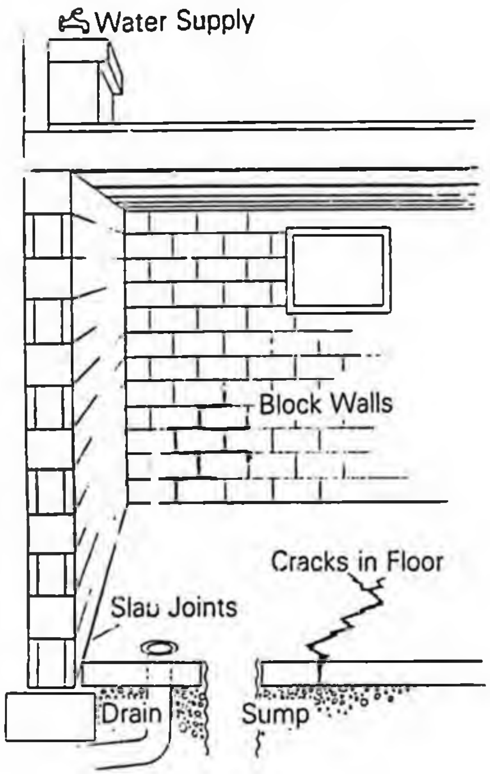
How does radon get into a home?

Radon is a gas which can move through small spaces in the soil and rock on which a house is built. Radon can seep into a home through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints, and tiny cracks or pores in hollow-block walls.

Radon also can enter water within private wells and be released into a home when the water is used. Usually, radon is not a problem with large community water supplies, where it would likely be released into the outside air before the water reaches a home. (For more information concerning radon in water, contact your state's radiation protection office.)

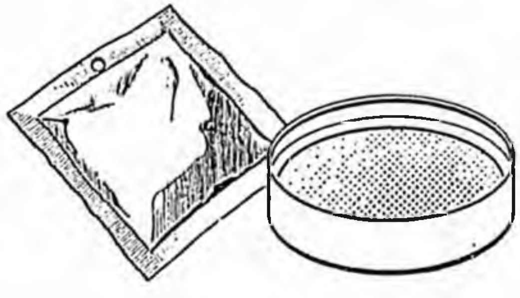
In some unusual situations, radon may be released from the materials used in the construction of a home. For example, this may be a problem if a house has a large stone fireplace or has a solar heating system in which heat is stored in large beds of stone. In general, however, building materials are not a major source of indoor radon.

Common Radon Entry Points

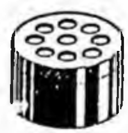


How is radon detected?

Since you cannot see or smell radon, special equipment is needed to detect it. The two most popular, commercially-available radon detectors are the charcoal canister and the alpha track detector. Both of these devices are exposed to the air in your home for a specified period of time and sent to a laboratory for analysis.



Charcoal Canisters
Test Period: 3 to 7 days
Approximate Cost: $10 to $25 for one canister



Alpha Track Detectors
Minimum Test Period: 2 to 4 weeks
Approximate Cost: $20 to $50 for one detector; discounts for multiple detectors

There are other techniques—requiring operation by trained personnel—which can be used to measure radon levels, but such techniques may be more expensive than the devices shown above.

Your measurement result will be reported to you in one of two ways. Results from devices which measure radon decay products are reported as "Working Levels" (WL). Results from devices which measure concentrations of radon gas are reported as "picocuries per liter" (pCi/l).

How can I get a radon detector?

Homeowners in some areas are being provided with detectors by their state or local government. In many areas, private firms offer radon testing. Your state radiation protection office may be able to provide you with information on the availability of detection devices or services.

The U.S. Environmental Protection Agency conducts a Radon Measurement Proficiency Program. This voluntary program allows laboratories and businesses to demonstrate their capabilities in measuring indoor radon. The names of firms participating in this program can be obtained from your state radiation protection office or from your EPA regional office.

How should radon detectors be used?

Obtaining a useful estimate of the radon level in your home may require that several detectors be used to make measurements in different areas. Following the steps below should provide the information needed as you decide whether or not further action is advisable. (In making radon measurements, you should be sure to follow the instructions of the manufacturer as to the proper exposure period for the particular device you are using.)

Step One: The screening measurement

The first step you should take is to have a short-term "screening" measurement made to give you an idea of the highest radon level in your home. Thus, you can find out quickly and inexpensively whether or not you have a potential radon problem.

The screening measurement should be made in the lowest livable area of your home (the basement, if you have one). All windows and doors should be closed for at least 12 hours prior to the start of the test, and kept closed as much as possible throughout the testing period. This is necessary to keep the radon level relatively constant throughout the testing period. Because of the need to keep the windows closed as much as possible, we recommend that you make short-term radon measurements during the cool months of the year.

Step Two: Determining the need for further measurements

In most cases, the screening measurement is not a reliable measure of the *average* radon level to which you and your family are exposed. Since radon levels can vary greatly from season to season as well as from room to room, the screening measurement only serves to indicate the *potential* for a radon problem. Depending upon the result of your screening measurement, you may need to have follow-up measurements made to give you a better idea of the average radon level in your home.

The following guidance may be useful to you in determining the urgency of your need for follow-up measurements.

If your screening measurement result is **greater than about 1.0 WL or greater than about 200 pCi/l**, you should perform follow-up measurements as soon as possible. Expose the detectors for no more than one week. Doors and windows should be closed as much as possible during testing. You should also consider taking actions (see page 13) to immediately reduce the radon levels in your home.

If your screening measurement result is **about 0.1 WL to about 1.0 WL or about 20 pCi/l to about 200 pCi/l**, perform follow-up measurements. Expose detectors for no more than three months. Doors and windows should be closed as much as possible during testing.

If your screening measurement result is **about 0.02 WL to about 0.1 WL or about 4 pCi/l to about 20 pCi/l**, perform follow-up measurements. Expose detectors for one year, or make measurements of no more than one week duration during each of the four seasons.

If your screening measurement result is **less than about 0.02 WL or less than about 4 pCi/l**, follow-up measurements are probably not required. If the screening measurement was made with the house closed up prior to and during the testing period, there is relatively little chance that the radon concentration in your home will be greater than 0.02 WL or 4 pCi/l as an annual average.

Step Three: The follow-up measurement

Follow-up measurements will provide you with a relatively good estimate of the average radon concentration to which you and your family are exposed. **We strongly recommend that you make follow-up measurements before you make any final decisions about whether to undertake major efforts to permanently correct the problem.**

Follow-up measurements should be made in at least two lived-in areas of your home. If your home has lived-in areas on more than one floor, you should make measurements in a room on each of the floors. An example is to take a measurement in the living room on the first floor and another in a second-floor bedroom. The results of the follow-up measurements should be averaged together.

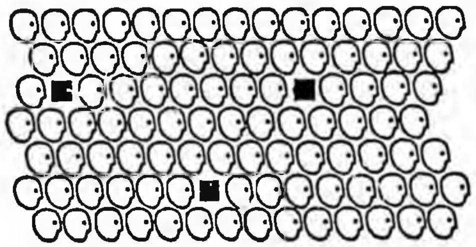
What do my test results mean?

The results of your follow-up measurements provide you with an idea of the average concentration throughout your home. The actual risk you face depends upon the amount of time you are exposed to this concentration.

The figures on the facing page illustrate the number of lung cancer deaths, out of a group of 100 people, that scientists would attribute to exposure to specific levels of indoor radon. The first three figures assume that these 100 individuals spent 75 percent of their time in the dwelling for 70 years. The numbers below each picture indicate what scientists consider to be a reasonable range of estimates of lung cancer deaths that could be attributed to the radon exposure. This is **in addition** to the number of lung cancer deaths attributed to other causes. (On average, about four people out of a hundred die of lung cancer from all causes combined.) The pictures represent the midpoint of the ranges.

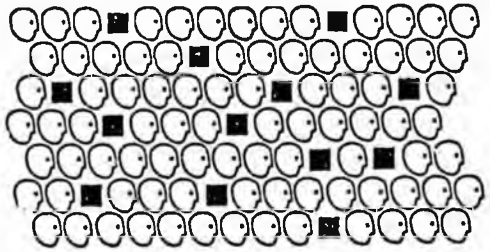
Lung Cancer Deaths Associated With Exposure To Various Radon Levels Over 70 Years

WL = 0.02
pCi/l = 4



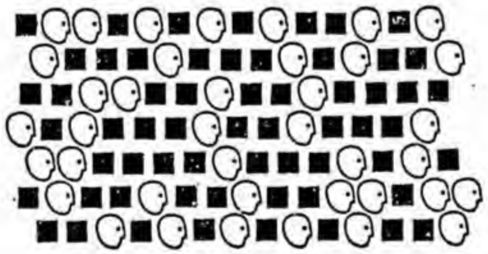
Between 1 and 5 out of 100

WL = 0.1
pCi/l = 20



Between 6 and 21 out of 100

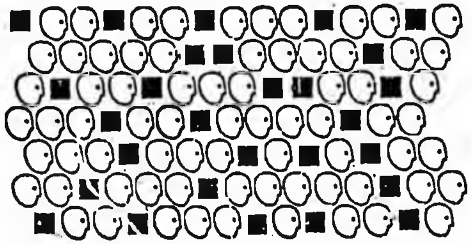
WL = 1.0
pCi/l = 200



Between 44 and 77 out of 100

If these same 100 individuals had lived only 10 years (instead of 70) in houses with radon levels of about 1.0 WL, the number of lung cancer deaths expected would be:

WL = 1.0
pCi/l = 200



Between 14 and 42 out of 100

Another way to think about the risk associated with radon exposure is to compare it with the risk from other activities. The chart below gives an idea of how exposure to various radon levels over a lifetime compares to the risk of developing lung cancer from smoking and from chest x-rays. The chart also compares these levels to the average indoor and outdoor radon concentrations.

As you look at the chart, be sure to use the proper radon-level column for your results (either WL or pCi/l).

Radon Risk Evaluation Chart

pCi/l	WL	Estimated number of lung cancer deaths due to radon exposure (out of 1000)	Comparable exposure levels	Comparable risk
200	1	440—770	1000 times average outdoor level	More than 60 times non-smoker risk 4 pack-a-day smoker
100	0.5	270—630	100 times average indoor level	20,000 chest x-rays per year
40	0.2	120—380		
20	0.1	60—210	100 times average outdoor level	2 pack-a-day smoker
10	0.05	30—120	10 times average indoor level	1 pack-a-day smoker
4	0.02	13—50		5 times non-smoker risk
2	0.01	7—30	10 times average outdoor level	200 chest x-rays per year
1	0.005	3—13	Average indoor level	Non-smoker risk of dying from lung cancer
0.2	0.001	1—3	Average outdoor level	20 chest x-rays per year

How quickly should I take action?

In considering whether and how quickly to take action based on your test results, you may find the following guidelines useful. EPA believes that you should try to permanently reduce your radon levels as much as possible. Based on currently available information, EPA believes that levels in most homes can be reduced to about 0.02 WL (4 pCi/l).

If your results are about 1.0 WL or higher, or about 200 pCi/l or higher:
Exposures in this range are among the highest observed in homes. Residents should undertake action to reduce levels as far below 1.0 WL (200 pCi/l) as possible. We recommend that you take action within several weeks. If this is not possible, you should determine, in consultation with appropriate state or local health or radiation protection officials, if temporary relocation is appropriate until the levels can be reduced.

If your results are about 0.1 to about 1.0 WL, or about 20 to about 200 pCi/l:
Exposures in this range are considered greatly above average for residential structures. You should undertake action to reduce levels as far below 0.1 WL (20 pCi/l) as possible. We recommend that you take action within several months.

If your results are about 0.02 to about 0.1 WL, or about 4 pCi/l to about 20 pCi/l:
Exposures in this range are considered above average for residential structures. You should undertake action to lower levels to about 0.02 WL (4 pCi/l) or below. We recommend that you take action within a few years, sooner if levels are at the upper end of this range.

If your results are about 0.02 WL or lower, or about 4 pCi/l or lower:
Exposures in this range are considered average or slightly above average for residential structures. Although exposures in this range do present some risk of lung cancer, reductions of levels this low may be difficult, and sometimes impossible, to achieve.

Remember: There is increasing urgency for action at higher concentrations of radon. The higher the radon level in your home, the faster you should take action to reduce your exposure. If you find elevated radon concentrations in your home, you should take the relatively easy, short-term actions described on page 13.

Are there other factors I should consider?

Most of the risk information given in this pamphlet, as well as the recommendations for taking corrective action, are based on the general case. Your individual living patterns could influence your assessment of your risk and your decisions about the need for further action. Your answers to the following questions may help you evaluate your personal risk.

- Does anyone smoke in your home? Scientific evidence indicates that smoking may increase the risk of exposure to radon. In addition, smoking significantly increases your overall risk of lung cancer.
- Do you have children living at home? Although there are no studies of children exposed to radon to determine whether they are more sensitive than adults, some scientific studies of other types of radiation exposure indicate that children may be more sensitive. Consequently, children could be more at risk than adults from exposure to radon.
- How much time does any family member spend at home? The risk estimates given in this pamphlet assume that 75 percent of a person's time is spent at home. If you or your family spend more or less time at home, you should take this into consideration.
- Does anyone sleep in your basement? Since radon concentrations tend to be greater on the lower levels of a home, a person who sleeps in the basement is likely to face a greater risk than a person who sleeps in a second-floor bedroom.
- How long will you live in your home? The risk estimates in this booklet are based on the assumption that you will be exposed to the radon level found in your home for roughly 70 years. As you evaluate your potential risk, therefore, you might consider the total amount of time you expect to live in your home. But remember: other houses you have lived in—or will live in—may have the same or higher radon levels.

How can I reduce my risk from radon?

Your risk of lung cancer from exposure to radon depends upon the amount of radon entering your home and the length of time it remains in your living areas. Listed below are some actions you might take to immediately reduce your risk from radon. These actions can be done quickly and with minimum expense in most cases.

- Stop smoking and discourage smoking in your home. By doing so, you should reduce your family's overall chance of developing lung cancer, as well as reducing your family's risk from radon exposure.
- Spend less time in areas with higher concentrations of radon, such as the basement.
- Whenever practical, open all windows and turn on fans to increase the air flow into and through the house. This is especially important in the basement.
- If your home has a crawl space beneath, keep the crawl-space vents on all sides of the house fully open all year.

While the above actions will help reduce your risk from radon, they generally do not offer a long-term solution. You can find more information about permanent, cost-effective solutions to a radon problem in the EPA publication, *Radon Reduction Methods: A Homeowner's Guide*. A copy of this booklet may be obtained from your state radiation protection office or from your EPA regional office.

Before undertaking major modifications to your home, we recommend that you consult with your state radiation protection office to obtain whatever specific advice or assistance they may be able to provide for your particular situation.

Sources of Information

If you would like further information or explanation on any of the points mentioned in this booklet, you should contact your state radiation protection office.

If you have difficulty locating this office, you may call your EPA regional office listed below. They will be happy to provide you with the name, address, and telephone number for your appropriate state contact.

State—EPA Region

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

EPA Regional Offices

EPA Region 1
Room 2203
JFK Federal Building
Boston, MA 02203
(617) 223-4845

EPA Region 2
26 Federal Plaza
New York, NY 10278
(212) 264-2515

EPA Region 3
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-8320

EPA Region 4
345 Courtland Street, NE.
Atlanta, GA 30365
(404) 881-3776

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

EPA Region 6
1201 Elm Street
Dallas, TX 75270
(214) 767-2630

EPA Region 7
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2803

EPA Region 8
Suite 1300
One Denver Place
999 18th Street
Denver, CO 80202
(303) 283-1710

EPA Region 9
215 Fremont Street
San Francisco, CA 94105
(415) 974-8076

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

(8) HB519

Alaska State Legislature

House of Representatives

Committee on Community & Regional Affairs

Pouch V
State Capitol
Juneau, Alaska 99811
(907) 465-4833

TO: Rep. Henry Springer, Chairman HCRA

FROM: David C. Harrison, P. A., HCRA DCH

BILL REVIEW: March 7, 1988

RE: HB 519 "An Act establishing a revolving loan fund for radon mitigation; and providing for an effective date." Sponsors: Davis, Koponen, Ulmer

*Section 1. Findings: Legislative findings indicate exposure to radon in homes can cause some health concerns. That some Alaskan homeowners do not have the financial resources to install radon mitigation systems in their homes. State response to the health threat posed by radon is necessary and should continue or expand.

COMMENT: S. Heidersdorf, a radiological physicist of the Division of Public Health, State of Alaska, reported results of 246 tests for radon in 246 Alaska homes and provided the following:

204 homes with 4 or less (PCl/1) No remedial action -
16 homes with 5 - 8 " could consider some action
(18 homes with 9 - 20 " radon mitigation should be
8 homes with 20+ " taken with concentration of
radon, picocuries per liter of air.) (A picocurie is one trillionth of a curie, a common unit of radioactivity.) Radon is a colorless, radioactive, heavy gaseous element. Curie is a unit of radioactivity of a sample of an element in which 3.7×10^{10} nuclear disintegrations occur each second.

Natural Resources Geologic Management, a component of Land and Public Safety, states that Alaska is one of the few states for which EPA has little or no information pertaining to radon potential or actual data from radon surveys of homes or public buildings. Limited data have been or are currently being gathered in land surveys of selected areas of the state. We do not have enough data to estimate the magnitude of the statewide radon problem. See No. 4 HB 519.

*Sec. 2. AS 44.47. is amended by adding new sections to read:

ARTICLE 11A RADON MITIGATION REVOLVING LOAN FUND.

Sec. 44.47.650. RADON MITIGATION REVOLVING LOAN FUND. There is in the Department of Community and Regional Affairs the randon mitigation revolving loan fund to carry out the purposes of AS 44.47.650 - 44.47.658. The fund may not be used for any other purpose.

COMMENT: This Section provides legal authority to establish the radon revolving loan fund within the DCRA.

Sec. 44.47.652 POWERS AND DUTIES OF THE DEPARTMENT IN ADMINISTERING THE FUND.

The DCRA may make loans and adopt regulations as stated within this bill.

The DCRA shall develop eligibility standards for loans and adopt guidelines for the determinations of loan terms. Also provides for the disposing of property acquired through default or foreclosure of a loan hereunder.

Sec. 44.47.654 LOAN TERMS AND PAYMENTS

Loans may not exceed $10,000.

Duration of loan may not exceed 10 years.

Interest rate on a loan is the annual rate charged member banks for advances by the 12th Federal Reserve District on the day the loan is made.

All principal and interest payments shall be paid into the radon mitigation revolving loan fund.

COMMENTS: General loan conditions established are considered basic loan conditions established under similar laws dealing with state loans.

Sec. 44.47.656 ELIGIBILITY FOR LOANS.

1. radon measurements in the homeowner's residence exceeded six picocuries;

2. a homeowner has applied for a loan to mitigate the effects of radon from a state chartered or a federal lending institution, and the application has been rejected;

3. the homeowner submits to the DCRA a plan for the use of the loan funds that is approved by the commissioner;

4. the applicant meets additional eligibility standards established by DCRA under AS 44.47.652.

COMMENTS: Items 1 through 4 establishes eligibility for radon mitigation state loans from DCRA. Item number 2 particularly points to a loan applicant that has been rejected a loan from a state or a federal lending institution may apply for a radon mitigation from DCRA.

Sec. 44.47.568. SPECIAL ACCOUNT ESTABLISHED.

A foreclosure expense account is established as a reserve from fund equity.

Allows the DCRA commissioner to expend money credited to the foreclosure expense account when necessary to protect the state's security interest in collateral on loans made under AS 44.47.650 - 44.47.658 or to defray expenses incurred during foreclosure proceedings after default by an obligor.

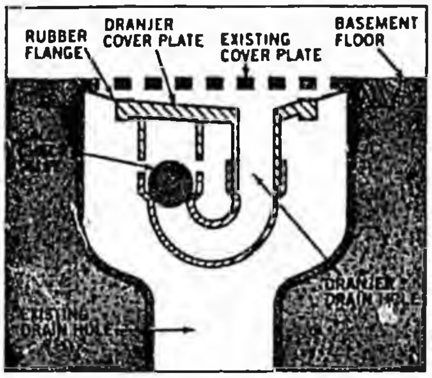
COMMENT: Provides general authority to initiate ways and means to accomplish legal tasks regarding loans and property encumbered through state loans per purposes of this bill.

(9) HB 519

Radon roadblock

"In Winnipeg we had a radon problem," recalls Harold Westdal, president of Dranjer Corp. Of 53 homes tested there, more than a third had concentrations of radon gas, a carcinogen, above the U.S. Environmental Protection Agency's recommended limit—even in upstairs bedrooms.

Westdal's company designed a simple assembly, called a Dranjer, to keep radon from wafting in through basement drains, a common entry point (see drawing). Contractors began installing Dranjers in homes last year. The devices have helped reduce radon levels, and they have some beneficial side effects.



Rubber flange in Dranjer's retrofit assembly is trimmed to match existing cover plate, which holds it in place to seal basement floor drain. Ball check valve permits water to flow downward, but prevents upward gas infiltration.

Winnipeg's problem isn't unique. During the last two winters, the EPA and state agencies tested more than 15,000 U.S. homes for radon gas. About one fifth had radon readings above that at which the EPA recommends remedial action. Measurements taken in the summer, when houses receive better ventilation, are usually lower. Still, the survey shows that radon is a widespread problem.

For some, it's a fatal problem. The EPA estimates that radon causes between 5,000 and 20,000 lung-cancer deaths a year.

Radon, a radioactive decay product of uranium and radium, rises from rocks and soil. Luckily, monitoring the gas is easy [Sept. '87]; and reducing infiltration isn't necessarily difficult or expensive. In fact, sealing off a basement floor drain can cut indoor radon levels by nearly half, according to studies by Canada's National Research Council.

However, an ordinary seal defeats a drain's purpose: to provide an exit route for laundry discharges, rainwater seepage, and spills. Even water traps (curved sections of pipe that hold water, obstructing airflow) may not stop radon, and they often dry up.

In Winnipeg, the Dranjer seal not only plugged radon leaks, but also solved a few other problems. Some residents had complained about odors rising from sewer lines, reports Westdal. He says Dranjers keep out noxious fumes, mold spores, and insects. Cold air, too: In chilly climates, the seals reduce energy bills by up to 10 percent, Westdal claims.

Dranjers are sold by hardware chains and cost less than $20. Retrofit models can be placed over sumps or drains. Dranjers made for new installations have a retaining ring that is set into the basement floor when the foundation is poured. Dranjer Corp., 1441 Pembina Hwy., Winnipeg, Man. R3T 2C4.—*Dawn Stover*

(10) HB 519

Alaska State Legislature

Representative Mike Davis District 19

P.O. Box V
Juneau, Alaska 99811
(907) 456-4930/4941

Interim Office:
P.O. Box 81435
Fairbanks, Alaska 99708
(907) 456-8161

TO: Rep. Henry Springer
Chairman, House Community & Regional Affairs Committee
FROM: Rep. Mike Davis
DATE: April 6, 1988
RE: HB 519, establishing a radon mitigation revolving loan fund in the Dept. of Community and Regional Affairs.

Attached is a draft CS for HB 519 which I have prepared in response to concerns raised by members of the Community and Regional Affairs Committee. The primary concern was that the legislation be broad enough to permit loans to mitigate other serious indoor air pollutants in addition to radon.

The draft CS renames the "Radon Mitigation Revolving Loan Fund" the "Indoor Air Quality Revolving Loan Fund". Section 44.47.658 on page two has been expanded to allow the department to make loans for "other indoor air pollutants in the homeowner's residence if the department identifies them as priorities."

My office has investigated the other indoor air pollutants which may present a health risk to Alaskans. The EPA has guidelines for ambient, or outside, air quality. The state and federal Occupational Safety and Health Administrations (OSHA) have set personal exposure limits for approximately 400 contaminants in the workplace. These include methane, formaldehyde, carbon monoxide, and asbestos, but not radon. In its inspections, the state OSHA office has found no office situations exceeding the legal exposure limits.

The CS would permit the loan program to adapt to new discoveries about air pollutants and mitigation techniques. However, I believe radon should remain the primary focus of the loan fund for several reasons. We know that a serious radon problem exists in Alaska. At this time radon is the worst residential air pollutant in terms of numbers of Alaskans facing a significant health risk. The technology exists to reduce radon levels in homes. Finally, radon contamination results from the geological characteristics of the land rather than objects brought into the home.

I would appreciate a hearing for HB 519 and HB 520 at your earliest convenience.

(1,29) HB 519

5-1651L
Chenoweth
3/31/88

Original sponsors: Davis, Koponen and Ulmer

IN THE HOUSE

CS FOR HOUSE BILL NO. 519 (   )

IN THE LEGISLATURE OF THE STATE OF ALASKA

FIFTEENTH LEGISLATURE - SECOND SESSION

A BILL

For an Act entitled: "An Act establishing a revolving loan fund to mitigate radon and indoor air pollutants [for radon mitigation]; and providing for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

* Section 1. FINDINGS. The legislative finds that

(1) exposure to radon poses a serious threat to public health and is estimated to cause approximately 5,000 to 20,000 lung cancer deaths each year nationally;

(2) fourteen percent of the indoor radon measurements made by the state's divisions of geological and geophysical surveys and public health exceeded four picocuries, the level at which the Environmental Protection Agency recommends action be taken to reduce the level;

(3) there may be other indoor air pollutants that present serious health risks to Alaskans;

(4) environmental conditions in Alaska contribute to the health risk of indoor air pollution [radon] due to the long heating season, amount of time spent indoors, and pressure differentials caused by extreme indoor-outdoor temperature differentials;

(5) high levels of radon may decrease property values, making loans difficult to obtain and greatly hindering resale;

(6) techniques such as vapor barriers, air-to-air heat exchangers, and certain house pressurization strategies may be used to mitigate radon in homes;

(7) many Alaskans do not have the financial resources to install

mitigation systems to reduce the amount of radon <u>and other indoor air pollutants</u> in their homes; and

(8) state response to the health threat posed by [radon] <u>indoor air pollution</u> is essential and should continue at existing or expanded levels.

* Sec. 2. AS 44.47 is amended by adding new sections to read:

ARTICLE 11A. [Radon Mitigation] <u>INDOOR AIR QUALITY</u> REVOLVING LOAN FUND.

Sec. 44.47.650. [Radon Mitigation] <u>INDOOR AIR QUALITY</u> REVOLVING LOAN FUND. There is created in the Department of Community and Regional Affairs the [radon mitigation] <u>indoor air quality</u> revolving loan fund to carry out the purposes of AS 44.47.650 - 44.47.658. The fund may not be used for any other purpose.

Sec. 44.47.652. POWERS AND DUTIES OF THE DEPARTMENT IN ADMINISTERING THE FUND. (a) The department may

(1) make loans to homeowners to mitigate the effects of

(A) radon on property used as the homeowner's residence;

(B) <u>other indoor air pollutants in the homeowner's residence if the department identifies them as priorities;</u>

(2) adopt regulations necessary to carry out the provisions of AS 44.47.650 - 44.47.658.

(b) The department shall

(1) determine by regulation eligibility for loans based on a measurement of air quality within the borrower's residence; eligibility must be established based on a sliding scale that inversely relates the minimum measurement level to qualify for a loan to the length of the time period during which the air quality measurement was taken;

(2) develop other eligibility standards for loans;

(3) adopt guidelines for the determination of loan terms.

(c) The department shall dispose of property acquired through default or foreclosure of a loan made under AS 44.47.650 - 44.47.658. Disposal shall be made in a manner that serves the best interests of the state, and may include the amortization of payments over a period of years.

Sec. 44.47.654. LOAN TERMS AND PAYMENTS. (a) A loan made by the department under AS 44.47.650 - 44.47.658 may not exceed $10,000.

(b) The duration for repayment of a loan may not exceed 10 years.

(c) The interest rate on a loan made by the department under AS 44.47.650 - 44.47.658 is the annual rate charged member banks for advances by the 12th Federal Reserve District on the day the loan is made.

(d) All principal and interest payments on loans under AS 44.-47.650 - 44.47.658 shall be paid into the [radon mitigation] <u>indoor air quality</u> revolving loan fund.

Sec. 44.47.656. ELIGIBILITY FOR LOANS. A homeowner is eligible for a loan under AS 44.47.650 - 44.47.658 if

(1) a measurement of [radon] <u>air pollutants</u> in the homeowner's residence exceeded the level determined by program regulation under AS 44.47.652(b)(1);

(2) the homeowner has applied for a loan to mitigate the effects of [radon] <u>indoor air pollution</u> from a state chartered or federally chartered lending institution, and the application has been rejected;

(3) the homeowner submits to the department a plan for the use of the loan funds that is approved by the commissioner; and

(4) the applicant meets additional eligibility standards established by the department under AS 44.47.652.

Sec. 44.47.658. SPECIAL ACCOUNT ESTABLISHED. (a) There is established as a special account within the [radon mitigation] indoor air quality revolving loan fund the foreclosure expense account. This account is established as a reserve from fund equity.

(b) The commissioner may expend money credited to the foreclosure expense account when necessary to protect the state's security interest in collateral on loans made under AS 44.47.650 - 44.47.658 or to defray expenses incurred during foreclosure proceedings after a default by an obligor.

* Sec. 3. This Act takes effect July 1, 1988.

(1) HB 519

(1) HB519

OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

THE SEAL OF THE STATE OF ALASKA

OCCUPATIONAL SAFETY AND HEALTH STANDARDS

ALASKA DEPARTMENT OF LABOR

Division of Labor Standards and Safety

JIM SAMPSON, COMMISSIONER STEVE COWPER, GOVERNOR

STEVE COWPER
Governor of Alaska

JIM SAMPSON
COMMISSIONER, DEPARTMENT OF LABOR

DIVISION OF LABOR STANDARDS AND SAFETY

TOM STUART, DIRECTOR
P.O. Box 21149, Juneau, Alaska 99802-1149

Field Offices

3301 Eagle Street
P.O. Box 7022
Anchorage, Alaska 99510-7022

675-7th Avenue, Station J
Fairbanks, Alaska 99701-4596

326 Dock Street
Ketchikan, Alaska 99901-6408

309 Center Street
Kodiak, Alaska 99615-6315

120 Trading Bay, Road Box 1909
Kenai, Alaska 99611-1909

The standards prescribed in this subchapter are effective as of June 30, 1973, as amended October 14, 1987. Alaska safety codes and standards apply to all places of employment. Information relative to the safety codes will be furnished by the above offices.

ALASKA DEPARTMENT OF LABOR

Section 18.60.010 of the Alaska Statutes designates the Alaska Department of Labor as the agency responsible for developing and administering an occupational safety and health program for the State of Alaska. To carry out this responsibility, AS 18.60.055 established the Division of Labor Standards and Safety.

The division is charged with the responsibility and has the authority to:

> Enforce all laws and lawful orders requiring work and work places to be safe and healthful;
>
> Investigate disabling or fatal occupational injuries and illnesses;
>
> Inspect work places to determine if conditions are safe and healthful;
>
> Develop occupational safety and health standards which, after adoption, have the effect of law; and
>
> Establish special orders, or rules and regulations to cover a specific place of employment or process of work.

A variance from an occupational safety and health standard adopted by the department may be granted by the Commissioner of Labor as provided by AS 18.60.077, AS 18.60.081 and regulations promulgated pursuant thereto.

The safety and health standards prescribed in Subchapter 04, Occupational Health and Environmental Control Code, are adopted by reference in Title 8 of the Alaska Administrative Code and are effective as of June 30, 1973, as amended October 14, 1987.

Jim Sampson
Commissioner of Labor

Contents

Article 1 - Occupational Health and Environmental Control Code

SUBCHAPTER 4 – OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

ARTICLE 1 – OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

04.0101 Air Contaminants. An employee's exposure to any material listed in Table 1–1, 1–2, or 1–3 of this section shall be limited in accordance with the requirements of the following paragraphs of 04.0101

(a) Table 1–1

(1) Materials with names preceded by 'C' ––Ceiling values. An employee's exposure to any material in Table 1-1, the name of which is preceded by a "C" (e.g. C Boron trifluoride), shall at no time exceed the ceiling value given for that material in the table

(2) Other materials ––8-hour time weighted averages. An employee's exposure to any material in Table 1–1, the name of which is not preceded by "C", in any 8-hour work shift of a 40–hour work week, shall not exceed the 8 hour time weighted average given for that material in the table

(b) Table 1–2.

(1) Eight-hour time weighted averages. An employee's exposure to any material listed in Table 1–2, in any 8–hour work shift of a 40–hour work week, shall not exceed the 8–hour time weighted average limit given for that material in the table.

(2) Acceptable ceiling concentrations. An employee's exposure to a material listed in Table 1–2 shall not exceed at any time during an 8–hour shift the acceptable ceiling concentration limit given for the material in the table, except for a time period up to a concentration not exceeding the maximum duration and concentration allowed in the column under "acceptable maximum peak above the acceptable ceiling concentration for an 8–hour shift."

(3) Example. During an 8–hour work shift, an employee may be exposed to a concentration of Benzene above 25 p.p.m. (but never above 50 p.p.m.) only for a maximum period of 10 minutes. Such exposure must be compensated by exposures to concentrations less than 10 p.p.m. so that the cumulative exposure for the entire 8–hour work shift does not exceed a weighted average of 10 p.p.m.

(c) Table 1–3. An employee's exposure to any material listed in Table 1–3, in any 8–hour work shift of a 40–hour work week, shall not exceed the 8–hour time weighted average limit given for that material in the table.

(d) Computation formulae.

(1) The cumulative exposure for an 8–hour work shift shall be computed as follows

$$E = \frac{C_aT_a + C_bT_b + \ldots\ldots C_nT_n}{8}$$

Where:

E is the equivalent exposure for the working shift,

C is the concentration during any period of time where the concentration remains constant,

T is the duration in hours of the exposure at the concentration C.

The value of E shall not exceed the 8-hour time weighted average limit in Table 1–1, 1–2, or 1–3 for the material involved.

(2) To illustrate the formula prescribed in 04.0101(d)(1), note that isoamyl acetate has an 8–hour time weighted average limit of 100 p.p.m. (Table 1–1). Assume that an employee is subject to the following exposure

Two hours exposure at 150 p.p.m
Two hours exposure at 75 p.p.m.
Four hours exposure at 50 p.p.m.

Substituting this information in the formula, we have

$$\frac{2 \times 150 + 2 \times 75 + 4 \times 50}{8} = 81.25 \text{ p.p.m.}$$

Since 81.25 p.p.m. is less than 100, the 8-hour time weighted average limit, the exposure is acceptable.

(3) In c... ixture of air contaminants, an employer shall compute the equiva... ure as follows

$$E_m = \frac{C_1}{L_1} + \frac{C_2}{L_2} + \ldots \frac{C_n}{L_n}$$

Where:

E_m is the equivalent exposure for the mixture,

C is the concentration of a particular contaminant,

L is the exposure limit for that contaminant, from Table 1–1, 1–2, or 1–3.

The value of E_m shall not exceed unity (1)

(4) To illustrate the formula prescribed in 04.0101(d)(3), consider the following exposures:

Material	Actual concentration of 8–hour exposure	8-hour time weighted average exposure limit
Acetone (Table 1–1)	500 p.p.m	1,000 p.p.m
2-Butanone (Table 1–1)	45 p.p.m.	200 p.p.m
Toluene (Table 1–2)	40 p.p.m	200 p.p.m

Substituting in the formula, we have:

$$E_m = \frac{500}{1,000} + \frac{45}{200} + \frac{40}{200}$$

$$E_m = 0.500 + 0.225 + 0.200$$

$$E_m = 0.925$$

Since E_m is less than unity (1), the exposure combination is within acceptable limits.

(e) To achieve compliance with 04.0101 (a) through (d), administrative or engineering controls must first be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in 04.0101. Any equipment or technical measure used for this purpose must be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with 01.0403.

(f) Whenever percussion drilling is performed, the drilling apparatus shall be provided with engineering controls which will suppress the drilling dust. This may be accomplished by methods known as "damp drilling," "modified wet drilling," "detergent drilling," "dust extraction" or any other means of dust control which produces comparable results.

TABLE 1-1

Substance	p.p.m.[a]	mg./M³ [b]
Acetaldehyde	200	360
Acetic acid	10	25
Acetic anhydride	5	20
Acetone	1,000	2,400
Acetonitrile	40	70
Acetylene dichloride, see 1, 2-Dichloroethylene		
Acetylene tetrabromide	1	14
Acrolein	0.1	0.25
Acrylamide —Skin		.3
Aldrin —Skin		0.25
Allyl alcohol —Skin	2	5
Allyl chloride	1	3
**C Allylglycidyl ether (AGE)	10	45
Allyl propyl disulfide	2	12
2-Aminoethanol, see Ethanolamine		
2-Aminopyridine	0.5	2
**Ammonia	50	35
Ammonium sulfamate (Ammate)		15
n-Amyl acetate	100	525
sec-Amyl acetate	125	650
Aniline —Skin	5	19
Anisidine (o, p-isomers) —Skin		0.5
Antimony and compounds (as Sb)		0.5
ANTU (alpha naphthyl thiourea)		0.3
Arsine	0.05	0.2
Azinphos-methyl —Skin		0.2
Barium (soluble compounds)		0.5
p-Benzoquinone, see Quinone		
Benzoyl peroxide		5
Benzyl chloride	1	5
Biphenyl, see Diphenyl		
Bisphenol A, see Diglycidyl ether		
Boron oxide		15
C Boron trifluoride	1	3
Bromine	0.1	0.7
Bromoform —Skin	0.5	5
Butadiene (1, 3-butadiene)	1,000	2,200
Butanethiol, see Butyl mercaptan		
2-Butanone	200	590
2-Butoxy ethanol (Butyl Cellosolve) —Skin	50	240
Butyl acetate (n-butyl acetate)	150	710

Substance	p.p.m.[a]	mg./M³ [b]
sec-Butyl acetate	200	950
tert-Butyl acetate	200	950
Butyl alcohol	100	300
sec-Butyl alcohol	150	450
tert-Butyl alcohol	100	300
C Butylamine —Skin	5	15
C tert-Butyl chromate (as CrO_3) —Skin		0.1
n-Butyl glycidyl ether (BGE)	50	270
*Butyl mercaptan	10	35
p-tert-Butyltoluene	10	60
Calcium oxide		5
Camphor		2
Carbaryl (Sevin ®)		5
Carbon black		3.5
Carbon dioxide	5,000	9,000
Carbon monoxide	[illegible]	55
Chlordane —Skin		0.5
Chlorinated camphene —Skin		0.5
Chlorinated diphenyl oxide		0.5
C Chlorine	1	3
Chlorine dioxide	0.1	0.3
C Chlorine trifluoride	0.1	0.4
C Chloroacetaldehyde	1	3
α-Chloroacetophenone (phenacylchloride)	0.05	0.3
Chlorobenzene (monochlorobenzene)	75	350
o-Chlorobenzylidene malononitrile (OCBM)	0.05	0.4
Chlorobromomethane	200	1,050
2-Chloro-1, 3-butadiene, see Chloroprene		
Chlorodiphenyl (42% Chlorine) —Skin		1
Chlorodiphenyl (54% Chlorine) —Skin		0.5
1-Chloro, 2, 3-epoxypropane, see Epichlorhydrin		
2-Chloroethanol, see Ethylene chlorohydrin		
Chloroethylene, see Vinyl chloride		
C Chlorform (trichloromethane)	50	240
1-Chloro-1-nitropropane	20	100
Chloropicrin	0.1	0.7
Chloroprene (2-chloro-1, 3-butadiene) —Skin	25	90
Chromium, sol. chromic, chromous salts as Cr		0.5
Metal and insol. salts		1
Coal tar pitch volatiles (benzene soluble fraction) anthracene, BaP, phenanthrene, acridine, chrysene, pyrene		0.2
Cobalt, metal fume and dust		0.1
Copper fume		0.1
Dusts and mists		1
Cotton dust (raw)		1
Crag ® herbicide		15
Cresol (all isomers) —Skin	5	22
Crotonaldehyde	2	6
Cumene —Skin	50	245
Cyanide (as CN) —Skin		5
Cyclohexane	300	1,050
Cyclohexanol	50	200
Cyclohexanone	50	200
Cyclohexene	300	1,015
Cyclopentadiene	75	200
2, 4-D		10
DDT —Skin		1
DDVP, Skin		
Decaborane —Skin	0.05	0.3
Demeton ® —Skin		0.1
Dibutyl Phosphate	1	5

Substance	p.p.m.[a]	mg./M³ [b]
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	50	240
1, 2-diaminoethane, see Ethylenediamine		
Diazomethane	0.2	0.4
Diborane	0.1	0.1
Dibutylphthalate		5
C o-Dichlorobenzene	50	300
p-Dichlorobenzene	75	450
Dichlorodifluoromethane	1,000	4,950
1, 3-Dichloro-5, 5-dimethyl hydantoin		0.2
1, 1-Dichloroethane	100	400
1, 2-Dichloroethylene	200	790
C Dichloroethyl ether –Skin	15	90
Dichloromethane, see Methylenechloride		
Dichloromonofluoromethane	1,000	4,200
C 1, 1-Dichloro-1-nitroethane	10	60
1, 2-Dichloropropane, see Propylenedichloride		
Dichlorotetrafluoroethane	1,000	7,000
Dichlorvos (DDVP) –Skin		1
Dieldrin –Skin		0.25
Diethylamine	25	75
Diethylamino ethanol –Skin	10	50
Diethylether, see Ethyl ether		
Difluorodibromomethane	100	860
C Diglycidyl ether (DGE)	0.5	2.8
Dihydroxybenzene, see Hydroquinone		
Diisobutyl ketone	50	290
Diisopropylamine –Skin	5	20
Dimethoxymethane, see Methylal		
Dimethyl acetamide –Skin	10	35
Dimethylamine	10	18
Dimethylaminobenzene, see Xyllidene		
Dimethylaniline (N-dimethylaniline) –Skin	5	25
Dimethylbenzene, see Xylene		
Dimethyl 1, 2-dibromo-2, 2-dichloroethyl phosphate, (Dibrom)		3
Dimethylformamide –Skin	10	30
2, 6-Dimethylheptanone, see Diisobutly ketone		
1, 1-Dimethylhydrazine –Skin	0.5	1
Dimethylphthalate		5
Dimethylsulfate –Skin	1	5
Dinitrobenzene (all isomers) –Skin		1
Dinitro-o-cresol –Skin		0.2
Dinitrotoluene –Skin		1.5
Dioxane (Diethylene dioxide) –Skin	100	360
Diphenyl	0.2	1
Diphenylmethane diisocyanate (see Methylene bisphenyl isocyanate (MDI))		
Dipropylene glycol methyl ether –Skin	100	600
Di-sec, octyl phthalate (Di-2-ethylhexylphthalate)		5
Endrin –Skin		0.1
Epichlorhydrin –Skin	5	19
EPN –Skin		0.5
1, 2-Epoxypropane, see Propyleneoxide		
2, 3-Epoxy-1-propanol, see Glycidol		
Ethanethiol, see Ethylmercaptan		
Ethanolamine	3	6
2-Ethoxyethanol –Skin	200	740
2-Ethoxyethylacetate (Cellosolve acetate) –Skin	100	540
Ethyl acetate	400	1,400
Ethyl acrylate –Skin	25	100
Ethyl alcohol (ethanol)	1,000	1,900
Ethylamine	10	18

Substance	p.p.m.[a]	mg./M³ [b]
Ethyl sec-amyl ketone (5-methyl-3-heptanone)	25	130
Ethyl benzene	100	435
Ethyl bromide	200	890
Ethyl butyl ketone (3-Heptanone)	50	230
Ethyl chloride	1,000	2,600
Ethyl ether	400	1,200
Ethyl formate	100	300
C Ethyl mercaptan	10	25
Ethyl silicate	100	850
Ethylene chlorohydrin –Skin	5	16
Ethylenediamine	10	25
C Ethylene glycol dinitrate and/or Nitroglycerin –Skin	0.2[d]	1
Ethylene glycol monomethyl ether acetate, see Methyl cellosolve acetate		
Ethylene imine –Skin	0.5	1
Ethylidine chloride, see 1, 1-Dichloroethane		
N-Ethylmorpholine –Skin	20	94
Ferbam		15
Ferrovanadium dust		1
Fluoride (as F)		2.5
Fluorine	0.1	0.2
Fluorotrichloromethane	1,000	5,600
Formic acid	5	9
Furfural –Skin	5	20
Furfuryl alcohol	50	200
Glycidol (2, 3-Epoxy-1-propanol)	50	150
Glycol monoethyl ether, see 2-Ethoxyethanol		
Guthion, ® see Azinphosmethyl		
Hafnium		0.5
Heptachlor –Skin		0.5
Heptane (n-heptane)	500	2,000
Hexachloroethane –Skin	1	10
Hexachloronaphthalene –Skin		0.2
Hexane (n-hexane)	500	1,800
2-Hexanone	100	410
Hexone (methyl isobutyl ketone)	100	410
sec-Hexyl acetate	50	300
Hydrazine –Skin	1	1.3
Hydrogen bromide	3	10
C Hydrogen chloride	5	7
Hydrogen cyanide –Skin	10	11
Hydrogen peroxide (90%)	1	1.4
Hydrogen selenide	0.05	0.2
Hydroquinone		2
C Iodine	0.1	1
Iron oxide fume		10
Isoamyl acetate	100	525
Isoamyl alcohol	100	360
Isobutyl acetate	150	700
Isobutyl alcohol	100	300
Isophorone	25	140
Isopropyl acetate	250	950
Isopropyl alcohol	400	980

R 6/9/85

Substance	p.p.m.[a]	mg./M3 [b]
Isopropylamine	5	12
Isopropylether	500	2,100
Isopropyl glycidyl ether (IGE)	50	240
Ketene	0.5	0.9
Lead arsenate		0.15
Lindane - Skin		0.5
Lithium hydride		0.025
L.P.G. (Liquified petroleum gas)	1,000	1,800
Magnesium oxide fume		15
Malathion - Skin		15
Maleic anhydride	0.25	1
C Manganese		5
Mesityl oxide	25	100
Methanethiol, see Methyl mercaptan		
Methoxychlor		15
2-Methoxyethanol, see Methyl cellosolve		
Methyl acetate	200	610
Methyl acetylene (propyne)	1,000	1,650
Methyl acetylene-propadiene mixture (MAPP)	1,000	1,800
Methyl acrylate -Skin	10	35
Methylal (dimethoxymethane)	1,000	3,100
Methyl alcohol (methanol)	200	260
Methylamine	10	12
Methyl amyl alcohol, see Methyl isobutyl carbinol		
Methyl (n-amyl) ketone (2-Heptanone)	100	465
C Methyl bromide -Skin	20	80
Methyl butyl ketone, see 2-Hexanone		
Methyl cellosolve -Skin	25	80
Methyl cellosolve acetate -Skin	25	120
Methyl chloroform	350	1,900
Methylcyclohexane	500	2,000
Methylcyclohexanol	100	470
o-Methylcyclohexanone -Skin	100	460
Methyl ethyl ketone (MEK), see 2-Butanone		
Methyl formate	100	250
Methyl iodide -Skin	5	28
Methyl isobutyl carbinol -Skin	25	100
Methyl isobutyl ketone, see Hexone		
Methyl isocyanate -Skin	0.02	0.05
C Methyl mercaptan	10	20
Methyl methacrylate	100	410
Methyl propyl ketone, see 2-Pentanone		
C α Methyl styrene	100	480
C Methylene bisphenyl isocyanate (MDI)	0.02	0.2
Molybdenum:		
Soluble compounds		5
Insoluble compounds		15
Monomethyl aniline - Skin	2	9
C Monomethyl hydrazine -Skin	0.2	0.35
Morpholine -Skin	20	70
Naphtha (coaltar)	100	400
Naphtahlene	10	50
Nickel carbonyl	0.001	0.007
Nickel, metal and soluble compounds, as Ni		1
Nicotine -Skin		0.5
Nitric acid	2	5
Nitric oxide	25	30
p-Nitroaniline -Skin	1	6
Nitrobenzene -Skin	1	5
p-Nitrochlorobenzene - Skin		1

Substance	p.p.m.[a]	mg./M3 [b]
Nitroethane	100	310
C Nitrogen dioxide	5	9
Nitrogen trifluoride	10	29
C Nitroglycerin -Skin	0.2	2
Nitromethane	100	250
1-Nitropropane	25	90
2-Nitropropane	25	90
Nitrotoluene, -Skin	5	30
Nitrotrichloromethane, see Chloropicrin		
Octachloronaphthalene -Skin		0.1
Octane	500	2,350
Oil mist, mineral		5[e]
Osmium tetroxide		0.002
Oxalic Acid		1
Oxygen diflouride	0.05	0.1
Ozone	0.1	0.2
Paraquat -Skin		0.5
Parathion -Skin		0.1
Pentaborane	0.005	0.01
Pentachloronaphthalene -Skin		0.5
Pentachlorophenol -Skin		0.5
*Pentane	1,000	2,950
2-Pentanone	200	700
Perchloromethyl mercaptan	0.1	0.8
Perchloryl fluoride	3	13.5
Petroleum distillates (naphtha)	500	2,000
Phenol -Skin	5	19
p-Phenylene diamine -Skin		0.1
Phenyl ether (vapor)	1	7
Phenyl ether-biphenyl mixture (vapor)	1	7
Phenylethylene, see Styrene		
Phenylglycidyl ether (PGE)	10	60
Phenylhydrazine -Skin	5	22
Phosdrin (Mevinphos ®) -Skin		0.1
Phosgene (carbonyl chloride)	0.1	0.4
Phosphine	0.3	0.4
Phosphoric acid		1
Phosphorus (yellow)		0.1
Phosphorus pentachloride		1
Phosphorus pentasulfide		1
Phosphorus trichloride	0.5	3
Phthalic anhydride	2	12
Picric acid - Skin		0.1
Pival ® (2-Pivalyl-1, 3-indandione)		0.1
Platinum (Soluble Salts) as Pt		0.002
Propane	1,000	1,800
n-Propyl acetate	200	840
Propyl alcohol	200	500
n-Propyl nitrate	25	110
Propylene dichloride	75	350
Propylene imine - Skin	2	5
Propylene oxide	100	240
Propyne, see Methylacetylene		
Pyrethrum		5
Pyridine	5	15
Quinone	0.1	0.4
Rhodium, Metal fume and dusts,		
as Rh		0.1
Soluble salts		0.001

Substance	p.p.m.[a]	mg./M3 [b]
Ronnel		15
Rotenone (commercial)		5
Selenium compounds (as Se)		0.2
Selenium hexafluoride	0.05	0.4
Silver, metal and soluble compounds		0.01
Sodium fluoroacetate (1080) –Skin		0.05
Sodium Hydroxide		2
Stibine	0.1	0.5
Stoddard solvent	500	2,900
Strychnine		0.15
Sulfur dioxide	5	13
Sulfur hexafluoride	1,000	6,000
Sulfuric acid		1
Sulfur monochloride	1	6
Sulfur pentafluoride	0.025	0.25
Sulfuryl fluoride	5	20
Systox, see Demeton ®		
2, 4, 5T		10
Tantalum		5
TEDP –Skin		0.2
Tellurium		0.1
Tellurium hexafluoride	0.02	0.2
TEPP –Skin		0.05
C Terphenyls	1	9
1, 1, 1, 2-Tetrachloro-2, 2-difluoroethane	500	4,170
1, 1, 2, 2-Tetrachloro-1, 2-difluoroethane	500	4,170
1, 1, 2, 2-Tetrachloroethane –Skin	5	35
Tetrachloromethane, see Carbon tetrachloride		
Tetrachloronaphthalene –Skin		2
Tetraethyl lead (as Pb) –Skin		0.075
Tetrahydrofuran	200	590
Tetramethyl lead (as Pb) –Skin		0.075
Tetramethyl succinonitrile –Skin	0.5	3
Tetranitromethane	1	8
Tetryl (2, 4, 6-trinitrophenyl-methylnitramine) –Skin		1.5
Thallium (soluble compounds) –Skin as Tl		0.1
Thiram		5
Tin (inorganic compounds, except oxides)		2
Tin (organic compounds)		0.1
Titanium dioxide		15
C Toluene-2, 4-diisocyanate	0.02	0.14
o-Toluidine –Skin	5	22
Toxaphene, see Chlorinated camphene		
Tributyl phosphate		5
1, 1, 1-Trichloroethane, see Methyl chloroform		
1, 1, 2-Trichloroethane Skin	10	45
Trichloromethane, see Chloroform		
Trichloronaphthalene –Skin		5
1, 2, 3-Trichloropropane	50	300
1, 1, 2 Trichloro 1, 2, 2-trifluoroethane	1,000	7,600
Triethylamine	25	100
Trifluoromonobromomethane	1,000	6,100
2, 4, 6-Trinitrophenol, see Picric acid		
2, 4, 6-Trinitrophenylmethylnitramine, see Tetryl		
Trinitrotoluene –Skin		1.5
Triorthocresyl phosphate		0.1
Triphenyl phosphate		3
Turpentine	100	560
Uranium (soluble compounds)		0.05

Substance	p.p.m.[a]	mg./M3 [b]
Uranium (insoluble compounds)		0.25
C Vanadium:		
V_2O_5 dust		0.5
V_2O_5 fume		0.1.
Vinyl benzene, see Styrene		
Vinylcyanide, see Acrylonitrile		
Vinyl toluene	100	480
Warfarin		0.1
Xylene (xylol)	100	435
Xylidine –Skin	5	25
Yttrium		1
Zinc chloride fume		1
Zinc oxide fume		5
Zirconium compounds (as Zr)		5

*1970 Addition

[a]Parts of vapor or gas per million parts of contaminated air by volume at 25° C. and 760 mm. Hg pressure.

[b]Approximate milligrams of particulate per cubic meter of air.

(No footnote "c" is used to avoid confusion with ceiling value notations.)

[d]An atmospheric concentration of not more than 0.02 p.p.m., or personal protection may be necessary to avoid headache.

[e]As sampled by method that does not collect vapor

[f]For control of general room air, biologic monitoring is essential for personnel control.

TABLE 1-2

Material	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift: Concentration	Maximum duration
Benzene (Z37.4-1969)	10 p.p.m.	25 p.p.m.	50 p.p.m.	10 minutes
Beryllium and beryllium compounds (Z37.29-1970)	2 μg./M3	5 μg./M3	25 μg./M3	30 minutes
Cadmium fume (Z37.5-1970)	0.1 mg./M3	3 mg./M3	....	....
Cadmium dust (Z37.5-1970)	0.2 mg./M3	0.6 mg./M3	....	....
Carbon disulfide (Z37.3-1968)	20 p.p.m.	30 p.p.m.	100 p.p.m.	....do ...
Carbon tetrachloride (Z37.17-1967)	10 p.p.m.	25 p.p.m.	200 p.p.m.	5 minutes in any 4 hours
Chromic acid and chromates (Z37.7-1971)	....	do3	....	....
Ethylene dibromide (Z37.31-1970)	20 p.p.m.	30 p.p.m.	50 p.p.m.	5 minutes
Ethylene dichloride (Z37.21-1969)	50 p.p.m.	100 p.p.m.	200 p.p.m.	5 minutes in any 3 hours
Formaldehyde (Z37.16-1967)	3 p.p.m.	5 p.p.m.	10 p.p.m.	30 minutes
Hydrogen fluoride (Z37.28-1969)	3 p.p.m.	....	....	....
Fluoride as dust (Z37.28-1969)	2.5 mg./M3	....	....	....
Mercury (Z37.8-1971)	....	1 mg./10 M3	....	....
Methyl chloride (Z37.18-1969)	100 p.p.m.	200 p.p.m.	300 p.p.m.	5 minutes in any 3 hours
Methylene chloride (Z37.3-1969)	500 p.p.m.	1,000 p.p.m.	2,000 p.p.m.	5 minutes in any 2 hours
Organo (alkyl) mercury (Z37.30-1969)	0.01 mg./M3	0.04 mg./M3	....	....
Styrene (Z37.15-1969)	100 p.p.m.	200 p.p.m.	600 p.p.m.	5 minutes in any 3 hours
Trichloroethylene (Z37.19-1967)	100 p.p.m.	200 p.p.m.	300 p.p.m.	5 minutes in any 2 hours
Tetrachloroethylene (Z37.22-1967)	100 p.p.m.	200 p.p.m.	300 p.p.m.	5 minutes in any 3 hours
Toluene (Z37.12-1967)	200 p.p.m.	300 p.p.m.	500 p.p.m.	10 minutes
Hydrogen sulfide (Z37.2-1966)	....	20 p.p.m.	50 p.p.m.	10 minutes once only if no other measurable exposure occurs.

TABLE 1-3 Mineral Dusts

Substance	Mppcf[g]	Mg./M3
Silica:		
Crystalline:		
Quartz (respirable)	$\frac{250^{h}}{\%SiO_2 + 5}$	$\frac{10mg./M^3}{\%SiO_2 + 2}$ m
Quartz (total dust)	....	$\frac{30mg./M^3}{\%SiO_2 + 2}$
Cristobalite: Use ½ the value calculated from the count or mass formulae for quartz		
Tridymite: Use ½ the value calculated from the formulae for quartz		
Amorphous, including natural diatomaceous earth	20	$\frac{80mg./M^3}{\%SiO_2}$
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc (non-asbestos-form)	20[n]	
Talc (fibrous). Use asbestos limit		....
Tremolite (see talc, fibrous)		....
Portland cement	50	
Graphite (natural)	15	
Coal dust (respirable fraction less than 5% SiO_2)	....	2.4mg./M3 or
For more than 5% SiO_2	....	$\frac{10mg./M^3}{\%SiO_2 + 2}$
Inert or Nuisance Dust:		
Respirable fraction	15	5mg./M3
Total dust	5	15mg./M3

Note: Conversion factors –
mppcf X 35.3 = million particles per cubic meter
= particles per c.c.

[g] Millions of particles per cubic foot of air, based on impinger samples counted by light-field technics.

[h] The percentage of crystalline silica in the formula is the amount determined from air-borne samples except in those instances in which other methods have been shown to be applicable.

Table 1–3 Mineral Dusts (continued)

[m] Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

[n] Containing <1% quartz; if 1% quartz, use quartz limit.

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an ACE instrument. The respirable fraction of coal dust is determined with a MRE; the figure corresponding to that of 2.4 M_g/M^3 in the table for coal dust is 4.5 M_g/M^3.

(12) HB519

INDOOR AIR QUALITY

Prepared by

The United States Environmental Protection Agency
Washington, D.C.

Presented by:

A. James Barnes
Deputy Administrator
Before the NATO Committee on the
Challenges of Modern Society (CCMS)

November 16. 1987

INDOOR AIR QUALITY

This paper, presented for Round Table discussion to the NATO Committee on the Challenges of Modern Society, addresses the status of Indoor Air Quality Policy and Research in the United States. It briefly reviews the issue, characterizes the nature of the problem, and discusses potential mitigation options. It also presents a case study of the United States' effort on radon, summarizes research efforts, and reviews the development of indoor air policy for the United States.

TABLE OF CONTENTS

I. BACKGROUND AND HISTORICAL PERSPECTIVE

Over the past several decades, efforts to control air pollution in the United States have focused on outdoor ambient air and the industrial work environment. The quality of indoor air, including the air in homes, offices, and other commercial buildings, was not originally considered to be an issue requiring national attention.

In the early 1970s, however, indoor air pollution received increased public attention when the Federal government instituted energy conservation measures that led to the use of newer insulating materials to "tighten" buildings and the design of new buildings with significantly reduced intake of outdoor air. During this time, formaldehyde was identified as the cause of acute irritant reactions, primarily eye and nose irritation and respiratory distress, in individuals living in homes insulated with urea-formaldehyde foam insulation, and mobile homes constructed with large quantities of particle board and plywood.

The formaldehyde issue led to additional research to assess the types and quantities of air pollutants found in various indoor environments, all of which came to the same conclusion: for certain pollutant types, concentrations were often much higher indoors than they were outdoors. Furthermore, when high concentrations were coupled with the fact that most people spend more of their time indoors than outdoors, the risk to human health from indoor air pollution was shown to be greater than previously thought. Certain particularly susceptible people -- children, persons with lung diseases or impaired immune systems, and the elderly -- may be at considerable risk.

As the general problem of indoor air pollution was drawing more nationwide attention as a potential public health problem, a particular type of indoor air pollution, radon, was causing immediate concern in certain parts of the country. Public concern over the potential health effects of radon exposure, and the realization that such exposures could be occurring over wide areas, led to the establishment of EPA's Radon Action Program in 1985. Preliminary results of a recent 10-state survey under this program indicate the potential magnitude of the problem. The survey showed 21 percent of the 11,600 homes studied had elevated radon levels, defined by EPA as levels above 4 picocuries per liter of air.

Radon is only one of the indoor air problems. Occupants of particularly modern, energy-efficient buildings are experiencing acute health symptons that are caused by indoor air pollutants. Building-associated illnesses are becoming an increasing public health concern and have been observed in many types of buildings, including offices, schools, and health care facilities. As of early 1987, the National

Institute for Occupational Safety and Health, an agency of the Federal Government, had investigated over 450 outbreaks of building-associated illnesses and discomfort complaints. The magnitude of the problem is confirmed by environmental and health agencies in European countries and Canada, who report similar incidences.

Indoor air pollution has thus emerged as an international air quality issue. Several international conferences on indoor air quality have been held in recent years, the most recent being the Fourth International Conference on Indoor Air Quality and Climate held in August of this year in West Berlin. This conference was sponsored by the World Health Organization, the Commission of the European Communities, and the U.S. Environmental Protection Agency, as well as other organizations from the United States, West Germany, and Japan. It is important that the international nature of the indoor air quality problem lead to further international cooperation and information exchange aimed at finding solutions to indoor air quality problems.

II. CHARACTERIZATION OF INDOOR AIR POLLUTION

Microenvironments and Total Exposure

Assessment of total human exposure to environmental pollutants is an emerging science which focuses on the activities of populations and individuals that bring them into contact with pollutants. A major component of total exposure is total exposure to air pollutants. Total air exposure is the sum of pollutant exposures encountered in different air environments or spaces, integrated over some defined time period (e.g., day, year, lifetime). Indoor environments include residences, public and private buildings, and vehicles. The total air exposure concept is illustrated in Figure 1.

Pollutants and Pollutant Sources

Table 1 summarizes the major indoor pollutant categories and some of their possible sources. Most pollutants in most environments have multiple sources.

Concentrations and Exposures

A growing body of evidence indicates that exposure to air pollutants in indoor environments (e.g., the home, office building, school) can contribute significantly to total air exposure; in many cases, exposure levels in the indoor environment exceed outdoor exposure levels. High indoor exposure levels are the result of the elevated indoor pollutant concentrations and the fact that most people spend approximately 90 percent of their daily time in indoor environments. This is best illustrated by data from EPA's Total Exposure Assessment Methodology (TEAM) Studies, which analyzed total exposure to selected organic chemicals. Table 2 presents a summary of indoor/outdoor concentration ratios and estimated exposures for various volatile organic compounds measured in these studies.

Health Effects and Risks

The health effects that may result from exposure to chemicals that occur as indoor air pollutants include acute toxicity, noncarcinogenic chronic health effects, and cancer. Moreover, different types of health effects are associated with different indoor air pollutants. Chemical class-specific trends are evident. For example, particulates and some inorganic gases primarily impair respiratory function; some aldehydes cause eye and respiratory irritation; and some halogenated hydrocarbons cause liver/kidney damage and/or cancer. It is likely that some indoor

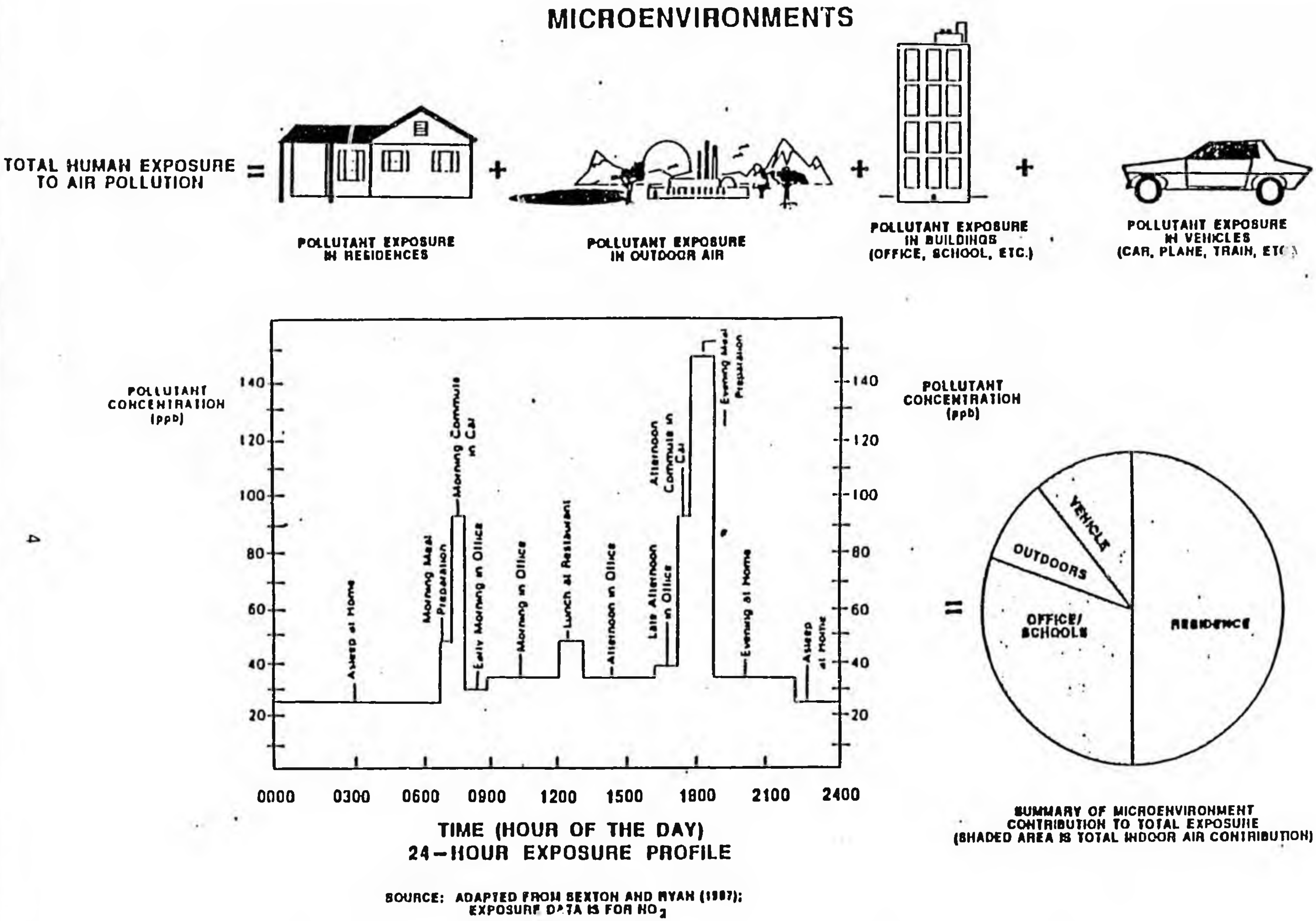


Figure 1. Representations of Microenvironment Contributions to Total Air Pollution Exposure.

7631H

Table 1. Summary of Pollutant Categories and Subcategories and Potential Sources

Pollutant category/subcategory	Examples of Potential Sources
Inorganic gases (e.g., carbon dioxide, carbon monoxide, ozone, nitrogen monoxide)	Heating, ventilation and air conditioning (HVAC) systems Combustion appliances Tobacco Outdoor air Garages (vehicular exhaust) Human and animal origin (metabolism, respiration) Electrical equipment
Metals and other inorganics (e.g., lead, cadmium, phosphates)	HVAC systems Combustion appliances Tobacco Outdoor air Garages (vehicular exhaust) Paints and associated supplies Pesticides Building materials
Particulates/fibers	
- Biological origin (viable and nonviable) (e.g., pollen, bacteria, viruses)	HVAC systems (e.g., air conditioning reservoirs, filters, fan coils, ductwork, humidifiers) Human, animal, and plant origin Outdoor air
- Nonbiological origin (e.g., asbestos, dust)	Tobacco Building materials (insulation, wallboards) HVAC systems Combustion appliances Outdoor air Garages (vehicular exhaust) Cleaners and waxes Pesticides Paints and supplies Cosmetics and body care products Furnishings and apparel Activities associated with do-it-yourself projects and hobbies (fiberglass finishing, wood sanding)
Radioactive pollutants (e.g., radon)	Soils/rocks Building materials (brick, cement, stone) Drinking water (well water)

Table 1. (continued)

Pollutant category/subcategory	[illegible] sources
Volatile organic compounds (VOCs) (e.g., formaldehyde, benzene, methylene chloride)	Cleaners and waxes Paints and associated supplies Pesticides Adhesives Building materials (insulation, plywood, tiles) Furnishings and apparel (furniture, upholstery, carpets, clothing) Newspapers and printed material Tobacco Drinking water (aspirated, such as during showering) Automotive products Specialty chemicals associated with hobbies Cosmetics and body care products Garages (vehicular exhaust) Combustion appliances HVAC systems Science or laboratory chemicals (in schools) Art supplies (in schools) Office equipment (photocopiers) Outdoor air
Polynuclear aromatic hydrocarbons (PAHs) (e.g., benzo(a)pyrene, benzoanthracene)	Tobacco HVAC systems Combustion appliances Cleaners and waxes Garages (vehicular exhaust) Automotive products (oils, hydraulic fluid) Pesticides Paints and supplies Adhesives

Table 2 Comparison of Indoor/Outdoor (I/O) VOC Concentration Ratios and Exposure Estimates for VOCs from TEAM Study

Chemical	Measured I/O concentrations		Calculated annual exposure range (mg [illegible])	
	Average I/O ratio	I/O range	Indoor	Outdoor
Chloroform	8	1 - 15	0.06 - 20	0.03 - 0.56
1,1,1-Trichloroethane	50	0.5 - 100	26 - 150	1.2 - 4.0
Benzene	20	--	26 - 89	1.5 - 15
Carbon tetrachloride	5.5	1 - 10	3.9 - 8.9	0.26 - 0.69
Trichloroethylene	4	3 - 5	1.5 - 16	0.05 - 1.2
Tetrachloroethylene	3.5	3 - 4	11 - 49	0.21 - 6.3
Styrene	8	--	4.2 - 17	0.20 - 3.6
m & p-Dichlorobenzene	9	8 - 10	3.1 - 25	0.21 - 1.5
Ethylbenzene	8.5	7 - 10	11 - 47	0.56 - 9.4
o - Xylene	8	6 - 10	12 - 58	0.33 - 11
m & p-Xylene	7	4 - 10	36 - 130	1.1 - 26

air pollutants may act cumulatively or synergistically to cause effects that the individual pollutants could not cause by themselves.

A number of known or suspected cancer-causing chemicals are present in indoor air (e.g., trichloroethylene, chlordane, formaldehyde, radon, tobacco smoke). Exposure to these and other indoor pollutants may result in significant risk. Total risks posed by exposure to indoor pollutants will likely exceed those posed by exposure via other environmental exposure pathways (e.g., outdoor air, drinking water). Radon alone is estimated to be responsible for from 5,000 to 20,000 lung cancer deaths per year. Published risk estimates of lung cancer deaths in nonsmokers exposed to environmental tobacco smoke range from 500 to 5,000 per year, with total mortality estimates ranging from 4,000 to 50,000 deaths per year.

Additional adverse health effects can result from exposure to microorganisms and other biological contaminants. These health effects are of three general categories: allergic reactions (e.g., asthma), infections (e.g., pneumonia), and fungal releases of chemical toxins (e.g., mycointoxication). Allergic reactions can be caused by a variety of agents such as pollen, fungi, animal dander, house dust mites, and insect products. Infectious diseases result from the airborne spread of bacteria and viruses. Building heating, ventilation, and air conditioning (HVAC) systems contribute to the movement of biological contaminants indoors and, when not properly maintained, can provide an environment for contaminant growth and dispersal. This is best demonstrated by the outbreak of "Legionnaire's Disease" among American Legion Society members following a convention in a Philadelphia Hotel in 1980.

Exposure to indoor air pollutants may also result in loss of productivity in the workplace. Even at low exposure levels, some indoor air pollutants, such as carbon monoxide and lead, are known to cause impairments in nervous system-muscle performance, decision-making, and tasks requiring concentration or neurophysiological function. Mixtures of chemicals (e.g., tobacco smoke) may also lead to loss of productivity. Another measure of loss of productivity is absenteeism from work. If workers are exposed to high enough levels of indoor air pollutants to cause overt illness ("sick building syndrome"), they may stay home more frequently because of the illness symptoms and, possibly, psychological aversion to returning to a work environment that caused such illnesses. Some of the most notable research concerning exposure to chemical mixtures and possible loss of worker productivity has been performed by Dr. Lars Mølhave of the University of Aarhus in Denmark.

Table 3 summarizes some of the health effects and risk issues concerning indoor air pollution.

Table 3. Summary of Issues - Indoor Air Health Effects and Risks

Issue area	Issue	Conclusions	Comments
Health effects	Overview	All major indoor air pollutant categories contain chemicals that cause adverse health effects.	Effects can include eye and respiratory tract irritation, respiratory impairment, neurotoxic effects, effects on major organs, effects on developing fetus, allergies, infectious disease(s), cancer.
	Cancer	More than a dozen known or suspected human carcinogens are known to be present in indoor air; radon and tobacco smoke in indoor air have been demonstrated to cause cancer based on epidemiological data.	Monitoring data are limited for many pollutants.
	Chronic effects	Most chronic effects data are from single-pollutant studies with animals or human volunteers. Studies confirm chronic effects for formaldehyde, pollen, nitrogen dioxide (NO_2), combustion particles, and tobacco smoke in actual indoor settings.	Many additional indoor pollutants are likely to be involved in chronic effects; most chronic effects focus on the respiratory tract
	Acute effects	Major target sites are the respiratory tract and central nervous system, although other sites (e.g., eye) can be involved	A collection of acute effects not associated with a specific disease is referred to as the Sick Building Syndrome ([illegible])
	Synergistic effects	These are more than additive effects involving multiple pollutants and multiple exposure routes.	Synergistic effects are known to [illegible] and aerosols, O_3 and aerosols, SO_2 and aerosols, radon and tobacco smoke, and PAH with other compounds.
	Effects of biological contaminants	These contaminants result in symptoms that range from hypersensitivity pneumonitis or other allergic resonses to infectious diseases.	Biological contamination includes bacteria, fungi, protozoa, or other products of biological origin.

Table 3. (Continued)

Issue area	Issue	Conclusions	Comments
Health effects (continued)	Loss of productivity	This result is potentially caused by pollutants in indoor air; may be measured as reduced performance and increased absenteeism.	
	Sensitive populations	On the order of 30% of the population exposed to indoor air pollutants may be particularly sensitive to pollutant effects.	
[illegible] syndrome ([illegible])	Definition	Short-term reversible symptoms can be associated with occupancy of a specific building.	
	Symptoms	Effects can be eye and respiratory tract irritation, impaired respiratory function, respiratory infections, dizziness and headaches, fatigue, nausea, diarrhea, chest and abdominal pain, dermatitis.	Characterized by persistence of symptoms and consistent association with exposure to indoor air in specific buildings.

III. MITIGATION OPTIONS

There are two basic approaches to indoor air pollution mitigation: source controls and multipollutant strategies. Source controls remove or isolate pollutant sources to reduce indoor pollutant emissions. Multipollutant strategies are aimed at reducing indoor concentrations, typically through ventilation or air cleaning. Table 4 summarizes the various mitigation options, their pollutant applicability, and the individuals or agents who can initiate their use.

Source Control

Source control as a mitigation option includes source removal or substitution, design changes, and encapsulation and other physical barriers. These methods can be used by building designers or inhabitants or by the source's manufacturer. Source removal is an option that can be used by a building's occupants to effectively eliminate the pollutant source from the indoor space. This option has been employed as a control measure for asbestos in many buildings and is essentially 100 percent effective as a source control.

The substitution of one product for another is an option that building designers, builders, or occupants may use to reduce indoor emissions of pollutants. For example, the use of low-emission formaldehyde building materials in place of other higher emission rate materials during the design or construction phases would result in lower formaldehyde emissions in the building. Changes in product design or chemical content can be used by manufacturers to mitigate indoor pollution. These changes may have a significant effect on emission reduction as has been seen in pressed wood products where the development of newer products by manufacturers has significantly reduced formaldehyde emissions.

Encapsulation or the use of physical barriers can inhibit source emissions. This option can be used by the product manufacturer or by the builder or occupant of a building. This option is useful where the pollutant source is too large for removal or is inherent in the building structure. It has been shown to be an effective control measure for asbestos, formaldehyde, and radon. Encapsulation of asbestos can reduce the number of airborne fibers by 99 percent. Coatings have been shown to be effective in reducing formaldehyde emissions from pressed-wood products. Radon entry into a building may be reduced by sealing foundation cracks.

Table 4. Mitigation Options, Applicability, and Control Agents

Method	Description	Applicability	Control Agent
Source Control			
Removal or Substitution	Source is removed or replaced by a less contaminating source which fulfills same function.	All Sources	Designer, Builder
Change in Design	Design is altered for lower emissions.	All Sources	Manufacturer
Encapsulation	Impermeable material covers source to restrict emissions.	Continuous nonmechanical sources	Manufacturer Builder Inhabitant
Confinement	Source is used in a confined area	Localized sources	Inhabitants
Temporal Use	Source is used so only a few persons will be exposed.	Inhabitant-controlled sources	Inhabitants
Maintenance and Cleaning	Source is maintained and cleaned to prevent increased emissions.	Combustion and biological	Inhabitants
Multipollutant strategies			
Natural Ventilation	Open windows, doors, or vents.	All pollutants	Builders control placement; inhabitants control use
Mechanical Ventilation	Forced air movement replaces indoor air with outdoor air.	All pollutants	Builders select and install; inhabitants control use
Local Ventilation	Exhaust contaminants from specific source to outside.	Localized source	Builders or inhabitants place limits
Air cleaning by filtration or electrostatic interaction	Remove particles from air.	Particulates	Builders or inhabitants place limits; inhabitants control use
Air cleaning by adsorption	Remove [illegible] from air	Some gases and vapors	Builders or inhabitants place limits; inhabitants control use

Source control has several general limitation. It can be used only here the pollutant source is identified and where a feasible mitigation ethod exists. Source controls, particularly where building renovation r product redesign is required, include some of the most expensive otential mitigation methods. In addition, the methods discussed may pply only to a specific source and a specific pollutant.

ultipollutant Strategies

In addition to specific source controls are methods that reduce verall pollutant concentrations. These approaches include ventilation trategies and air treatment.

Removal of contaminants from indoor air using ventilation can be ccomplished by three ventilation strategies: 1) dilution ventilation, 2) local exhaust ventilation, and 3) improved ventilation efficiency. ilution ventilation reduces indoor air pollutant concentrations by eplacing indoor air with makeup air. In cases where the initial entilation rate is low, small increases in ventilation rate can enerally reduce indoor pollutant concentrations without a substantial ise in energy costs.

Local exhaust ventilation is used to minimize the transport of ollutants from a defined source to the general indoor air. The use of nis strategy to reduce concentrations in areas with strong pollutant ources (e.g., kitchens, bathrooms, smoking areas) can be much more ffective and less costly than providing increased ventilation to an ntire building.

Ventilation efficiency should be considered a possible means of nproving indoor air quality. In areas where uniform mixing of indoor ir is not achieved, contaminant stratification can occur, resulting in reas of higher exposure potential. Improving ventilation efficiency nproves the delivery of outside air to occupied spaces and minimizes ckets of dead air space.

Air treatment methods available for removing indoor air contaminants nclude filters, adsorbents, negative ion generators, and electrostatic recipitators. These methods are used separately or are combined in a ries within a single air cleaning device. Air cleaning can be fective in removing particulates; however, it has not been demonstrated o be an effective method of controlling gaseous pollutants.

IV. RESEARCH

Prior to the enactment of the Radon Gas and Indoor Air Quality Research Act in 1986 (Title IV of the Superfund Amendments and Reauthorization Act (SARA)), EPA's indoor air research efforts were supported through supplements to research and development funding authorizations. EPA initiated a research program on indoor air quality in 1984. Funding for this program, through supplemental appropriations from Congress, has been $2 million per year for each of the three fiscal years since startup. In fiscal years 1984 and 1985, research on radon measurement and mitigation was included in the basic indoor air research program. In the current (1987) fiscal year, a separate $1.5 million was appropriated by Congress for radon mitigation, which has, in effect, become a separate program because of the uniqueness of radon as an indoor air pollution problem.

<u>Research in EPA</u>

EPA's research program has made significant advances in the state of knowledge on indoor air. For example:

- Through the Agency's air research program, progress has been made on several fronts. For example, through EPA's air toxics research effort, the Total Exposure Assessment Methodology (TEAM) was developed and validated. TEAM studies rely on state-of-the-art personal and ambient exposure monitors, plus a unique blend of scientific approaches, to determine human exposure to pollutants. The initial TEAM studies, which focused on volatile organic compounds (VOCs), provided critical evidence of the extremely high concentrations of VOCs indoors. The TEAM approach is currently being expanded to address exposure to particulate emissions. It is also being used in an EPA study of residential pesticide exposure.

- Through the innovative Integrated Air Cancer Program, EPA has been able to develop and field test instruments and methods to characterize carcinogens in ambient and indoor air, to identify the sources of these emissions, and to evaluate complex mixtures of pollutants to discover the most potent components of these mixtures and screen for possible health effects.

- Several significant advances have been made through specific health effects and source characterization studies. For instance, the exposure portion of a clinical study of children whose parents smoke cigarettes has recently been completed. A pilot field study has been initiated to examine the levels of nicotine in children of smoking parents as well as to evaluate indoor levels of nicotine and other pollutants in the homes where the children live.

- EPA has a special testing chamber in which the Agency has pioneered research to determine the composition and rate of pollutant emissions for several common building materials and consumer products. Among the products tested so far are construction adhesives, flooring materials, paints, floor waxes, and moth crystals.

- Significant progress has also been made in the standardization of emission testing procedures and in the development of much needed personal and fixed monitoring equipment for assessing human exposures to indoor air pollutants. In addition, EPA is conducting studies to develop a model that can be used to estimate exposure from volatilization of chemicals from tap water into the home.

Because of the nature of the indoor air quality issue, two basic approaches will be taken in EPA's future research effort: a cross-cutting, generic approach that will focus on building design, ventilation, and the general characterization of indoor air exposures and a source-specific approach that will concentrate on controlling specific pollutants (e.g., radon) or specific sources (e.g., building materials). This dual approach will ensure that the research program is comprehensive.

Generic research needs will be addressed by projects that are aimed at developing standard measurement protocols for monitoring indoor air, establishing emission reduction baselines, and identifying and disseminating information regarding mitigation techniques to the public. Issues that will be assessed with this approach include:

- Characterization of air pollution in high risk buildings and various building types;

- Characterization of individual exposures to pollutants (the development and use of personal monitors, and the assessment of "total exposures" from the ambient and indoor environments);

- Identification of factors affecting exposure (building types/materials), ventilation levels and rates, and classes and types of consumer products; and

- Preparation of guidelines for mitigating/preventing indoor air quality problems (building practices, guidelines for defining acceptable indoor air quality, control technologies, and maintenance practices).

Source-specific research is necessary to ensure that important indoor air risks are not overlooked and to focus continued emphasis on known risks. This will allow assessment of known high risk categories, such as radon, as well as suspected high risk categories (e.g., biologicals contaminants from HVAC systems), and of combustion appliances and building materials and products. Seven exposure source categories have been established to focus research on specific pollutants/sources:

1. Environmental Tobacco Smoke.

Because this source of indoor pollutants is believed to contribute perhaps the largest overall risk to health, it is addressed in an individual category.

2. Combustion Appliances.

Combustion appliances for heating and cooking, particularly unvented ones, can be major sources of indoor pollutants. For example, these appliances are common sources of NO_2, CO, and particulate matter, all of which also occur (and are regulated) in the ambient environment. Of special interest is the risk from the total emissions containing numerous products of incomplete combustion, which are largely uninvestigated.

3. Materials and Furnishings.

Included in this category are building materials, which can be sources of asbestos and other fibers; furnishings, such as furniture and carpeting, which can be sources of formaldehyde and other organic vapors; and stored materials and various surface coatings, which can be sources of solvent-based organics.

4. Biological Contaminants.

Included are molds and their spores, bacteria, viruses, and insects and other products. Sources include moist areas or other favorable indoor environments, among them automobile and building air conditioning and ventilation systems and humidifiers.

5. Human Activities.

Many indoor exposures occur as a result of everyday activities, ranging from vacuuming (which can reentrain molds, dust mites, and other particles) to showering (which can produce vapors of chloroform and trichloroethylene present in water supplies). Of perhaps greatest concern are exposures during the use and application of commercial/consumer products, including pesticides, paints, solvents, cleaning agents, polishes, and waxes.

6. Ambient (Outdoor) Environment (Radon, Pesticides).

An indoor air pollutant of great public concern, radon originates primarily from the natural outdoor environment. Other significant indoor pollutants of concern that have their source primarily outdoors include pesticides, such as termiticides, that are applied to soils around residences.

7. Nonionizing Radiation.

Numerous sources of electric and magnetic fields are found indoors. Sources include any appliance that has an electric motor or electric heating element and electric light bulbs. Several major classes of effects have been observed from extremely low frequency electric and magnetic fields, but whether indoor exposures cause these effects is uncertain. The effects of negatively and positively charged ions in indoor air are also uncertain.

V. U.S. POLICY DEVELOPMENT

Current Status

The Superfund legislation in part directs the Administrator of the Environmental Protection Agency to establish an indoor air quality research program designed to contribute to the understanding of health problems associated with indoor air pollutants. The statute also directs EPA to coordinate with federal, state, local, and private sector research and development efforts related to improvement of indoor air quality and to assess federal actions to mitigate associated health risks. The statute also encourages EPA to disseminate information regarding indoor air pollutant sources and concentrations, high risk building types, measurement instruments, and health effects, as well as recommended methods for the prevention and abatement of indoor air pollution.

In June 1987, EPA prepared a Report to Congress, the EPA Indoor Air Quality Implementation Plan, in which the Agency's overall indoor air goals and policy objectives were identified. As presented in the Implementation Plan, EPA's ultimate goals in addressing indoor air quality problems are to characterize and understand the risks to human health that pollutants pose in indoor environments and to lessen those risks by reducing exposure to indoor pollutants. The Agency's indoor air program will seek to reduce the risks to human health posed by indoor air pollution through the pursuit of the following policy objectives:

- The Agency will conduct research to further refine its assessment of the nature and magnitude of the health and welfare problems posed by individual air pollutants as well as pollutant mixtures indoors. Such research will focus in the near term on improvement of exposure data, continued development and testing of modeling tools necessary to perform essential risk assessments, and the development and consolidation of data bases. Development of appropriate ranking and risk assessment tools will be a top priority in this effort.

- The Agency will identify and assess the full range of mitigation strategies available to address high priority indoor air pollution problems. Equal emphasis will be placed on strategies that reduce or eliminate the source of the risk, as well as on more generic strategies that may reduce exposures, and thus risks, to multiple pollutants simultaneously (e.g., ventilation-related strategies).

- For identified high risk, high priority problems, the Agency will adopt and carry out appropriate mitigation strategies. Strategies may involve one or more of the following:

  - issuing regulations under existing Federal regulatory authorities (e.g., Toxic Substances Control Act, Federal Insecticide, Fungicide, and Rodenticide Act; Safe Drinking Water Act);

  - building state and local government and private sector capability to address indoor air quality problems through nonregulatory programs of information dissemination, technical assistance, guidance, and training;

  - referring problems to other federal agencies with appropriate statutory authority (e.g., Consumer Product Safety Commission, Department of Housing and Urban Development); and

  - requesting separate indoor air regulatory authority from Congress if deemed appropriate.

In October 1988, EPA is required to report to Congress on its indoor air quality activities under Title IV and provide its recommendations.

Policy Approaches to Controlling Indoor Air Pollution

Although EPA's historical and traditional approach to environmental problem solving has been primarily regulatory in nature, the indoor air issue presents unique problems and issues for which regulatory solutions may not always be the most effective approach. Since indoor air pollution problems are largely a function of the products and materials used within specific building settings, the character of the problem will differ in each setting and the most appropriate mitigation strategy will depend on a variety of factors. In many instances, the Agency hopes to be able to achieve its indoor air policy goals through nonregulatory approaches, which will include research and development, information dissemination, and technical assistance and training. To a large extent, the Agency's success in reducing the risks to human health from indoor air pollution will depend upon how successfully the Agency is able to build public and private sector capability to investigate, assess, and solve indoor air quality problems, to effect change in product purchasing and use, and to change building design and operation to minimize the risks from indoor air pollution.

Administrative control options may be effective in reducing pollutant exposure to building occupants. Administrative alternatives are actions on the part of organizations in the public and private sector that influence or require mitigation of indoor air quality problems. Table 5 summarizes public and private sector roles in providing or servicing mitigation needs.

Administrative alternatives can be both regulatory and nonregulatory in nature. Regulatory alternatives include such actions as:

- Development of chemical-specific use regulations where high health risks are possible as authorized by the Toxic Substances Control Act (TSCA) and Federal Insecticide, Fungicide, Rodenticide Act (FIFRA), the Safe Drinking Water Act (SDWA), and the Resource Conservation and Recovery Act (RCRA).

- Development of chemical-specific standards for the office or school environments; and

- Development/modification of building codes and standards (e.g., air exchange rates).

The U.S. EPA has been conducting both regulatory and nonregulatory indoor air activities for the past several years. From a regulatory standpoint, the Agency has addressed a number of chemicals, including several pesticides, found indoors through the use of TSCA and FIFRA. These statutes enable EPA to obtain information on chemical substances from manufacturers and processors when there is reason to believe that the use of these substances may present an unreasonable risk to human health and the environment. Based on assessments of risks and benefits, the Agency determines whether or not an unreasonable risk exists for a specific compound; if so, the Agency can take action to control exposure to the substance, restrict its use, or ban the substance entirely.

To date, EPA has taken a number of actions under various statutes on specific chemicals that have been found to pose risks indoors. EPA has issued the Asbestos Worker Protection Rule to protect public employees not covered by the Occupational Safety and Health Administration (OSHA) from exposure to asbestos during abatement activities. The Agency has also proposed to phase out commercial uses of asbestos over a 10-year period. This proposed rule, known as the Asbestos Ban and Phase Down Rule, will significantly reduce future uses of asbestos and exposure to asbestos fibers in all environments, including indoors. The proposed Asbestos in Schools Rule was just issued under the Asbestos Hazard Emergency Response Act (AHERA) passed by Congress in October 1986. This

Table 5. Summary of Public and Private Sector Roles in Providing or Servicing Mitigation Needs

Responsible control agent	Role/responsibility
Individuals	• Purchase low emission products • Use, maintain, and store products according to specifications to minimize pollutant emissions • Exercise discretionary control over ventilation to ensure clean air supply • Be knowledgeable of indoor air quality problems and take actions to avoid personal exposure
Building owners and managers	• Adopt ventilation maintenance procedures to eliminate ventilation sources of pollutants and ensure an adequate supply of clean air to building occupants • Restrict high pollutant emissions to designated areas and use zone/spot ventilation or local exhaust for indoor sources • Develop specific procedures for the use of cleaners, paints, pesticides, and other products with high pollutant emission rates to protect building occupants • Purchase building supplies with low pollutant emission rates • Adopt investigatory protocols to respond to occupant complaints • Be knowledgeable of indoor air quality problems and take actions to avoid occupant exposure
Architects and builders	• Adopt indoor air quality as a design objective • Ensure compliance with indoor air quality ventilation standards • Specify low emission requirements in designs and procurement specifications for building materials from manufacturers • Provide for separation of occupants and pollutant sources in buildings • Specify containment or ventilation of known pollution sources • Be knowledgeable of state-of-the-art advances in interior design, HVAC and air cleaning systems, and other indoor air quality issues
Manufacturers of products	• Adopt test procedures and standards to minimize product and material emissions • Substitute materials to minimize pollutant emissions from products

Table 5. (continued)

Responsible control agent	Role/responsibility
Manufacturers of products (continued)	• Adequately label products as to emission level and proper maintenance and use of products • Conduct research to advance mitigation technology • Be knowledgeable of state-of-the-art advances in mitigative techniques and indoor air quality issues • Develop training programs for commercial product users to ensure low emissions
Professional engineering associations	• Adopt building codes for design, construction, and ventilation requirements to ensure adequate indoor air quality • Adopt test procedures to monitor pollutant emissions from products • Disseminate technical information to members concerning indoor air quality issues • Encourage research and development • Provide a forum for information exchange
Consumer and health professionals and organizations	• Be knowledgeable of symptoms, effects, and mitigation and advise clients • Develop information and education programs for members and for the general public
State and local governments	• Conduct studies of specific problems in state or local area and adopt mitigation strategies • Establish building codes for design, construction, and ventilation requirements to ensure adequate indoor air quality • Enforce and monitor code compliance • Educate and inform building community, health community, and public about problems and solutions
Federal government	• Coordinate actions of other sectors • Conduct research and technology transfer programs • Conduct specific programs to inform, encourage, or require specific sectors to take actions toward mitigation • Investigate high risk pollutant problems and take regulatory action as mandated by Congressional acts (e.g., TSCA, FIFRA)

rule requires schools to inspect for asbestos, prepare management plans, and take appropriate response action when friable asbestos is found.

In 1986, EPA prohibited the use of pentachlorophenol as a wood preservative for treatment of logs for log-home construction. Creosote and pentachlorophenol were also prohibited as preservatives indoors, with very few exceptions.

In 1983, EPA issued a phase-out of fumigation devices containing the pesticide lindane, used to control pests in residences. As of May 1986, such use of lindane is prohibited. The Agency is currently evaluating monitoring data received from manufacturers on chlorda·· and is examining the health effects and benefits data for chlordane and other termiticides, such as heptachlor and aldrin/dieldrin, to determine whether further regulatory action is necessary. A decision is expected on these compounds in 1987.

On April 16, 1987, the Agency announced the results of its risk assessment on formaldehyde, a probable human carcinogen. While decision-making options are under consideration, studies are being conducted of formaldehyde emissions from plywood and particle board used in mobile and conventional homes. The findings of these and other studies are being shared with OSHA and with the Department of Housing and Urban Development (HUD) for use in considering regulatory action.

Under the Safe Drinking Water Act (SDWA), EPA is currently considering the establishment of maximum contaminant levels for volatile organic compounds.. Such compounds vaporize in hot water and are then inhaled.

EPA has recently instituted a nonregulatory program to mitigate risks from radon exposure in residences. This program involved demonstrations, technical assistance, training, and information dissemination. The EPA Radon Program, a potential model for other pollutant nonregulatory initiatives, is presented in Appendix A.

Emerging Policy Issues

Traditionally, EPA has approached air quality problems on a pollutant-by-pollutant basis. However, because of the nature of the indoor air issue, a multipollutant approach is also required to achieve the greatest reduction of risk. Emerging policy questions related to the U.S. approach include the following:

- What are the roles of the federal, state, and local governments, and private sector organizations in the design, operation, diagnosis, and remedial services for sick buildings?

- What is the most effective approach to providing information and technical services to the public?

- What is the proper role of the federal government in ensuring the establishment and operation of adequate ventilation systems for all buildings?

- What mechanisms would ensure that emissions from commercial/consumer products will not produce significant indoor contamination and risks?

- What should be the federal role in establishing indoor air quality standards or guidelines?

EPA is only one of many federal agencies that are either actively engaged in indoor air research or vitally interested in the research being conducted. Coordination of indoor air policy with the United States is achieved by EPA and other members of the Interagency Committee on Indoor Air Quality (CIAQ). A brief description of the areas of concern for each of the various CIAQ members is provided in Appendix B.

International Cooperation and Information Exchange

The United States also seeks to promote international scientific cooperation and understanding of scientific considerations in indoor air pollution on a range of technical matters. These activities add to scientific knowledge and contribute to protection of health. As part of its research effort, EPA participates in international information exchange programs relating to indoor air quality research. The predominant mechanisms for this information exchange are international conferences and workshops that are co-sponsored by EPA. Through these activities, EPA provides for the integration of research efforts being carried out by various countries.

EPA also takes part in cooperative research efforts with other countries. For example, as part of a cooperative effort with the Peoples Republic of China, EPA is conducting a study of lung cancer in Xuan Wei, a county in southeastern China. It is thought that the county's abnormally high rates of lung cancer are linked to indoor exposure to particle-bound organic compounds from the coal and wood cooking and heating fuels used by the residents of Xuan Wei.

APPENDIX A

Indoor Radon Case Study

APPENDIX A
Indoor Radon Case Study

The Environmental Protection Agency has identified indoor radon as a serious public health problem. Scientists estimate that between 5,000 and 20,000 people in the U.S. each year may die from exposure to indoor radon. When EPA released its strategy, it announced that as many as 8 million houses in the United States may be above EPA's recommended action level of 4 picocures per liter. Follow-up surveys in individual States indicate that even more homes may have elevated levels of indoor radon.

Background

Radon is a radioactive gas produced by the radioactive decay of radium-226, which occurs naturally in almost all soils and rocks. Radon is present in the atmosphere everywhere because of its release from radium decaying in the ground. Outdoor radon levels generally are low. Radon gas seeps into houses through cracks in the foundation, areas around drainage pipes, sump pumps and other openings in the foundation or walls. Typical indoor levels are usually about five times higher than average outdoor levels, but can be over ten thousand times higher. Exposure to such elevated levels may greatly increase an individual's risk of developing lung cancer.

History

Exposure to elevated indoor concentrations of radon gas was first recognized as a potential health problem in the State of Colorado in the 1960's when houses that had been built with materials contaminated by uranium mill tailings were found with high levels. In the 1970's, EPA discovered that some houses built on reclaimed phosphate lands in the State of Florida also had elevated radon levels. In December 1984, however, extremely high radon levels were detected in homes located on the Reading Prong, a geological formation which runs from New Jersey, through Pennsylvania and into New York.

While the Reading Prong area of Pennsylvania, New Jersey, and New York is the best known high-radon area in the United States at this time, indoor radon is potentially a widespread problem. Elevated radon levels have been found in houses in many States--not only where suspected geological factors or the presence of uranium deposits suggest that radon might be a problem. As public awareness increases, many States are responding by organizing radon programs to assess the extent of the radon problem and educate homeowners.

Recent Surveys

EPA established its Radon Action Program in 1985 in response to the serious radon problem discovered in the Reading Prong. The goal of our program is to significantly reduce the health risks of radon by forming a partnership with other Federal agencies and the States. Certain types of activities, such as research and technical studies, are best done by the Federal Government. Other activities, such as providing day-to-day advice to the public and detailed analyses of local situations, are best handled by State and local agencies because of their proximity to the problem.

EPA's Radon Action Program consists of four elements:

1. To assess the extent of the radon problem nationally (Problem Assessment);

2. To conduct research into methods of reducing radon levels in existing and new homes (Mitigation and Prevention);

3. To help States develop programs to measure and diagnose radon problems, as well as to assist the public (Capability Development); and

4. To develop information for the States to use in helping citizens understand the risks associated with radon and how to reduce them (Public Information).

Problem Assessment

EPA has two complementary activities underway to assess the extent of the radon problem. A national survey is being designed to better define the distribution of radon levels in houses across the country. The Agency is also assisting States in designing and conducting their own surveys to identify high risk areas within the State and to determine the distribution of indoor radon levels across the State.

Ten States were surveyed in fiscal year 1987. Over 10,000 houses were measured in more than 600 counties. Elevated levels were found in every survey State and the distribution of radon levels varied among States; radon "hot spots" were found within States that had relatively low State-wide distributions. These surveys confirm that geology is a good indicator of high risk areas. For fiscal year 1988, seven more States and three Indian tribes have been selected to participate in EPA's Radon Survey Assistance Program. Standardized measurement methods have been issued to ensure the comparability of radon measurements

EPA and the United States Geological Survey are conducting Land Evaluation Studies to more precisely identify those geological factors and characteristics which are most useful as indicators of high radon levels. EPA is also conducting preliminary work on the use of soil gas measurements to predict the radon potential for individual parcels of land.

Mitigation and Prevention

EPA has been working closely with the States in conducting a research and demonstration program for reducing indoor radon levels. These houses had initial average radon levels ranging from 6 to 1,200 picocuries per liter (pCi/l). Indoor radon levels have been reduced in most of the homes by more than 90 percent.

In addition to our demonstration work of reducing radon levels in air, we have recently released a brochure on methods to remove radon from drinking water.

EPA has initiated a House Evaluation Program (HEP) to evaluate the cost and effectiveness of mitigation methods in the private sector and to train State and private sector personnel in diagnosing and mitigating radon in houses. We have completed 80 homes in the HEP and identified radon entry pathways and mitigation alternatives and have provided diagnostic training to over 50 State and local personnel.

The results of EPA's mitigation efforts have been very promising. Private contractors are successfully reducing radon levels at a reasonable cost and the number of contractors performing mitigation services is increasing.

A critical element in reducing the health risk from radon exposure is to prevent radon entry in new construction. EPA is planning to demonstrate radon resistant techniques in up to 125 houses this year. EPA and the National Association of Home Builders recently released a brochure that demonstrates radon resistant techniques in new construction.

Capability Development

Another important aspect of the Radon Action Program is to develop State and private sector capabilities to diagnose and reduce indoor radon levels. A technical training course for Federal and State officials and private contractors was developed and has been offered approximately 28 times to over 1,500 State officials and private contractors. The course is also made available on videotape.

The Agency provides technical advice on radon measurement methods and calibration services to the States and private firms. To ensure that those in the radon measurement business meet certain minimum standards, EPA established the Radon Measurement Proficiency (RMP) program. Participation in this quality assurance program is voluntary, but some States are using the proficiency evaluations as a basis for certification. The program has grown from 35 firms and 47 detection methods in the first round to 360 participants and 590 methods tested in the most recent round. Presently there are over 800 applications for the sixth round scheduled for February 1988.

Public Information

As public concern about the health risks associated with indoor radon increased, the development and dissemination of public information became a high priority for the States and EPA. In 1986, EPA released two brochures, "A Citizen's Guide To Radon: What It Is and What to Do About It," and "Radon Reduction Methods: A Homeowner's Guide." More than 250,000 copies of these publications have been distributed by EPA and the States.

EPA staff participate in frequent seminars, symposiums, and public meetings to discuss health risks from indoor radon and to disseminate information and have participated in television and radio appearances discussing radon.

Conclusion:

Federal Coordination

There is active interest on the part of other Federal Agencies to evaluate the problem of elevated radon concentrations in homes. EPA and the Department of Energy have cooperated in a research project on radon mitigation diagnostics. The Department of Housing and Urban Development is assisting us in developing inexpensive and effective mitigation techniques. These different agency concerns have led to the formation of several forums and intra-agency committees to discuss the indoor radon problem.

In September 1986, Congress passed the Superfund Amendments and Reauthorization Act of 1986 (SARA). Within this Act, Title I- the Radon Gas and Indoor Air Quality Act (1986), directs EPA to conduct a national assessment of radon, to demonstrate radon mitigation methods, and to carry out other research and public information activities.

To complement existing efforts, several pieces of proposed legislation have been introduced in Congress. The most comprehensive legislation, the State Radon Program Development Act, would direct EPA to expand technical assistance to States on radon issues and would provide $10 million annually in FY 1988, 1989, and 1990 for grants to help States develop their radon programs. The bill would provide $1.5 million to expand EPA's radon training activities and proficiency testing programs. The bill would also provide $1 million for EPA to conduct a study of radon contamination in the nation's schools, plus an additional $500,000 for demonstrations of radon reduction techniques in schools. A recent amendment to the bill would direct EPA to conduct a radon survey in Federal buildings.

Other radon bills under consideration would provide IRS tax breaks for the costs of correcting radon problems in residences and eligible medical expenses; establish a Housing and Urban Development program to assist States and localities in modifying building codes to require testing for radon; and require EPA to establish a standard for exposure to radon in indoor environments.

Under the Safe Drinking Water Act - EPA is developing drinking water standards for radon and other radionuclides; these will be published in June of 1989.

The success of the efforts to date rests on the partnership that has developed with the States during the past two years. For the past two years, EPA's efforts have been successfully directed toward meeting the urgent needs of the States affected by the Reading Prong. In the future, the Agency will focus on fulfilling its regulative responsibilities and assisting those States which are now finding elevated levels.

EPA is expanding its mitigation efforts into States outside the Reading Prong and will include a variety of housing types in various climates. Working with building code organizations will help to ensure that radon-resistant techniques are incorporated into new construction practices through modifications to local building codes.

EPA will continue to provide technical assistance to States to enable them to develop radon programs and expand private sector capabilities. Several of the programs the Agency developed in response to the needs of the Reading Prong will be continued and expanded to assist other States.

With the anticipated growth in the radon measurement industry, EPA's quality assurance progra- will continue to provide a critical service to the States and the puc

The Agency will also work to provide States with some of the information necessary to help howeowners understand and evaluate the radon problem. An effective public education program is an essential component of EPA's approach to reducing risks from indoor radon.

The Agency is pleased with the results of its initial efforts. States are accepting their responsibilities and are helping citizens reduce their risk from indoor radon. By strengthening this Federal-State partnership, EPA can achieve the mutual goals of reducing the public health risks from radon.

APPENDIX B

MEMBERS OF THE INTERAGENCY COMMITTEE ON INDOOR AIR QUALITY (CIAQ)

U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

A number of offices within the Environmental Protection Agency have responsibilities related to indoor air quality. The Office of Program Development (OPD) within the Office of Air and Radiation has primary responsibility for establishing indoor air policy and coordinating the activities of various EPA offices. In addition, OPD serves as the focal point for Agency policy coordination with other federal agencies, state and local governments, and the private sector. The Office of Research and Development has primary responsibility for the technical aspects of the indoor air quality research program called for under Title IV of SARA, as well as other research related to indoor air quality. The Office of Radiation Programs within the Office of Air and Radiation has primary responsibility for implementing the Agency's Radon Action Program and carrying out the radon research program mandated by SARA Title IV. The Office of Pesticides and Toxic Substances is responsible for regulating pesticides and toxic substances, some of which are used indoors and contribute to indoor air pollution. The Office of Policy, Planning and Evaluation has general responsibility for reviewing policy developed by the program offices. The Office of Air Quality Planning and Standards, although not directly involved in indoor air quality activities, has developed some expertise on indoor air and human activity patterns in implementing the ambient air programs. The Office of Water sets standards for pollutants in drinking water, some of which are of concern for their ability to volatilize and contribute to the indoor air pollution problem. The EPA regional offices serve as the contact between EPA and state and local governments.

U.S. Consumer Product Safety Commission
Room 700
5401 Westbard Avenue
Bethesda, MD 20207

The Consumer Product Safety Commission (CPSC) has regulatory authority over most sources of indoor air pollution. In that capacity, CPSC focuses on the determination and reduction of health risks posed by the use of structural materials, combustion sources, consumer products, and chemicals used in the home and schools. The Consumer Product Safety Act (CPSA) and the Hazardous Substances Act (HSA) provide the basis for establishing standards and instituting recalls or bans in order to address identified hazards.

U.S. Department of Energy
100 Independence Avenue
Washington, DC 20585

The Department of Energy (DOE) conducts a variety of activities related to indoor air quality in support of DOE policies to encourage the use of advanced energy conservation measures while maintaining a safe and healthful indoor environment. These activities include identifying indoor air pollutant sources and factors affecting human exposure, determining the relationship between indoor air quality and energy conservation, and developing control and mitigation techniques. Bonnerville Power Administration (BPA), part of DOE and also a member of CIAQ, conducts similar research in the Northwest.

Department of Health and Human Resources
National Institute for Occupational Safety and Health
944 Chestnut Ridge Rd.
Morgantown, WV 26505-2888

The Department of Health and Human Services (DHHS) investigates buildings for indoor air quality problems (through NIOSH), provides funding for a major health study of people exposed to indoor and outdoor pollutants in various areas of the country ("Six Cities Study"), conducts health effects studies, and develops health databases (through NIEHS).

U.S. Department of Housing and Urban Development
Room 8100
451 7th Street, S.W.
Washington, DC 20410-6000

The Department of Housing and Urban Development (HUD) is responsible for establishing and enforcing standards for properties being financed with HUD/Federal Housing Administration-insured mortgages or assisted through one of the HUD-assisted or directed loan programs; HUD also establishes, manages, and enforces the Federal Manufactured Housing Construction and Safety Standards. Past research efforts have included developing and instituting standards for formaldehyde emissions in materials in manufactured housing; investigating the problems of radon infiltration in housing built on mine tailings in Grand Junction, Colorado and Butte and Helena, Montana; and arranging for tests of radon mitigation approaches on Florida phosphate lands.

U.S. Tennessee Valley Authority
3N 51A Signal Place
Chattanooga, TN 37402-2801

The Tennessee Valley Authority's (TVA) indoor air program is primarily concerned with investigating the interrelationships among building construction characteristics, energy use, conservation, and indoor air quality, and with developing public information dissemination approaches. In addition to establishing these general relationships, exposures of specific population groups to unique indoor environments, such as those found in public housing, commercial buildings, and rural housing are being studied. Indoor air quality in commercial buildings operated by TVA, as well as the environment in the industrial workplace, is being investigated.

U.S. General Services Administration
Room 4320
18th & F Streets, N.W.
Washington, DC 20405

The General Services Administration (GSA) develops indoor air quality policies for federally-owned buildings.

National Aeronautics and Space Administration
National Space Technology Laboratories
Building T2423
NSTL Station, MS 39529

The National Aeronautics and Space Administration (NASA) conducts studies and maintains an extensive database on pollutants found in indoor environments.

U.S. National Bureau of Standards
Room A1138, Administration Building
Gaithersburg, MD 20899

The National Bureau of Standards (NBS) develops measurement standards and through its Center for Building Technology (CBT) conducts laboratory, field, and analytical research and develops models to predict, measure, and test the performance of building materials, components, systems, and practices.

From the Field

(13) HB 519

General Principles for the Resolution of Indoor Air Complaints

Edward N. Light

Abstract

Public Health agencies are increasingly being asked to resolve complaints related to various indoor air exposures. A screening process is suggested to help determine what, if any, air testing is justified in each situation. When the goal of an investigation is to provide general problem identification, extensive and highly accurate sampling may not be necessary. Testing can often be limited to indicator pollutants. Test conditions should include worst case exposure, when feasible. A thorough inspection should precede final determination of sampling strategy. Interpretation of test results must take into account variations in source and environmental factors. Distinctions should be made between ventilation-related and source-related situations and also between primary and secondary sources. Methods of evaluating exposure include comparison with guidelines, generalized statements of risk and specific medical diagnoses. Effective remedial measures can be recommended for most indoor air exposure problems.

The increasing public recognition of indoor air pollution translates into a major new challenge for public health agencies. Most health departments now receive requests to resolve questions and disputes regarding alleged indoor air exposure to a variety of potentially toxic agents. While the techniques needed to assess such situations are often new, the principles guiding such investigations are similar to those customarily used in traditional environmental health program areas. For example, the strategy for tracing the origin of an outbreak of foodborne illness or the response to a complaint over unsanitary conditions in an institution may follow the same type of sampling and inspection procedures needed for indoor air.

Some of the more common indoor air complaints being received by health departments are listed in Table 1. Since the potential volume of such complaints can be high, it is often necessary to assign priorities. A health-based scheme for prioritizing indoor air investigations is presented in Table 2.

Table 1
Common Indoor Air Complaints

- Asbestos
- Building-related illness
- Poor ventilation
- Odors
- Insecticides
- Carbon monoxide
- Tobacco smoke
- Formaldehyde

Table 2
Prioritization of Indoor Air Complaints

1. High potential for chronic disease
2. Acute illness occurring
3. Minor temporary symptoms only
4. Hypersensitive responses only
5. Nuisance odor or dust
6. Curiosity

Table 3
Multi-Party Indoor Air Disputes

- Product liability (i.e., mobile homes)
- Service liability (i.e., termite control)
- Landlord/tenant (i.e., ventilation)
- Labor/management (i.e., office workers)
- Owner/occupant (i.e., school)
- Smoker vs. non-smoker

Indoor air complaints may be pollutant-related, symptom-related, or both. Pollutant-related refers to an observation or concern that specific contaminants or indicators are present. Symptom-related reflects a concern that pollutants (sometimes unknown) may be contributing to occupant illness.

While some indoor air complaints may only involve a request to resolve an exposure question for a home or building owner, many encompass disputes between two or more parties. Table 3 provides examples of such situations. Few indoor air problems are covered by exposure or product standards, making resolution dependent on either voluntary compliance, private litigation or, in the case of extreme health hazards, special enforcement action. Constrained by a lack of technical guidance and resources, health departments have been reluctant to initiate comprehensive indoor air testing programs.

Complaint Screening

Indoor air complaints range from the frivolous to the immediate emergency, with the accuracy of initial information reported by occupants often suspect.

Journal of Environmental Health V. 49 (1) 28-31.

Edward N. Light, Industrial Hygienist II, Division of Public Health Sanitation, West Virginia Department of Health, Charleston, WV 25305.

Under such circumstances, a screening process is desirable before committing resources to a field investigation. Some health departments require a physician's statement prior to testing. However, most physicians' knowledge of indoor air pollution exposure is limited. An alternate approach utilizes locally available experts to inspect potential sources of indoor air pollution in a complaint residence or building. Table 4 lists contractors or service organizations which can be of assistance in conducting such evaluations. Their observations can then be discussed with the health department to determine the appropriate response.

Table 4
Screening of Indoor Air Complaints

- Physician
- Heating/cooling contractor
- Plumber/sewer authority
- Ventilation consultant
- Gas company/fire department
- Pest control operator
- Equipment service representative
- Commercial laboratory
- Mail order test kit

Following the initial screening, if the problem appears to be either routine and predictable or low priority, the health department may choose to provide only general advice (suggestions, literature, referral) with no on-site visit. Where an inspection is warranted, detailed information from the complainant in the form of a phone interview or detailed written request is helpful in the development of an effective and efficient investigation strategy. A complainants' description of symptoms and potential sources will often reveal patterns which suggest or rule out different types of problems.

General Strategy

Factors affecting indoor air complaints can be complex, with the most obvious source not always related to the problem. In some complaints, a totally unrelated factor may be responsible for the observed symptoms. This may include illnesses with a medical, food or water-related, or pychosomatic origin. An investigation protocol should consider the possibility of such alternative explanations where indicated.

When an indoor air complaint is accepted for investigation, a realistic goal must be set, based on the priority of the situation and available resources, to determine the scope of the study. Such studies can range from an initial screening (where relatively few samples and observations of limited accuracy are used to identify general problems) to a more detailed evaluation of specific sources, exposure, and remedial measures. The majority of health department indoor air investigations tend to fall into the screening category. More detailed studies tend to be reserved for cases where legal action may be involved. In some cases, an initial health department screening can be followed with more detailed testing by a commercial laboratory or consultant.

Since indoor air quality issues often become controversial and are easily sensationalized, it is important to deal fairly and openly with all parties in a dispute. A general explanation of sampling strategy and evaluation criteria before testing will tend to make the eventual recommendations resulting from a study more acceptable. It is essential to put exposure information in proper perspective. This may necessitate withholding initial data until it can be interpreted in a more complete context.

Interview/Inspection

Before any testing is initiated, occupant histories should be collected through interviews or a questionnaire and the facility inspected. The histories help to determine if there is a pattern of building-related symptoms which suggest or rule out particular sources. They also may suggest whether the reactions are widespread or possibly due to hypersensitivity. Similarly, occupant observations of unusual odors, dust accumulation, equipment malfunctions, etc., may help to identify suspect sources. The collection of occupant histories is generally followed by a walkthrough of the facility accompanied by a person knowledgeable in the building and its activities. At this time, building materials, chemical use, equipment, activities, ventilation and other factors related to indoor air quality (odors, soot, dust, mold growth, etc.) should be noted. Table 5 presents an example checklist which can be used to help select which potential sources appear to be serious enough to require further consideration.

Testing

After sources and/or pollutants are selected for testing, a sampling strategy must be developed. Far too many indoor air tests have been conducted in nonrepresentative conditions, using inappropriate sampling procedures, resulting in misleading conclusions. One common mistake is the assumption that all industrial hygiene methods are directly applicable to indoor air pollution. Indoor air situations involve unique test conditions and require a lower detection limit than the industrial environment.

Ideally, indoor air sampling should be conducted under conditions which reflect both average and peak occupant exposure. To accomplish this, the effects of changes in ventilation, temperature, occupant activity, and equipment operation must be estimated. Such variations must be considered when selecting sampling conditions and locations. In this regard, it is sometimes suggested that environmental conditions be manipulated before sampling indoor air. For example, a formaldehyde test might be preceded by closing all windows and raising the temperature to 80°F in order to approximate peak occupant exposure. On the other hand, a home which has been unoccupied may have accumulated excessive formaldehyde and should be ventilated prior to conducting a representative test.

Health department testing of indoor air should normally be limited to situations where the data generated will help resolve a potential health problem. When an obvious problem is involved (i.e., sewer gas), reasonable recommendations may be made without resorting to characterization of pollutants and measurements of exact levels.

In addition, testing should generally be limited to pollutants which the initial inspection and occupant histories suggest are potential problems. Often it is possible to test for an indicator pollutant and use the results to assume exposure to associated contaminants (i.e., carbon dioxide). In some instances, the ideal list of tests for a given site must be reduced due to resource limitations, or expanded for public relations purposes.

A goal for sample accuracy should be selected based on the testing objective, although it will often be limited by the availability of equipment and expertise. Where only screening is being conducted, general range finding with an error of ±50% or more may provide sufficient data to determine if exposure is high, moderate, or low. In some cases qualitative sampling alone may be sufficient. On the other hand, testing for legal or medical purposes may require accuracy to ±5%. Similarly, quality control and chain-of-custody requirements will vary greatly depending on the goal set for an investigation.

The number of samples is usually constrained by time and cost, but should be adequate to characterize, at a minimum, average and/or peak exposure. Such samples must be collected from the breathing zone of an occupied area. In addition, it is often helpful to collect samples which distinguish major from minor sources and help characterize their dynamics. This may be accomplished by diagnostic air sampling in or next to a specific source (i.e., cabinet made from particleboard). Sometimes bulk or wipe sampling of potential sources helps to define their emissions.

Where the complaint is due to a pollution source which is intermittent or has since ceased, it may be possible to collect samples which provide historical evidence of exposure. For example, settled dust can be sampled for asbestos content, or fabric for the adsorption of persistent pesticides. In the case of an intermittent odor not present during the onsite visit, it may be advantageous to leave test equipment with a reliable individual in the building along with instructions to collect a sample during a major odor incident.

Table 5
Building Inspection Checklist

Potential Problem	No Apparent Problem	
______	______	1. Lack of fresh air?
______	______	2. Inadequate air circulation?
______	______	3. Excessive cigarette smoke?
______	______	4. Air too dry during heating season?
______	______	5. Poorly vented heating equipment?
		(specify) ______
______	______	6. Pollution source near air intakes?
		(specify) ______
______	______	7. Mold growth in building?
______	______	8. Odor from new fimishings or materials?
		(specify) ______
______	______	9. Odor from chemical use? (paints, cleaners, pesticides, etc.)
		(specify) ______
______	______	10. Sewer odors?
______	______	11. Other unusual odors?
		(describe) ______
______	______	12. Deteriorated suspect asbestos materials?
______	______	13. Other unusual dust accumulation?
		(describe) ______
______	______	14. Excessive emissions from equipment? (printing, etc.)
		(specify) ______
______	______	15. Excessive exposure in special activity areas? (labs, shops, art rooms, etc.)
		(specify) ______
______	______	16. Infiltration from attached garage?
______	______	17. Other (describe) ______
		______

Sample duration should ideally be determined by the type of potential health problems involved. For example, short-term peak samples may best reflect the action of an eye irritant while long-term average levels may be critical for carcinogens. However, time constraints and equipment limitations often restrict complaint sampling to an instantaneous or short-term measurement. Where the amount and duration of sampling must be limited, consideration for representative conditions during the testing is especially important.

Interpretation of Results

Air sampling data should only be considered as an exposure estimate after fluctuating environmental and source factors have been taken into account. One method used to accomplish this is the adjustment of readings to levels which would be expected to occur at a standard condition (i.e., convert formaldehyde levels to 77°F). Another approach is to state that a reading only represents exposure at the moment of sampling and will vary under different conditions (for example, higher exposure is often likely when there is less ventilation or greater source activity).

When exposure estimates, occupant histories, and inspection results combine to create a fairly consistent picture of indoor air quality at a given location, an attempt can be made to draw specific conclusions. For instance where readings are low and there are no other indications of a source problem, negative findings can be stated. If the study has been limited in scope, it is important to emphasize potential limitations in any conclusions due to methodology.

In identifying the origin of an indoor air problem, source-related situations can usually be distinguished from those that are ventilation-related. In the former category, source emissions are excessive and must be directly controlled. In the latter, ventilation is inadequate and allows the accumulation of normal building contaminants.

Another distinction should be made between primary and secondary sources. Primary sources produce the original pollutant emissions. Secondary sources collect these contaminants for release at a later time (i.e., dust from an HVAC system or odor from a fabric).

Three basic approaches are available for evaluating exposure to indoor air pollutants. The first involves comparison with standards or, more commonly, guidelines to define relatively safe exposure levels for the general population. Such guidelines may be in the form of either allowable pollutant concentrations, product standards, work practices, or ventilation rates. Standards for exposure to pollutants at industrial or construction sites are generally not directly applicable to indoor air investigations but are sometimes reduced by a factor of 10 or more to account for continuous exposure to sensitive individuals.

The second method of evaluating exposure is a generalized risk assessment. This divides pollutant exposure into different ranges (background, low, moderate, and high) taking into account the incidence of various health problems. For example, a low level might be defined as one where only allergic individuals experience symptoms, or a high level designated when the expected cancer risk exceeds 1/10,000.

The final method involves a specific medical diagnosis. In this case, information on pollutant exposure is presented to a patient's physician, where it is evaluated in conjunction with a physical examination and medical history to determine if symptoms are exposure-related.

Whenever symptoms related to indoor air pollution are suspected, investigations should consider the possible explanations of hypersensitivity and mass hysteria. In the former case, a very small percentage of sensitized individuals exhibit symptoms at levels far below those affecting the normal population. A solution must often involve either complete elimination of the pollutants in question or relocating the individual. Mass hysteria and other psychological phenomena may explain some symptoms incorrectly attributed to indoor air pollution. These must be diagnosed with great caution and only after all other reasonable possibilities have been eliminated.

Where an indoor air pollution problem and its sources are positively identified, specific recommendations can be developed. However, some investigations result in the finding of more than one suspect source and no clear-cut abatement strategy. In this instance, a trial and error approach may be suggested, eliminating potential sources one at a time until symptoms or contaminant levels are controlled. Alternatively, general problem identification by the health department can be followed with more detailed testing by a specialist to develop an effective control program.

Recommendations for the control of indoor air pollution can often be implemented in a two phase approach: immediately available temporary measures and permanent measures (Table 6). Follow-up testing may be offered by the health department to evaluate the effectiveness of control measures. This can again be made dependent on the priority assigned to the situation and resources available.

Table 6
Control of Indoor Air Pollution

Temporary
- Isolate
- Evacuate
- Reschedule
- Ventilate
- Clean
- Cease operation

Permanent
- Seal
- Replace
- Increase ventilation
- Adjust equipment
- Filter

Discussion

The investigation of indoor air pollution complaints has emerged as an important new environmental health program area. Since resources for conducting such activities are restricted in most health departments, it is often necessary to limit investigations to only priority situations and utilize sampling strategies which are sufficient to identify only general problem areas.

While experienced sanitarians can be most effective in conducting indoor air screening investigations, the detailed investigations necessary for the development of complex abatement programs may not be feasible for many health departments. When necessary to resolve non-routine requests of this nature, supplemental assistance may be solicited from other organizations, both public and private. Such detailed studies may require multi-disciplinary, team effort.

Utilizing the systematic approach presented in this paper, many indoor air complaints can be successfully resolved without resorting to legal action. Even though few formal standards currently apply to the regulation of indoor air pollution, site-specific health department findings and recommendations tend to carry considerable weight in the settlement of multiple-party disputes involving such issues. Where a health department can document potentially harmful exposure and present the responsible party with practical suggestions regarding abatement, voluntary improvements in indoor air quality generally result.

Rabies Report Shows 1984 Cases Down

The Centers for Disease Control's Rabies Surveillance Annual Summary 1984, issued December 1985, shows rabies in wild animals in the United States totaled 5,174 cases, in domestic and farm animals 453 cases, and three human cases. The total of 5,630 cases in 1984 in the U.S. was down 4% from the previous year's 5,881 cases.

In Canada, of 1,699 reported cases, 1,365 were wild animals; 333 were domestic and farm animals, and one was human.

In Mexico, of 10,346 reported cases, 9,857 were domestic and farm animals; 431 were wild animals and 58 humans. The total represented an increase of 3,487 cases over 1983.

In the U.S., there was an increase of raccoon rabies cases in Pennsylvania and Maryland and a decline in Virginia, West Virginia and the District of Columbia, showing a northern movement of the epizootic. A study of rabies in skunks is being conducted in the states of Texas and New York.

Of the rabies in domestic and farm animals in the United States, cattle continued to be the predominant animal infected, followed by cats, which outnumbered dogs for the fourth consecutive year.

Canada reported a 40% reduction in cases of rabid domestic and farm animals; Mexico showed a marked increase in the number of reported rabid dogs, from 3,176 in 1983 to 9,274 in 1984.

Some Soils Filter Acid Precipitation

University of Wisconsin Soil Scientist, James Brockheim, reports on an Electric Power Research Institute funded study, saying that soils in northwestern Wisconsin are capable of neutralizing acidic precipitation before it reaches groundwater or seeps into lakes. Brockheim's research shows that rain is neutralized when it hits the leaves of trees and in percolating through the soil in the study area, it becomes nearly 100 times less acid than when it fell.

(14) HB519

Local part of radon study complete

by PHIL CARSON

A radon detection study of 21 Routt County homes has just been completed and results should be back to homeowners in two months, a local health official says.

According to Environmental Health Director Mike Zopf, the 21 homes were selected from a list of 65 county homes randomly selected by a computer.

Cannisters were placed in the study homes for 48 hours to register radon levels.

Those individuals whose homes were used in the study will get a response from the federal Environmental Protection Agency on the radon level in their homes. Zopf also hopes to receive some data on home-types and geologic conditions which might be conducive to unhealthy radon levels.

Radon gas occurs naturally due to the decomposition of uranium, which is found in different concentrations in various soil and rock types. If trapped inside a home, for instance, high concentrations of radon gas can cause lung cancer in certain people.

How big is the threat? Scientists estimate that 5-20,000 lung cancer deaths annually are attributable to radon gas. In comparison, the American Cancer Society projects 130,000 people died in 1986 from smoking.

An individual's risk of developing lung cancer from radon depends on the concentration level of the gas and the length of time that person is exposed to it.

Still, Zopf says, radon can be a health hazard and steps can be taken to reduce the risk.

The first step is testing your home. Reliable test kits are available to homeowners and approved laboratories can analyze the results. Zopf has available to homeowners a list of test kit manufacturers and labs. His office at the courthouse annex also carries two pamphlets: "A Citizen's Guide to Radon - What It Is and What To Do About It," and "Radon Reduction Methods - A Homeowner's Guide."

"I'd be glad to talk to anyone who would like to test their home," Zopf says.

ADV IN ANCHORAGE PAPER

(15) HB 519

Testimony of Phil Loudon, Nortech April 1988

Radon gas is being found in an ever widening arc that now incorporates the Chena flood plane, as well, as the Fairbanks hill sides. The only recognized health effect of exposure to high levels of radon gas is lung cancer, and like lung cancer, encountering radon is a very private matter for the majority of our clients. People do not enjoy talking about lung cancer, or radon gas, and seldom do they share their experience with others.

If we compare the health effects of radon gas to those of asbestos, we find a great disparity in the respective threat levels. While asbestosis is responsible for between 750 to 1,000 deaths each year, radon exposure is estimated to kill from 10,000 to 30,000 U.S. citizens annually.

Radon gas is a natural disaster, however, unlike a flood or earthquake, radon kills with a slow painful death. Fairbanks demands your attention and your compassion. It has been over one year since the Fairbanks radon problem was made public in Juneau. I urge you to make yourselves aware of the magnitude of our radon problem and the specific needs necessary to deal in a rational manner with this problem.

Specifically we ask for the following assistance:

1. A local, state supported calibration facility. The department of Geological and Geophysical Survey can serve in this capacity with minimum funding as they already have trained personel and a good portion of the necessary equipment. We recently experienced confusion over the accuracy of two different methods of radon testing. This confusion resulted in delays and misunderstanding that should never have happened, and would not, had a local radon gas standard been available by which these methods could be calibrated against.

2. We need a better understanding of local geological factors if, we are to know which soils and what areas are most at risk. Without this information new houses will possibly be built in high risk areas without the additional measures necessary to guarantee that radon accumulation will not be a problem.

3. Solutions for radon mitigation of cold climate buildings is in its infancy. Residential construction in the Fairbanks area in general, is out of necessity, years ahead of other "radon rich' communities regarding issues of quality construction, envelope air tightness, and thermal efficiency. Due to our unique climate and the above issues, solutions for high radon concentrations in Fairbanks homes is underdeveloped at best, and disastrous at the worst.

Please support HB 519 and 520, or their concepts in another bill as the need is known and the tip of the radon iceberg has been located in Fairbanks. Thank you for this opportunity to inform you of my experience on this very critical subject.

put w/ today's packet

APL 21 '88 15:02 LIO - FAIRBANKS

P.1

TELECOPY COVER SHEET
FAIRBANKS INFORMATION OFFICE
907-452-4448

TO: JNU LIO

FOR: Rep. Davis, Rep. Frank, Rep. Pourchot, Rep. Springer, Senators Coghill, Fahrenkamp + Fanning PHONE: ____

FROM: Phil Loudon PHONE: ____

INSTRUCTIONS: pls make a copy for each as noted

DATE/TIME SENT: 4/21 SENT BY: mgo

PLEASE ACK. RECEIPT: ____ HOLD FOR PICK-UP: ____

NUMBER OF PAGES: (1) (NOT COUNTING COVER SHEET)

PUBLIC OPINION MESSAGE

(16) HB 519

DEAR: REPRESENTATIVE SPRINGER

APR 22 1988

NAME: PHIL LOUDON
TITLE:
ADDRESS: 109 WATERLOO LANE
CITY: FAIRBANKS ZIP: 99712
PHONE: 451-8378
BILL NO:
SUBJECT: FAIRBANKS RADON GAS PROBLEM
MESSAGE: PLEASE GIVE CAREFUL CONSIDERATION TO FUNDING DGGS RADON GAS STUDY. I HAVE EXPERIENCED THE CONFUSION WITH SEVERAL OF MY NEIGHBORS OVER OUR EXTREME HIGH LEVEL OF RADON GAS. IF POSSIBILITIES OF LOW INTEREST LOANS EXIST, PLEASE GIVE YOUR SUPPORT TO THEM ALSO. THANK YOU. EOM-FZ-C

POMID: 07170616
DATE: 04/21/88
TIME: 17:06:16
LIONAME: FAIRBANKS LIO

COPIES:

REPRESENTATIVES	REPRESENTATIVES	SENATORS
DONLEY	ELLIS	COGHILL
GRUENBERG	HANLEY	FAHRENKAMP
HUDSON	KOPONEN	FANNING
PHILLIPS	ADAMS	HALFORD
BOYER	BROWN	KELLY
DAVIS	FRANK	STURGULEWSKI
GOLL	LARSON	SZYMANSKI
POURCHOT	RIEGER	ZHAROFF
SWACKHAMMER	WALLIS	BINKLEY
CATO	COLLINS	DUNCAN
HERRMANN	ZAWACKI	FISCHER
MILLER	MARTIN	HENSLEY
		UEHLING
		JONES
		JOSEPHSON
		KERTTULA