

# **Protocol for Conducting Radon and Radon Decay Product Measurements in Multi-family Buildings**

*for Resident Managers and Measurement Professionals*

**Working Draft 11/10/07**

**NOT FOR PUBLICATION**

**With Comments**

***SOME COMMITTEE DISCUSSION IS PROVIDED IN GREEN TEXT***

**AARST CONSORTIUM ON NATIONAL RADON STANDARDS**

**AARST MAMF (Draft September, 2007)**

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Doug Wall and Bill Levy provided data on upper floors. A Swedish protocol was distributed as food for thought on this issue.

## Foreword

This document is contains protocols and guidance designed to respond to the health threat of radon in dwellings in multi-family buildings.

**Comment:** Questions regarding organizational aspects of document sections should still be reviewed after completing substantive content resolves.

Radon has been determined to be the leading cause of lung cancer among nonsmokers in the United States. It is believed that most people receive their greatest exposure to radon in their home or dwelling. The U.S. EPA and the Surgeon General state that “Indoor radon is the second-leading cause of lung cancer [after cigarette smoking] in the United States and breathing it over prolonged periods can present a significant health risk to families all over the country.” (*Health Advisory, January 13, 2005*)

The United States Environmental Protection Agency (EPA) developed measurement guidelines in the *Home Buyer's and Seller's Guide to Radon* and the *Citizen's Guide to Radon*. These measurement strategies assess radon concentrations in homes for the purpose of determining the need for remedial action. The protocols and guidance herein include the best practices from those documents, additional technical descriptions of requirements and recommendations, and guidelines for the interpretation of measurement results.

~~The Stewart McKinney Amendments to the 1988 Indoor Radon Abatement Act require U.S. Housing and Urban Development (HUD) to develop an effective departmental policy for dealing with radon contamination using available guidelines and standards to ensure that occupants of housing subsidized by HUD are not exposed to hazardous concentrations of radon. At the request of Congress, the document “Radon Measurement in HUD Multi-family Buildings” was developed to enable HUD to comply with the requirements of the legislation. The document was completed during 1995 by the EPA for the HUD under interagency agreement DU1001920000053. The American Association of Radon Scientists and Technologists document “AARST Interim Protocols for Conducting Radon Measurements in Multi-Family Buildings (MAMF October, 2004)” built on that document and added consortium review and revision. The document herein reflects a significant degree of continued review and amendment.~~

**Comment:** Is it important to provide EPA and HUD history (at this juncture for an ANSI/AARST document)?

~~This document shall be followed unless superseded by federal regulations or regulations of the state or locale in which the radon test is performed. If the minimum requirements of this document exceed local, state, or federal requirements for the locale in which the radon test is performed, then this document’s minimum requirements should be followed. This document is intended to aid professionals, multi-family building residents, state radiation control programs or anyone involved in the measurement of radon in multi-family buildings to assess the need for mitigation and to provide radon risk information for the benefit of occupants. These guidelines can be adopted as part of a state program or can be provided as recommendations by states to testing companies and interested individuals. AARST recommends that any authority or jurisdiction that is considering substantial modifications of this document as a condition of its use seek consensus within the consortium process at AARST Consortium on National Radon Standards prior to adopting a modified version. This provides the jurisdiction with a higher degree of expertise and an opportunity for the National Standards consortium to update its document if appropriate.~~

**Deleted:** shall

~~Mark Veckman comment: This document is not a regulation. AARST should recommend that "the more stringent of this document or state or federal regulations should be followed." This language is consistent with lead and asbestos regs.~~

**Comment:** The committee believes the substance of this comment is met in the wording given. Although the lead and asbestos regs are useful guides for wording, radon is significantly different from these contaminants and must have its own treatment.

Bill Levy concurs with Mark Veckman here.

Bob Stilwell: Forward: not needed. Some info could be included in a Purpose statement.

Editor Note: **The text above to be reviewed for content and need. Structural review should also occur later.**

**Comment:** The committee notes that this document serves multiple purposes including educating property managers to the radon risk and is remedy. The forward is consistent with other radon documents in this series of protocols.

## Consensus Process

The consortium processes developed for the AARST Consortium on National Radon Standards as accredited to meet essential requirements for American National Standards by the American National Standards Institute (ANSI) have approved this document. This Standard is to be reviewed and updated every five years at a minimum.

Bob Stilwell: Consensus Process: Not needed. The ANSI label will show that.

## Disclaimer

The AARST Consortium on National Radon Standards strives to provide accurate, complete, and useful information. The AARST Consortium on National Radon Standards will make every effort to correct errors brought to its attention. However, neither the AARST Consortium on National Radon Standards, its sponsoring organization the American Association of Radon Scientists and Technologists nor any person contributing to the preparation of this document makes any warranty, express or implied, with respect to the usefulness or effectiveness of any information, method, or process disclosed in this material. Nor does AARST or the AARST Consortium on National Radon Standards assume any liability for the use of, or for damages arising from the use of, any information, method, or process disclosed in this document. Mention of firms, trade names, or commercial products in this document does not constitute endorsement or recommendation for use. It is the sole responsibility of radon practitioners using this standard to stay current with changes to the standard and to comply with local, state and federal codes and laws relating to their practice.

**Comment:** Some of the information is required per bylaws and ANSI. Example: Inclusion of contact info and statements for openness to future comments are to be added. The committee believes the reiteration of the credentials of the document are worth repeating especially for those who are less aware of the ANSI process.

## THIS DOCUMENT INCLUDES

Bob Stilwell: Redundant. There is a table of contents.

**1) Introduction to Radon:** Background information on radon gas including physical characteristics, the health risk associated with radon, and how radon enters buildings.

**2) Introductory Guidance for Residence Managers:** An informational section providing guidance with a focus on planning a radon testing program.

**3) Protocol for Conducting Radon and Radon Decay Product (Radon Progeny?) Measurements in Multi-family Buildings:** Specific testing protocols that include instructions on where to test, strategies for conducting reliable tests, reporting and associated quality control measures.

Andy George: Insertion or replacement (Radon Progeny)

**Appendices A through F:** Information provided regarding devices, quality control, terms, special situations and step-by-step procedures.

**Exhibits 1-7:** Examples of test locations, paperwork and notices to residents.

(editorial note: confirm structure at publication)

**Comment:** This may be appropriate. Economical editing is always a benefit unless meaning or functionality is lost.

**Comment:** The committee questions the need for the more technical term.

**Comment:** It has fewer words and therefore easier to speak. The question probably should be, "which is easier to grasp?" If found desired, it would need to change for every location in the document (including title).

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(editorial note: Amend as per structure at publication)

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Editorial note: A list of referenced documents is yet to be included.

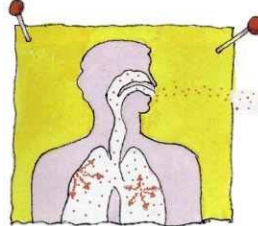
## Section I: Introduction to Radon

Bob Stilwell: This section should be removed. US EPA has a Citizen's Guide to cover this information, and many states have their own state-specific radon overview document.

### A. Radon Facts

Radon is a naturally-occurring radioactive gas. It comes from the breakdown (decay) of uranium that is found in soil, rock and ground water all over the United States. Radon is a component of the air in soil that enters buildings through cracks and other pathways in the foundation. Eventually, it decays into radioactive particles (decay products) that can become trapped in your lungs when you inhale. As these particles decay in turn, they release small bursts of radiation. This radiation can damage lung tissue and lead to lung cancer over the course of your lifetime. EPA studies have found that radon concentrations in outdoor air average about 0.4 pCi/L (picocuries per liter) of air. However, radon and its decay products can reach much higher concentrations inside a building.

Radon gas is colorless, odorless, and tasteless. The only way to know whether elevated concentrations of radon are present in any building is to test.



**Comment:** Originally provided in EPA's draft in order to establish an immediate overview of the topic. As pointed out in a later comment, the Citizen's Guide differs with this protocol in some aspects. As non-professionals will be making decisions about provisions within this document, it is well to keep basic information immediately available.

### B. Radon's Health Effects

Radon is a known **human carcinogen**. Prolonged exposure to elevated radon concentrations causes an increased **risk of lung cancer**. Like other environmental pollutants, there is some uncertainty about the magnitude of radon health risks. EPA estimates that radon may cause **15,000 to 21,000 lung cancer deaths** in the U.S. each year. (AG): (with an uncertainty of 7,000 to 30,000) The **U.S. Surgeon General** has warned that radon is the **second-leading cause of lung cancer deaths** in the U.S. Only smoking causes more lung cancer deaths.

Not everyone who breathes radon decay products will develop lung cancer. An individual's risk of getting lung cancer from radon depends mostly on three factors: the **concentration of radon**, the duration of **exposure**, and the individual's **smoking habits**.

Mark Veckman: ..... depends mostly on ~~three~~ **four** factors: the concentration of radon, the duration of exposure, ~~and the individual's smoking habits~~ **personal susceptibility, and exposure to other carcinogens such as cigarette smoke and asbestos.**

Risk increases as an individual is exposed to higher concentrations of radon over a longer period of time. Smoking combined with radon is an especially serious health risk. The risk of dying from lung cancer caused by radon is much greater for smokers than it is for non-smokers. Mark Veckman: (same holds true with asbestos)

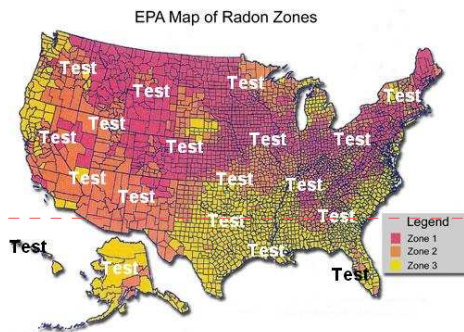
**Comment:** Since the range of deaths can be confusing, the committee believes that the simplification is wiser.

**Comment:** The committee believes that because the issue of genetics is so little understood in the cancer world, a reference directly to that possible cofounder adds confusion to the issues we are able to control.

### C. Radon Exposure

Because many people spend much of their time at home, the home is likely to be the most significant source of radon exposure. According to EPA, nearly 1 out of every 15 homes in the United States is estimated to have elevated radon concentrations.

Mark Veckman comment: Above what background level - elevated above 4? Bill Levy: again the ""should"" applies to



**Comment:** Could add: estimated to have radon concentrations that exceed the EPA action level.

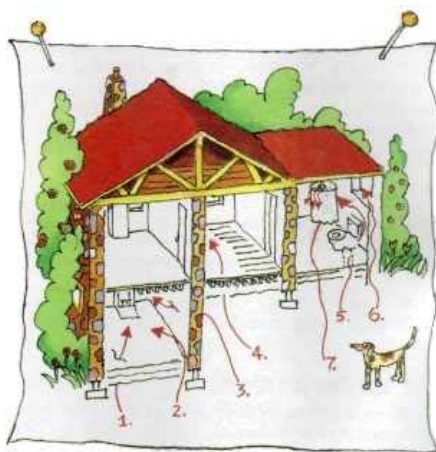
reduction below 4.0 pCi/l and ""may"" applies to 3.9 to 2.0 pCi/l. Elevated concentrations of radon have been found in homes and buildings in every state. While elevated radon may be more common in some areas, any building can have a problem. EPA recommends that ALL buildings should be tested regardless of the area of the country and that maps such as this should not be used to determine whether to test. More specific information on the likelihood of elevated radon in your area can frequently be found at your state or county radon offices. (See APPENDIX B.) (For clarification of the use of the EPA zone map, see APPENDIX G.)  
 (editorial note: confirm App# at publication)

**Comment:** The committee believes that, as no recommendations have been made to this point, the issue of shoulds and mays is premature. This section is informational only.

The concentration of radon in the air within a building should be reduced below EPA's radon action level of 4 pCi/L. Mark Veckman: should be reduced to the lowest practicable level, and below EPA's radon action level of 4 pCi/L. Any radon exposure creates some risk; no concentration of radon is safe. Even radon concentrations below 4 pCi/L pose some risk, and the risk of lung cancer can be reduced by lowering indoor radon concentrations. This action level is based largely on the ability of current technologies consistently to reduce radon concentrations below 4 pCi/L. Depending on the building characteristics, radon concentrations in some buildings can be reduced well below 4 pCi/L. In others, reducing radon concentrations to below 4 pCi/L may be more difficult.

**Comment:** Could add: to the lowest practical concentration

**Comment:** The committee believes the next 2 sentences address this comment.



### D. Radon Entry into Buildings

Radon in soil gas is the main source of radon problems. Pathways for radon to enter a building include cracks in the slabs and walls, the expansion joints between floor and walls, porous concrete block walls, open sump pits, and openings around utility penetrations. Some buildings have other pathways for radon to enter a building such as sub-slab utility tunnels and heating, ventilating and air conditioning (HVAC) ducts.

Sometimes radon enters the building through well water. For more information on radon in drinking water you may contact your state radon office (APPENDIX B), EPA's Drinking Water Hotline

(800) 426-4791 or visit <http://www.epa.gov/safewater/radon.html>.

Andy George: Missing brief paragraph regarding Radon and Water. Some multi-family buildings may get their water from well water. When do you test for radon in water?

**Comment:** Suggestion for additional paragraph: Radon gas may also enter buildings in well water. If a building is on a well, radon from water use may raise the concentrations above the action level. Well water should be tested at the same time as air testing, especially if the building is vacant or there is no water use in the testing area. Radon in water testing is covered in a separate document and is beyond the scope of this testing protocol.

**Comment:** Water: Could instead be a consideration for testing as a diagnostic procedure subsequent to discovery of high concentrations?

**Comment:** Could add: Though radon is usually entering a building as part of soil air, .... Bills sentence

A small number of buildings may have building materials that contain uranium and radium that can produce radon. Bill Levy (Replace previous line): A number of buildings have been found that have elevated indoor radon levels caused in whole or partially by radon emanation from some of the building materials.

A radon professional can help you evaluate this possibility.

#### Factors Influencing Radon Entry

Many factors contribute to the entry of radon gas into buildings. As a result, resident managers cannot know without testing if elevated concentrations of radon are present in their building



complex. The following factors determine why some buildings have elevated radon concentrations and others do not:

- ❖ The concentration of radon in the soil gas (**source strength**);
- ❖ The permeability of the soil or sub-surface geology (**gas mobility**) under the building;
- ❖ The **structure and construction** of a building; and,
- ❖ The type, design, operation, and maintenance of the heating, ventilating and air-conditioning (**HVAC**) system.

**Source strength:** The radon concentration in soil gas can vary greatly from building to building. It can even vary greatly under different parts of the same building.

**Gas mobility:** Certain geological features beneath a building, such as cracks, fissures, or solution cavities, can serve as a direct connection between the radon-producing minerals and the building's foundation. Such a direct connection can cause one unit of a building to have a radon concentration significantly higher than other units in the area. The permeability of the soil under a building, along with the differences between the air pressure inside a building and the air pressure under a building's foundation influence the rate at which radon enters a building. For example, if the air pressure in the building is greater than the air pressure under the building's foundation, radon should not enter through the openings of a building's foundation. If the air pressure in the building is less than the air pressure under the building's foundation, radon in the soil gas will move through any openings in the building's foundation [inside the home](#). (AG)

**Structure and construction:** Any building design can have a radon problem. Without testing, you cannot know if elevated concentrations of radon are present.

**HVAC:** Depending on their design and operation, HVAC systems can influence radon concentrations in buildings:

- ❖ Poor ventilation allows radon gas concentration to build up.
- ❖ Increasing ventilation helps dilute indoor radon concentrations with outdoor air, however, radon's source strength can overwhelm the practical limits of increasing ventilation.
- ❖ Depressurized buildings draw radon inside.
- ❖ Pressurizing a building helps keep radon out.

The frequency and thoroughness of HVAC maintenance can sometimes play an important role. For example, air intake filters that are not periodically cleaned and changed can significantly reduce the amount of outdoor air ventilating the indoor air environment. An understanding of the design, operation, and maintenance of a building's HVAC system and how it influences indoor air conditions is helpful for understanding and managing a radon problem, as well as many other indoor air quality concerns in buildings. However, since HVAC systems are only one of many factors that affect radon concentrations in a building, HVAC system modifications alone are often not an effective radon mitigation strategy.

## **E. Contacts for Additional Information**

( editorial note: confirm at publication )

- EPA Website <http://www.epa.gov/iaq/radon>
- State radon offices: <http://www.epa.gov/iaq/whereyoulive.html>
- Indian Nation radon offices: <http://www.epa.gov/epahome/tribal.htm>
- Regional EPA offices: <http://www.epa.gov/epahome/locate2.htm>
- The National Radon Safety Board (NRSB) - Radon Proficiency Program:  
[www.nrsb.org](http://www.nrsb.org) (AG)
- The NEHA (National Environmental Health Association) National Radon Proficiency Program: [www.neha-nrpp.org](http://www.neha-nrpp.org)



## SECTION II: INTRODUCTORY GUIDANCE FOR RESIDENCE MANAGERS

### A. Introduction

The purpose of testing is to identify locations that have elevated radon concentrations and to determine if radon mitigation is necessary to protect current or future occupants.

### Planning

Planning to test your building complex ~~(Mark Veckman: Planning to test your building(s) complex)~~ for radon requires a basic understanding of the radon testing process and the steps that are necessary to ensure your radon test results are reliable. Specifically, to plan for radon testing, you will need to:

**Comment:** The committee does not believe there is a significant change in meaning in these versions.

- ❖ Become familiar with testing methods and building conditions required to perform reliable radon tests;
- ❖ Determine an appropriate and practical testing strategy. Review logistics and estimate the number of detectors to aid in evaluating costs and competitive bids from companies providing radon testing services;
- ❖ Communicate information to your residents about your radon testing activities;
- ❖ Become familiar with guidance for when radon reduction is recommended.

A responsible and reliable plan for radon measurement requires technical knowledge, attention to detail, and planning. **You should use a trained and certified or state-regulated radon measurement contractor.** (See below for information on finding a qualified contractor for your area.) A qualified contractor can help assess the nature of your building complex and help you choose a responsible and reliable measurement plan.

Bob Stilwell: A. Note for clarification- Maine does not certify radon professionals, and does not require certification. We register, but require the same minimum training (for radon air work, more strict for radon water) as the certifying bodies. Telling a residence manager in Maine that they must use a certified contractor will put them in a bind. I suggest using the same language as used elsewhere to denote the required use of state-regulated individuals/companies.

**See APPENDIX F for a step-by-step checklist for testing a multi-family residential building for radon.**

(editorial note: confirm App# at publication)

### B. Communicating to Residents Prior to Testing

It is important to notify and inform residents prior to testing about what to expect during the testing process. Plan to:

- ❖ Distribute an appropriate *notice of inspection (for radon testing)* that provides the likely placement and retrieval dates and required building conditions prior to and during the

test. The notice should stress the importance of providing access to test locations and maintaining proper test conditions. Include advice that interfering with the test device or house conditions can invalidate the test results. It should also stress that the test is being performed to help ensure the occupants' safety.

- ❖ Inform residents that test devices are not dangerous in any way and that a sample test device is available if residents wish to see the device.
- ❖ Inform residents when test results might be available and that copies of EPA's current *A Citizen's Guide to Radon* or state-approved radon documents are available upon request to residents who want additional information on radon. For copies of these guides, contact your State Radon Office.

**Comment:** Good suggestion

**Deleted:** this

**Deleted:** or EPA regional office

Bob Stilwell: Why specify only the Citizens Guide? As noted above, some states have their own documents. Maine does not provide the EPA Citizens Guide, and recommends against its distribution in Maine.

Andy George: recommended "current" above.

Keven Stewart Comment: I observe that EPA's *Citizen's Guide to Radon* (CGR) includes language not designed for Multi-Family Buildings. Possible confusion could result from citing this document. Nevertheless, that deficiency notwithstanding, you may wish to add the language such as: "For an electronic version of this guide, visit [www.epa.gov/radon/pubs/citguide.html](http://www.epa.gov/radon/pubs/citguide.html)."

**Comment:** In response to Bob Stilwell's concern, the committee did not direct people to the website, but to the state office to properly direct the inquiry.

➤ Should we add: State radon offices:  
- <http://www.epa.gov/iaq/wherelive.html>

See Exhibits 6 and 7 for a sample notification forms. (editorial note: confirm numbers at publication)

### C. Selecting Radon Service Contractors

As with other activities that require contracted services, your goal is to select a contractor who will provide services using reliable techniques at a reasonable cost.

When seeking radon services, request bids from contractors who are state licensed (where applicable) or certified by either the National Radon Proficiency Program (NEHA-NRPP) or the National Radon Safety Board (NRSB).

Contact your State Radon Office or EPA Regional Office (APPENDICES B and C) for a *list of licensed or certified contractors*. Listings for certified contractors can also be found at [www.neha-nrpp.org](http://www.neha-nrpp.org) or [www.nrsb.org](http://www.nrsb.org). (For more information on private radon proficiency programs, visit [www.epa.gov/radon/proficiency.html](http://www.epa.gov/radon/proficiency.html)).

*Individuals placing and retrieving detectors should have an identification card or letter verifying their participation in State, NEHA-NRPP or NRSB Radon Proficiency Programs.* *Mark Veckman: Be sure this information is included in any report you receive.*

**Deleted:** RPP

**Comment:** The report information is included in a later section.

Bob Stilwell: Maine issues wallet ID cards to regulated individuals, not letters. Remove RPP before 'identification card' and this will be OK.

**Comment:** Agreed; done

### D. Role of Maintenance Personnel

Because maintenance personnel frequently have knowledge of the building and the occupants, they can play a key role during four important stages of radon testing: *planning*,

*scheduling, placing detectors and retrieving detectors.* By providing access into residences and supplying floor plans when available, the maintenance personnel can help the measurement service to quickly identify appropriate testing locations, plan testing strategy, and place and retrieve detectors within a building complex.

Committee discussion: While the document’s jurisdiction does not extend to compelling certification of testing personnel (in the manner required by law such as in Illinois), the text seeks to make the point regarding the value of trained and certified technicians. A training course for maintenance personnel to perform their own testing was a suggestion.

### E. Documenting the Testing Program

A record of the testing program should be maintained by the client for future reference. **Mark Veckman:** Testing reports should be kept for as long as the data are relied on by the Owner. This record should contain the following information:

**Comment:** The committee does not believe the statement significantly changes the meaning. Retaining a history has value regardless if there is any subjective concern over reliability.

- ❖ A copy of the final report submitted by the measurement service that conducted the tests and the measurement service’s statement outlining any recommendations concerning retesting or mitigation.
- ❖ All correspondence between you and the measurement service.

SECTION III describes the documentation that is appropriate for the measurement service testing your building. (editorial note: confirm Structure at publication)

### F. When to Test

Short-term radon tests (tests lasting just a few days) require minimizing air exchange into and out of a building: closed-building conditions. For testing programs where the occupants may not be active participants in the testing process, actions must be considered to help ensure closed-building conditions for short term tests.

**Keven Stewart Comment:** The parenthetical definition of short-term radon tests as “tests lasting just a few days” is different than that provided in CGR and Section III. 4.1.1. Please consider harmonizing language.

**Comment:** The committee believes these technicalities are addressed in the protocol section and providing more detail can detract from an otherwise general introductory message.

Choosing a time of year when required closed-building conditions are a normal condition will aid in ensuring reliable measurements. For example: In cooler climates it is recommended that you schedule short-term testing during the colder months of the year (i.e. heating seasons such as October through March).

- *Real-Estate Transactions:* Testing for radon prior to every transfer of a residential dwelling to a new owner is recommended. Even if a building has been tested before, additional measurements help to ensure that previous tests were performed reliably, without interference, and that conditions, including structure and ventilation, have not changed.
- *Non-Real-Estate Testing:* Although radon testing can begin at any time during the year, consider conducting measurements during a time of year when required closed-building conditions are the normal conditions. Contact your State Radon Office for information on seasonal variations.

**Deleted:** the new owner may use the building differently. **Mark Veckman:** ~~the new owner may use the building differently.~~ A

**Deleted:** ~~including changes to the structure, ventilation and alterations to ventilation systems.~~ **Andy George (paraphrased suggestion)**

**G. Retesting** *Keven Stewart Comment: I note that Part “H” immediately follows Part “F” and that Part “H” is followed by two Parts both labeled “G”. This needs repair.*

**Deleted:** H

**Comment:** corrected

Many factors can cause indoor radon concentrations in your building to change over time. New openings to the earth may develop due to settling/deterioration of the building structure and/or construction or renovation work including energy upgrades. Pressure relationships can change if the ventilation system becomes unbalanced or HVAC equipment is added, removed, or replaced. These changes may produce elevated radon concentrations in rooms in which the initial radon test results were below 4 pCi/L. Therefore, even if initial radon tests showed low concentrations, **retesting** the building every five years is recommended.

**Deleted:** to ensure that radon problems have not developed since the initial test, or that initial readings were representative of longer term radon concentrations.

Committee discussion item: **The retest recommendation each 5 years** was derived during the “Interim” version of this document as seeking a reasonable time for a new recommendation: That is, retest again even if readings are low. Multi-family buildings may not be sold as often as homes and a time period was sought so as to be reasonable. Committee members feel such a recommendation is warranted and are seeking precedence or other validation for the specific time period. **Input is welcome.**

*Mark Veckman comment: Might temper this with Radon Zone data. In Washington, DC for example, I have been testing for 19 years and have no results at or above 4.0.*

**Comment:** The committee is unclear on how Zone information might inform the 5-year recommendation.

*Andy George recommends deletion of confusing portion of last sentence: “ ... to ensure that radon problems have not developed since the initial test, or that initial readings were representative of longer term radon concentrations.”*

**Comment:** done

*Bob Stilwell: Retesting period of 5 years has been used by Maine for several years, as guidance for when a new test should be done on real estate or for confirmed low levels. There is no technical basis for this, but the half-century long experience of the Maine radon effort (in water) has shown this to be reasonable. Radon air should be similar.*

When tests indicate low concentrations, consider confirming low results by repeating tests during different seasons and weather conditions to account for possible seasonal variations.

*Keven Stewart Comment (here and for committee discussion: - Remember: Science is showing that the variability in building Rn over the course of a year is great enough that practically any simultaneous battery of shorter short-term tests showing “acceptable” results is automatically suspect.*

- Suggested language: “When tests indicate low concentrations, **consider confirming...**”

• Substantiating Statements: Studies by Field, McNees, Steck, et al.

**Comment:** There was lengthy discussion in the committee with regard to this issue and widely differing positions were found. Practical considerations may be different for a large complex than for that of a single family home. The committee believes that, as this data is in the process of being collected and is more evident in some parts of the country, the wording is sufficient for this version.

In addition, radon concentrations should be retested when the following occur:

- A new addition is added,
- An alteration is made that could change ventilation, including changes to the heating-cooling systems,
- Significant changes to the slab or foundation such as major cracks or penetrations that occur due to natural settling, water proofing or groundwater control efforts, and the like,
- Significant construction blasting or earthquakes occur nearby,
- An installed mitigation system is altered, modified or repaired,
- A ground contact area that was not previously tested is occupied.

Retests after mitigation: AG: replace title with: **Post-Mitigation Testing** To provide an initial measure of radon reduction system effectiveness, a short-term measurement must be performed no sooner than 24 hours after a radon reduction system is operational and within 30 days after installation of system. Additional testing should be performed in the areas that were mitigated at least every two years to ensure that the system remains effective and may be performed as often as desired.

**Comment:** Since this section is titled Retesting, the committee believes this is an appropriate subtitle.

Mark Veckman comment: two years seems a bit restrictive. If an O&M plan is in place to visually check gauges, then every 5 years seems more reasonable. This is consistent with G below.  
Bob Stilwell: While it is safe to agree with EPA on the two year re-test cycle for mitigated structures, this will be a considerable expense for a mid- to large- sized facility. After confirmation of low levels, it is as reasonable to consider a five year cycle (assuming-dangerous thing to do- that the system indicator(s) is/are regularly checked) as it is to consider a five year cycle for low initial tests.

**Comment:** As this guidance from the EPA are fairly clear, the committee believes mitigated areas should be tested every 2 years.

The test must be made in the same location as the pre-mitigation test location or the lowest livable area. A post-mitigation test must also be made in the lowest livable area above any crawl space that is isolated. It is recommended that additional measurements be made in the lowest livable area above each other unique structural area.

Andy George: Recommends deleting “or the lowest livable area” from first sentence. Recommends deleting last sentence “It is recommended that additional measurements be made in the lowest livable area above each other unique structural area.”

**Comment:** The committee believes that this recommendation applies only to mitigated areas and not the entire building.

## **H. Actions Recommended Based Upon Test Results**

**Deleted: G**

### **4.0 pCi/L or greater.**

If testing indicates radon concentrations equal to or greater than 4 pCi/L in any apartment or office area, you should reduce the radon to below 4 pCi/L. The higher the radon concentration, the more quickly action should be taken to reduce the concentrations.

### **Below 4 pCi/L.**

If test results are below 4.0 pCi/L, confirm the low results by testing again, at least every five years and whenever significant changes to the building’s structure or mechanical systems occur. **See Section H above for more information..**

You may also consider performing a long-term test or several short-term tests in different seasons of the year to verify average concentrations. The closer a long-term measurement is to 365 days, the more representative it will be of annual average radon concentrations. Such considerations may be especially important in regions where geology may cause wide variations in radon concentrations. Andy George: Recommends deleting this last sentence citing it as “speculation”.

**Comment:** Maybe add: “or other factors”

**Comment:** The committee voted to include this sentence as part of the data being recorded in several studies.

### **Between 2.0 and 3.9 pCi/L**

If the test results are between 2.0 and 3.9 pCi/L, you should consider taking measures to reduce the concentrations in the building. (Note that reducing and accurately confirming radon concentrations of about 2.0 pCi/L or below may be difficult.) Andy George: Recommends deleting “or impossible” from the last sentence.

**Deleted:** or impossible to achieve

**Comment:** done

### **100 pCi/L or greater**

Call the State Radon Office or Department of Health (Andy George) for immediate protective action recommendations if radon test results approach 100 pCi/L or greater.

**Comment:** accepted

**For Non-Residential Rooms/Enclosed Spaces:** Reduce the radon concentration

1. if testing indicates radon concentrations equal to or greater than 4 pCi/l in these locations (See Section III for complete testing protocol)  
**and**
2. if either (a) these areas are occupiable with little or no modification, or (b) these areas serve as a source of radon into apartments and offices of upper story floors that have radon concentrations equal to or greater than 4 pCi/l.

Committee discussions: REFER TO AN APPENDIX or give example

Keven Stewart Comment for above:

- Clauses of this Part do not take into account the language of Section III. 4., which outlines a testing protocol that recognizes the appropriateness of follow-up testing. The reader should not be led to believe routine or preferred protocol to be that the initial phase of short-term testing is sufficient to determine if mitigation is recommended.
- Consider adding language at the appropriate clauses recognizing the expectation that initial testing will preferentially have been confirmed by follow-up testing:
  - o Suggestion: “If testing according to the protocol indicates...”
  - o Suggestion: “If initial test results are below 4.0 pCi/L...”
  - o Suggestion: “If the test results according to the protocol are between 2.0 and 3.9 pCi/L...”
  - o Suggestion: “1. if testing according to the protocol indicates radon concentrations equal to or greater than 4 pCi/L...” [Note “pCi/L” form.]

**Comment:** The committee observes: There are a variety of test options in Section III and some have long been deemed to be acceptable for determining a need for mitigation without follow-up testing. These options introduce controls for a single test phase that might be used when single test devices are deployed. The Extended option clearly requires follow-up tests.

**Comment:** The committee observes that people might reach the conclusion that concentrations are usually less than 4 based upon retests or even multiple retests.

**Comment:** See Committees referral note

**How quickly** to begin the mitigation process will depend on the radon concentration detected. AG: the radon concentration ~~detected~~ measured. Elevated radon concentrations of more than twice the action level (or more than 8 pCi/L) demand a quicker response.

**Comment:** The committee did not see the significance of this change.

Keven Stewart: The language “demand a quicker response” is a blend of mandate and vagueness. Is there any way to communicate to the residence manager a better idea of the relative urgency with which mitigation should be pursued according to the confirmed radon results? The manager may not have a frame of reference to help him or her understand the context. What is “quick”? What is “quicker”? Perhaps a small table (4-8, 8-20, 20-100, 100 and above) could help the manager assign some broadly specific level of urgency (i.e., “within approximately” so many days, weeks, months...) to how quickly mitigation steps should be undertaken.

**Comment:** The text is based upon current EPA guidance. It was found years ago when EPA tried such breakouts (e.g. action within a few years for tests under 20), people never took action. The committee feels concurring with current EPA guidance to be the most responsible course of action.

## I. How to Mitigate

To successfully lower radon concentrations, conditions in the entire building must be evaluated. Reducing radon concentrations requires *diagnostics and mitigation*.

**Deleted: G**

- ❖ Diagnostics may include evaluation of radon entry points, air pressure relationships within and under a building and other factors. Diagnostics are often needed to identify the appropriate radon reduction technique and design.
- ❖ Mitigation is the design and implementation of a radon reduction system.

**You should use a contractor who is trained and certified to fix radon problems.** A qualified contractor can investigate a radon problem in your building and help you choose the right treatment method. Lowering high radon concentrations requires technical knowledge and special skills.

If you are considering fixing your building’s radon problem yourself, first contact your state radon office for guidance and assistance.

Keven Stewart: Not the best grammar, but a suggestion to add to the last sentence: “To identify trained and certified contractors, or if ~~H~~ you are considering fixing your building’s radon problem yourself...”

**Comment:** The committee believes this suggested guidance has been delivered in other places.

Bob Lewis comment: Should there be some language to qualify the “qualified contractor”? In particular, should there be some reference to selecting a contractor with at least some experience in dealing with large buildings?

**Comment:** The committee believes that, as this is a measurement protocol document, a foray into the qualifications of a mitigator were beyond its scope

Bob Stilwell: As probably noted by many others, there are two 'G's', and H prints out before either G. The 1st G should be moved before H, the 2nd G should become I.

**Comment:** Done



## Section III:



# Protocol for Conducting Radon and Radon Decay Measurements in Multifamily Buildings

## 1.0 Purpose and Scope

- 1.1 Purpose: The purpose of performing radon measurements is to identify locations that have elevated radon concentrations and to determine if radon mitigation is necessary in order to protect current or future occupants. The purpose of test protocols is to help achieve reliable radon measurements.

Andy George: Recommends deleting "in order to protect current or future occupants."

- 1.2 Scope: These protocols address measuring radon concentrations in Multi-family buildings comprised of more than three attached dwellings. When testing single-family residences or buildings comprised of three or less attached dwellings, see *Protocols For Radon Measurements In Homes (AARST- MAH September 2005)*.

Mark Veckman comment: generally multifamily is 4 or more dwellings. 4 is consistent with lead regulations. The terminology "4 or more" is also consistent with the way this is generally expressed. More than 3 is not used.

Bob Stilwell: The AARST Protocols for Radon Measurements In Homes are not a true consensus document (no ANSI 'stamp of approval'), so you should also mention other protocols, particularly government-issued ones.

- 1.3 Limitations: Suggested best practices to help ensure testing quality have been included, however, Bob Stilwell: I do not understand how suggested best practices are a limitation.

1.3.1 This document is not intended to address all detailed technical aspects of measurement device technology or quality assurance.

1.3.2 HVAC System: This testing protocol is primarily designed for multi-family housing with ducted, constant-volume, forced-air systems with a centralized return (i.e. each unit has its own air handler as typically seen in single detached housing). Other types of heating and air-conditioning (HAC) systems can cause significant room-to-room variations in the radon concentration and an adjustment to the strategy and number of rooms tested should be considered (see 3.5 below). (editorial note: confirm Structure at publication)

**Comment:** The committee believes the radon health message needs to be reiterated throughout the document

**Comment:** Your comment invoked further research. The definition of a multifamily house varies by organization. EPA has used only "low rise" or "residential" type descriptions. A multifamily home is considered by NAHB and in literal interpretation as a building containing two or more units (NAHB.com, 2002). We believe "more than three came from prior federal or a state's text. Most codes define it as more than two dwelling units. Congress defines it as "any project with four or more units" (www.fairhousing.vipnet.org). This definition is used for legislative and regulatory purposes in enforcing requirements for multifamily design. HUD released a study defining a multifamily mortgage as a loan secured by a property with five or more residential units (Segal and Szymanoski, 1998).

A consideration to Congress 4 unit text or HUD's 5 unit text might apply to more markets.  
I note: Condominium ownership limitations are not addressed herein.  
I note all references use "Multifamily" rather than "Multi-family".

**Comment:** Gary spoke with Bob. The Consortium bylaws were based upon ANSI essential requirements from the Consortium's inception. Changes that were made in the process of ANSI accreditation were primarily for clarity. The minutes from all discussions and voting are publicly available on the Consortium Bulletin Board and can be viewed to verify consensus. They are consensus documents in every sense of the word. Still the committee may consider adding or replacing with EPA protocols.

**Comment:** This wording will hopefully respond to this comment

Mark Veckman comment: A lot of older buildings and complexes have a central boiler with radiator heat. Not much variation room to room.

Bob Stilwell: Why isn't there guidance for other types of HVAC systems? They are generally the ones that need guidance the most.

**Comment:** Addressing both commenters: Text in this location is to specifically point out that complex HVAC systems may exist and can affect the test strategy. The committee gave lengthy consideration to many types of HVAC systems found in larger building. The possible configurations are endless. They attempted to address these major questions for various systems later in this section. Additional specific guidelines or directions for cautionary action will be welcomed.

- 1.3.3 Radon Decay Products: Due to difficulties establishing appropriate controlled conditions and other related concerns, the consensus of stakeholders found that radon decay product measurements require additional steps to create the conditions in residences that would allow them to be used to make radon mitigation decisions. Therefore, the use of working level monitors and any conversions between pCi/L and WL will be subject to the conditions described in Appendix B (editorial note: confirm Structure at publication)

Mark Veckman comment: Awkward section. Most building Owners will not relate to this at all.

Bob Stilwell: I suggest including a statement such as: "Due to the difficulties with radon decay product measurements (WL measurements) discussed in this section, conducting WL measurements is discouraged at this time."

**Comment:** This discussion was debated at length in the Residential protocol discussions. The consensus was to simply state the document does not support WL monitor use at this time. If problems that have been witnessed or expressed can be reconciled in text to accommodate responsible use to the committee's satisfaction, they can be included in the future. These problems may or may not be reconcilable. The committee believes care must be taken to encourage input from professionals in order to are create, publicly review as establish appropriate testing protocols for WL, if possible.

- 1.3.4 Other special considerations. See Appendix C for discussions of testing in karst regions, differing building construction styles, radon emanation from building materials, and other circumstances that may require additional steps in radon testing protocols. (editorial note: confirm Structure at publication)

## 2.0 Preparing for the Measurement

### 2.1 Devices and personnel:

- 2.1.1 All devices used for measuring radon in buildings shall meet state certification requirements or be listed by NEHA-NRPP or NRSB-RPP, and shall be used in strict accordance with manufacturer's instructions. (per AG)
- 2.1.2 The manufacturer should be consulted to determine whether the devices are capable of measuring over the chosen deployment period. Bob Stilwell: Does this mean that Air Chek will be called every time someone chooses to use their 'tea bags' to test an apartment building? Is this reasonable?
- 2.1.3 In addition, individuals who place or analyze radon measurement devices shall meet state certification requirements or should be certified by the NEHA-NRPP or NRSB.
- 2.1.4 For large testing projects, QC procedures should begin prior to deployment. (See Section 5.3 below). (editorial note: confirm Structure at publication)  
Bob Stilwell: Why only QC for large projects? Don't the folks living at "small" projects deserve the protection of QA/QC?

**Comment:** The committee observed situations where a test device might be chosen without realizing it was not capable of measuring accurately when deployed for too long or too short of time. A variety of devices suitable for large project deployment might not be appropriate for timelines chosen. The committee believes this guidance is indeed preferable to deployment of many devices in a large building over a time frame that is unsuitable to the device. This section is targeted at professionals who are expected to have established this parameter yet might not be intimately familiar with a chosen device. A reminder of caution seems in order.

**Comment:** The committee believes the wording indicates an additional level of activity for a large project which includes QC that begins before deployment. Section 5.3 specifies those activities and a suggested size of project. It is expected that a "qualified" professional will have an active, up-to-date QA/QC program under which they are operating.

## 2.2 Prior Notification and Closed-building compliance

Test conditions shall be controlled prior to and during testing. *Closed-building protocol* shall be maintained for short-term tests.

**2.2.1 Ensure Occupant Notification:** Failing to comply with required conditions is most likely to occur when residents are not properly informed about the necessary test conditions.

- 2.2.1.1 Seek to determine whether the building is new, occupied, and who will be responsible for closed-building conditions prior to and during the measurement period. *Bob Stilwell: You do not 'seek to determine' if a building is old, new, occupied, etc. These are a must-know, not a 'maybe you should know'. There is no option. Get that info or don't do the test.*
- 2.2.1.2 Prior to placing devices, ensure that an appropriate *notice of inspection* (See Exhibit VI) is distributed to residents. This will also help residents become familiar with the purpose of testing and the dates of testing the building.
- 2.2.1.3 Upon initiation of a short-term test, post *"Radon Survey in Progress"* notifications (See Exhibit VII) in conspicuous locations stating the conditions of the test.
- 2.2.1.4 Request occupant signatures on a *non-interference statement form* (See Exhibit VII). This can also help ensure that the occupant was able to comply with the required conditions and did not tamper with the test devices or conditions.

*Mark Veckman comment: This won't work for multifamily. It is hard enough to just gain entry much less to get a signature from a resident. The anti-tampering agreement should be with the Owner or Management Company so their reps don't mess with the equipment or space.*

*Bill Levy: agree and support, Marks comment in 99.9% of my testing the resident considers the test an intrusion and PIA*

**Comment:** This is a prior consideration in the process of establishing the needs for the test project. The experience of the committee members is that frequently some of these pieces of information are unavailable prior to the test, but will be determined onsite. Additionally, from week to week, occupancy might change.

**Comment:** A sample management/owner agreement could be created as an exhibit yet could only cover the actions of the managers and staff.

**Comment:** The committee believes the attempt is an important part of informing the occupant and building residents prior to the test. Testers experience a higher percentage of people noticing and therefore complying with the requirements when signature requests and notices are distributed. Notice that is a requested signature and not a required signature.

## 3.0 Where to Test

- 3.1** Take a measurement in each ground-contact apartment, dwelling, and room used as office space associated with the building complex. This means each unit that has floor(s) and/or wall(s) in contact with the ground. In addition, take a measurement in each residence over crawl spaces or enclosed parking garages. *(Andy George)*

Each unit should be tested in a room in the lowest livable level that is in contact with the ground or above a crawl or garage. If the lowest level is not currently used but could serve as a den, playroom, office, work area or an additional bedroom at some time in the future, take a test in this level.

**See placement example diagrams in EXHIBIT 1.**

*Bob Stilwell: What about large apartments? You only test one room on the ground contact floor even though the apartment might have a 3,000 sq. ft. footprint?*

**Comment:** Truly ... This is a consideration. The 2000 sq ft guidance is included herein in 3.6.2. but talks only about large rooms.  
Your reply was .... The committee believes that the directive to test every ground unit addresses this concern.

- 3.2** Also take a measurement in non-residential ground-contact rooms or areas (e.g. utility rooms, storage rooms, and maintenance rooms) that are:
- ❖ occupiable with little or no modification;
  - ❖ occupied more than four hours per day; and
  - ❖ areas that have air communication with occupiable areas (e.g. stairwells and elevator shafts).

Mark Veckman comment: Need to explain this better. I would not test a stairwell or elevator shaft.

When in doubt, test the area. Results from testing these unoccupied areas provide assurance regarding current or future use of the building, and they may indicate a need for additional testing in upper areas. These unoccupied areas may serve as a pathway for radon into apartments and offices of upper story floors

Mark Veckman comment: There is an awful lot of verbiage in this protocol. The more restrictive the protocol, the more likely a tester can get hung by a lawyer. Should leave wiggle room for the professional to make decisions based on observations. Not just follow wrote protocol.

Bill Levy: remember the owner not the occupant is the client and in many cases the testing is "as directed" and limited

**Comment:** The explanation is in the following paragraph. The committee shared experiences where stairwells and elevator shafts contributed to elevated radon concentrations on upper floors. These guidelines are an attempt to evaluate whether stairwells and elevators are pathways for radon to upper floors which are not being tested initially

**Comment:** As a protocol, the document must leave as little wiggle room as possible in an effort to protect the tester from varied interpretations. The committee believes the clearer the guidance, the fewer opportunities for a tester to be left to the courtroom.

**Comment:** The refusal to follow the protocol is then in the hands of the client rather than the tester. The report will show that the guidelines were modified at the request of the client so that the tester is not held responsible for failure to comply with accepted protocol.

- 3.3** Since adjacent apartments that have ground-contact rooms may have different radon concentrations, incomplete surveys or random sampling are **not** a substitute for comprehensively testing all appropriate locations and they should **not** be used to determine if a complete assessment is warranted.

Mark Veckman comment: I disagree. A screening is a good starting tool. If elevated levels found during a screening, then more comprehensive testing is warranted. Limited testing for radon is consistent with both lead-based paint and asbestos protocols. Not every unit is tested for lead, not every pipe is tested for asbestos.

Bill Levy: 3.3 does not make sense in the real world.. we almost always start an apartment testing project with some form of screening and move on from there, latest freddie mac says 10 % of apts or minimum of 1 per building , etc

**Comment:** The committee observes that we are not dealing with lead or asbestos. Instead, we are dealing with something that can be unpredictable from dwelling to dwelling within the same building. A 10% screening is in no way responsible to this fact.

**Comment:** The committee believes that the EPA findings and the experience of those consulted to establish this protocol indicated enough variability in the radon concentrations from room to room in larger buildings and complexes that the guidance must call for testing comparable to the currently accepted school protocol that is consistent with this document.

- 3.x** On the higher floors, a measurement should be made in at least one apartment on each floor; the measurements should include at least 20 % of the apartments on the higher floors. Radon measurements should be made in the apartments in which the building materials can be assumed to contribute to an elevated radon concentration and also in apartments which are adjacent to lift or ventilation shafts or other spaces which pass vertically through the building, since radon from the ground can pass up through such spaces.

**Comment:** This is exact copy of Swedish Text. Besides things like changing "apartment" to maybe "dwelling unit", DO WE EMBRACE SUCH CONCEPT?

- 3.4** All areas identified for testing should be tested during the same time period (days or phase).

Mark Veckman: All ~~rooms~~ units and common areas identified ..... comment: Perform testing continuously, beginning with the first unit or area, and ending with the last unit or area.

**Deleted: rooms**

Bill Levy: again real world conditions include access, lost key, residents that work nights, dogs etc etc..we always try to get single cycle testing but must be able to intergrate the stragglers into the mix

Keven Stewart comment: Consider giving a definition of “phase”. The meaning may not be clear to all readers.

Bob Stilwell: Do you mean test them all at the same time? I think so, but needed to make sure.

**Comment:** The committee believes that the additions and changes address these comments.

### 3.5 Considerations Regarding Complex Heating/Cooling/Ventilation Systems:

Some multi-family buildings have heating, ventilating and air conditioning (HVAC) systems that supply conditioned air and ventilation to dwellings. Many have heating and air conditioning systems that do not supply additional fresh air for ventilation (HAC) such as normally seen in single-family residences. Radon concentrations can vary widely from test to test based on the operational variances that occur when fresh air ventilation is supplied to a building.

Bob Stilwell: 1st paragraph- an example might help clarify what you're talking about here.

**Comment:** The committee is open to suggestions on concise descriptions of these systems.

In addition, if the multi-family building to be tested does not have a ducted, constant-volume, forced-air system with a centralized return (i.e. each unit has its own air handler as typically seen in single detached housing), the number of rooms to be tested may need to be adjusted. Depending on the type and configuration of an HAC (that does not supply fresh air ventilation), testing of all routinely occupied ground-contact rooms within each unit may be required.

Examples of systems where testing has shown significant room-to-room variation are units equipped with:

#### Group 1 - Variable air distributions

**Comment:** I'm wondering if displayed as a table with rearranging text to be under each bullet item of concern might be easier to consume.

- Variable Air Volumes (VAV) systems that perform automated duct dampening.
- Whole building ducted forced air systems with individual room returns, and
- Unit Ventilator (sometimes referred to as a through the wall package unit).

#### Group 2 - Non-ventilating

- Individual Room Ductless Split Systems,
- Baseboard heating, and/or window air-conditioners, and
- Non-Forced-Air Hot and Cold Water Circulation.

If you are unsure as to the type of system that is present, consult with a mechanical engineer or a heating and air-conditioning contractor. Bob Stilwell: 3rd paragraph/piece/section/whatever: you could also ask the bldg manager or maintenance supervisor what type of HVAC systems are in the building. They could also tell you if they are really working....

**Comment:** The committee has stipulated that the professional tester is working with the building manager or maintenance person. This guidance was directed for those who may not know about the HAC system. People have been told by mangers that all units were forced air only to find they are all on boiler systems. Sometimes, it is appropriate to call a specialist.

There are currently no techniques to readily determine the number of additional units that require testing for multi-family buildings equipped with either Group 1 or Group 2

types of systems. For Group 1 systems, testing rooms with less than (-) 4 Pa (0.016 in WC) differential pressure relative to the rest of the unit is recommended. For units with systems in Group 2, one option is to request that the resident keep all interior doors open during the test period.

Mark Veckman comment: These values will change on a daily basis, and with the weather. Most apartments are fairly small, and most are one level (except town houses). I generally test the most occupied room on the lowest occupied level. For apartments, might skip the detailed verbiage and make recommendation easier to follow.

**Comment:** The committee believes that addressing large buildings and complexes is an important part of this effort especially as this guidance is expected to be followed by HUD.

Bill Levy: again real world conditions include access, lost key, residents that work nights, dogs etc etc..we always try to get single cycle testing but must be able to intergrate the stragglers into the mix

**Comment:** The committee believes that addressing stragglers, etc/ is covered in the section on reporting where any occurrences not in compliance with the guidelines are identified and explained.

Bob Stilwell: 4th paragraph- Where did the pressure differential come from? Why is 0.016 in WC enough pressure to make you test one room but not another?

**Comment:** Dave Wilson—I leave this to you.

Testing of all routinely occupied ground contact rooms within each unit is the best way to evaluate a radon risk in multi-family buildings with Group 1 or 2 types of systems. If additional testing is warranted, suggested rooms to test are all ground contact bedrooms and any rooms that can be closed off from the main part of the unit.

**Comment:** Possible change: “may sometimes be considered as a way to help evaluate ….”

Mark Veckman comment: Think about how a lawyer could tear up a consultant who did not test all ground level rooms in all apartments

**Comment:** The committee believes the contrasting scenario is more damaging to the professional, viz. The professional chooses which rooms to test based on ??????. The judgment call can be questioned by any witness and the science is not there. Rather, if the protocol states every room ...etc., and the client has chosen NOT to conform to the protocol, it is the client’s liability, not the professionals’.

Keven Stewart comment: Observation: The recommendation here to “test all ground contact bedrooms ...” is more conservative than that of the CGR for detached housing. Is this truly the intention?

Bill Levy: again real world conditions and economic considerations will limit considering testing "all" rooms in a multifamily unit or apartment and the concept should not be part of the protocol. Do we test all rooms in the residential testing protocol ?

**Comment:** The committee believes a testing protocol should be conservative when the health of the occupants is at stake.

When in doubt, test the area.

Mark Veckman comment: Remove this comment.

**Comment:** Gary here: I suppose I do wonder if we should be more specific. Not certain of a good text recommendation. I also wonder if a dwellings size is a criteria here. It would seem that single floor dwellings of about 1,000-1500 Sq. Ft. would likely show up due to simple diffusion. Over 2000 sq feet and we might see significant differences across the dwelling due to Group 1 and 2. ??

Bill Levy: I agree, the if in doubt test is a generalization without definition

**Comment:** The committee will consider alternate wording that encourages testing areas where there is no protocol but in the judgment of the professional there may be a pathway.

### 3.6 Choosing a location in a room

The following criteria shall be used to select a location in a room to place devices:

3.6.1 Place the device within the general *breathing zone*. Locate the device no less than:

- Three feet (90 centimeters) from exterior doors and windows or other potential openings to the outdoors
- One foot (30 centimeters) from the exterior wall of the building
- 20 inches (50 centimeters) from the floor
- Four inches (10 centimeters) from other test devices and surrounding objects.



Mark Veckman comment: Remove this recommendation. Apartments are small and crowded. Tables, bookcases, etc. always have other objects. This seems unnecessary.

- For those devices that may be suspended, an optimal height is no higher than eight feet (2.5 meters) from the floor and a minimum of one foot (30 centimeters) below the ceiling.

**Comment:** The committee believes these guidelines are consistent with other protocol on radon measurement. Equilibrating devices such as charcoal canisters require the 4" distance due to physics of adsorption that result in device accuracy considerations.

3.6.2 For large rooms or open areas – Place one device every 2,000 square feet (e.g., a square area with each side 45 feet in length).

**Comment:** Move or include for whole dwelling unit.

3.6.3 Do not place devices in closets, cupboards, kitchens, baths, sumps, crawl spaces, or nooks within the building foundation

Mark Veckman comment: Kitchens are OK in vacant units that will not be occupied during the test period. Kitchen counters may be the only place to put the device in vacant units.

Bill Levy: kitchen/dining counters are the most favorable location in many cases as residents dislike having test devices placed on furniture

**Comment:** EPA and manufacturer guidance disallows testing in kitchens and bathrooms. In cases where circumstances allow this testing, the professional is expected to describe the conditions in the test report.

3.6.4 Do not take the measurement near drafts caused by heating, ventilating and air conditioning vents, or fans. Keven Stewart comment: What is the definition of "near"? Can/should this be quantified in the manner of 3.6.1?

TRUDY  
Reviewing MAH text. I recall the consideration for open kitchens (so common these days) and some solidly discussed text. Replace with these two ....

3.6.5 Do not take the measurement near heat sources, such as on appliances, near fireplaces or in direct sunlight. Keven Stewart comment: What is the definition of "near"? Can/should this be quantified in the manner of 3.6.1?

3.2.2 Do not place detectors in closets, crawl spaces or hallways or in enclosed areas of high humidity or high air velocity. The latter may include kitchens, laundry rooms, and bathrooms.  
3.3.2 Do not place detectors in cupboards, sumps, or nooks within the building foundation.

3.6.6 Select a position where the device will not be disturbed during the measurement period. The testing device must not be moved, covered or have its performance altered during the test.

**Comment:** It is difficult to find a perfect "near" criteria. Three feet might be reasonable similarly used for exterior doors, etc. ?? For ducts, three feet away from duct discharge and three feet away direct airflow from the duct???

## 4.0 Testing Strategies

Acceptable strategies:

Mark Veckman comment: See all 4 notes - For multifamily properties I recommend a different approach. Testing all ground floor units is impractical as an initial screening, especially during a Phase I real estate transaction. The Phase I is likely to be the primary vehicle for finding radon. Testing should be performed to meet a 95% confidence level that elevated radon is not present.

HUD has developed a table in their lead testing protocols for a 95% confidence level. I have attached a copy of this with my response. Do a screening first to the 95% confidence level, if no elevated radon found, then stop. No additional testing is required. Have attached Table 7.3 + title page and table of contents for this chapter. I prefer the screening approach as a first step. This eliminates a lot of properties from full testing without short changing residents.

If elevated radon at or above 4.0 found in one or more devices, then all ground floor units and other areas listed in this protocol can be tested. I have tested hundreds of apartment complexes over the past 19 years. I generally test 5% of the units or 10% of ground floor units, whichever is less, with a minimum of 3 and maximum of 15.



If any results 4.0 or greater, all ground floor units get tested, with some screening of upper floors. This approach has worked fairly well.

Bill Levy: we have a recommendation of 10% of Ground floor apts with at least 1 per building and some 2nd floor if client's scope will allow, then 100% if elevated levels are found. I am including the latest? freddie mac protocol

\*\*\*\*\* ? Protocol

Mark Veckman Multifamily buildings are different from single family homes in that one can see data trends over the complex after the first round of comprehensive sampling.

It has been my experience that another round of short term testing does not yield any more meaningful results. After the first round of comprehensive short term testing, long term testing is better to determine what actual units need to be mitigated. I like a year long test with alpha tracks, or a 3-4 month test in winter or summer when the units are mostly closed up.

Bill Levy: our experience with long term testing has shown more (%) apartments with elevated radon levels than the same complexes' short term results indicate

**Comment:** The committee believes very strongly that radon behavior is very different from the application of leaded materials and asbestos. As observable in protocols for lead paints and asbestos-containing materials, these products were applied at definable time periods in history and in specific manners. Only these facts allow adjusting sampling scope to seek anything close to a 95% confidence. Radon entry from dwelling to dwelling within the same building is not possible to predetermine. It is site specific and frequently unique to one or two units or rooms due to air pressure variances. This fact is observed in EPA's guidance for schools and large buildings. Achieving 95% certainty level by testing a small percentage of rooms cannot be accomplished.

A. **Extended Test Protocol** (*corresponding to EPA's Citizen's to Guide to Radon for homeowners and non-real estate situations*).

Andy George Comment: I think the Extended Protocol is obsolete. Why keep recommending it? Why bother? Duplicates or single test option for CRM will eliminate the follow-up test. I think it should be deleted throughout the draft. It is unrealistic, tedious, time consuming and expensive. Today, all major labs that supply passive devices do provide them in duplicate for about \$25.00. Also, 100% testing gives more confidence in the measurement in a single trip.

The **Extended testing protocol** entails an initial quick and cost-effective initial test followed by follow-up testing in locations where elevated radon concentrations were initially measured. The **Extended testing protocol** is an option when time constraints are not prohibitive and when occupant relations allow the performance of a second test when needed. Follow-up tests may be short-term tests or, when initial tests indicate concentrations of 4.0 to 8.0 pCi/L, long-term follow-up tests may be employed to provide a better understanding of the year-round average radon concentration for those occupants and to be more certain that you should mitigate.

Bob Stilwell: Consider using 2-8 pCi/l (rather than 4-8 pCi/l) as the criteria for long term (year long) tests.

**Comment:** The committee believes this is a point of debate for a much larger community. There are those that feel follow-up testing should always be required prior to mitigation regardless of current practice. Although this may be a future consensus or goal, the committee believes this document should stay consistent at this time with other guidelines presently in the public domain.

B. The **Time-Sensitive test protocol** (*corresponding to EPA's Home Buyers and Sellers Guide to Radon*)

**Time-Sensitive testing protocols** require enhanced quality control measures during a single phase of testing. **Time-Sensitive testing protocols** may be appropriate for situations where quick decisions are needed or when other strategies are unacceptable. Time-sensitive situations may include: real estate transactions; planned renovations; or other situations that require a quick

**Comment:** The protocol portion of a document regards decisions to fix is centered around the EPA action level of 4.0 or greater. The guidance in section II refers to how one might interpret results and covers the concern and option you express. The tables cover the split between "fix" at 4.0 and "consider fixing" between 2-4. At this time, the committee is hesitant to contradict EPA tables in this regard.

evaluation of whether radon mitigation is needed. Options provided in this protocol might also be desired when logistics or public relations with occupants render other strategies unacceptable (i.e. when occupants might consider repeated access and closed-building requirements to be disturbing intrusions into their homes.)

#### 4.1 Extended Protocol

Andy George: Obsolete?

<b>Extended Testing Protocol</b>	
(corresponding to EPA's <i>Citizen's to Guide to Radon</i> for homeowners - non-real-estate circumstances)	
<i>TYPE OF TEST</i> (passive devices)	<i>What to do next if the test result is 4.0 pCi/L or greater</i>
<b>Single Short-Term Test</b>	<b>Test this location again *</b>  <i>*If the first short term test is greater than 8.0 pCi/L, take a second short-term test immediately. If the first short term test is 4.0 to 8.0 pCi/L, take either a short term or a long-term test.</i>
Average of 2 Short-Term Tests	<b>Fix the building</b> <i>Consider fixing between 2.0 and 4.0 pCi/L</i>
<b>A Long-Term Test</b>	<b>Fix the building</b> <i>Consider fixing between 2.0 and 4.0 pCi/L</i>
<b>Less than 4.0 pCi/L: Confirm the low result by testing again every five years and whenever significant changes to the building's structure or mechanical systems occur. Testing during a different season and different weather conditions or with long-term testing is recommended.</b>	

##### 4.1.1 Step 1: Initial Measurements:

Take initial measurements using short-term tests (i.e. 2 to 90 days) to provide a quick answer to whether high radon concentrations are present. **Test periods of at least 4 to 5 days are strongly recommended for multifamily buildings** when short-term tests are employed, because it is sometimes difficult to ensure closed-building conditions existed 12 hours prior to the test at every dwelling.

Andy George: (i.e. 2 to 7 days) is more practical guidance

Mark Veckman comment: Getting residents to keep doors and windows closed for 4-5 days is more difficult than 2 days. Can be a self defeating approach. I would stick with the 2 days.

Bill Levy: the two day test during the week yields better results than a longer test period that runs over weekends

**Comment:** The committee debated these issues at length and the differences noted in the comments were also noted on the committee. For now, the committee believes consistency with other standards is important and looks forward to a thorough exploration of these issues in the radon community and beyond.

4.1.1.1 **Quality control:** The number of duplicate measurements needed should be at least **10 percent** of all the testing locations. The number of blank measurements needed is equal to **5 percent** of all the testing locations.

Mark Veckman comment: By duplicate, I assume this means each test uses a single detector, and duplicate means 2 detectors placed side by side. Should probably explain this more.

**Comment:** These terms are defined in the glossary and in the quality control sections.

Bob Stilwell: What? No spikes? Why not?

4.1.2 **Step 2: Follow-up Measurements**

Mark Veckman comment: If the screening shows elevated radon, and the comprehensive confirms elevated radon, no need to do duplicate testing in all units. Either mitigate, or do long term testing.

**Comment:** Due to the volume of test locations (i.e. 5-10 dwellings), the frequency of spikes that are part of the overall QC of a business might not coincide with the test project schedule. However, the frequency requirements for dupes and blanks would almost always apply and should be required in reporting. Scheduling the time considerations and expense for spikes to coincide with each small test project can be impractical. There are some comments herein suggesting that for passive devices, the analyzing lab is already performing spikes and it is an unwarranted expense for the client. The protocol seeks a minimum for inclusion in the report for these simple QA components (regardless of project size).

Bill Levy: the radon does not go away, and duplicate testing cycles only create more resident problems for the mitigation contractor

**Do not use the results of a single short-term passive test device as the basis for determining whether to mitigate an area.** Andy George comment: So use duplicated instead)

**Comment:** The committee believes these options need to be retained to minimize cost and encourage testing, also to remain consistent with other protocol. This is not the only option and a professional or residence manager can choose the time-sensitive protocol.

Bill Levy: recommending a collocated device protocol for all multifamily testing would be in agreement with other RE transfer testing protocols

Perform a follow-up test in every testing location with an initial short-term test result of 4 pCi/L or greater. All follow-up measurements should be initiated during the same time period (or phase) and placed in the same locations as the initial measurements.

Bob Stilwell: With all the info out now about seasonal variation, shouldn't that also be a factor when deciding when to do follow up measurements?

**Comment:** Seasonal variations have been witnessed to vary from region to region with sometimes contradictory trends and magnitudes. These are likely due to climate differences affecting building pressure differently in different regions as well as geology, soil density, etc. Professionals in any given county are quite aware of their local trends. Herein, the guidance for retests you note has been repeatedly noted. However, within the Extended protocol, one might still recommend or assume the follow-up test would be initiated immediately.

4.1.2.1 **Use a short-term, follow-up test if results are needed quickly.**

Mark Veckman comment: After a screening test of 10 units and a comprehensive test of 100 units, if 60 show levels of 4 or greater, no additional testing is required in these units. You have 60 results that show a problem. How much more data are required. I would be more concerned with the 40 that did not show a problem, and why.

Bill Levy: I agree, it is the low results in a mix that are questionable, especially when the owner is doing selective mitigation of the elevated level apartments only

**Comment:** This is one option offered to testers, but is not the only one. The time-sensitive does not call for follow-up measurements.

The higher the initial short-term test result, the more certain you can be that a short-term follow up test should be used rather than a long-term follow-up test.

If the initial short-term measurement for a testing location is more than twice the EPA's radon action level of 4 pCi/L, a short-term follow-up

measurement should be taken immediately. Use the average of the initial and follow-up test results to determine if this location needs mitigation.

All short-term tests should produce results in the same units and should be made in the same locations and under the same conditions as the initial tests (to the extent possible). This will ensure that the two results are comparable.

Bob Stilwell: With all the info out now about seasonal variation, shouldn't that also be a factor when deciding when to do follow up measurements?

Comment: See above

#### **4.1.2.2 Use a long-term, follow-up test to better understand the year-round average radon concentration and to be more certain that you should mitigate.**

Mark Veckman comment: My experience shows long term tests are best when levels are 3-6. Any complex showing comprehensive testing with consistent results above 4 throughout the complex probably needs mitigation. These are many data points. In a SFH you have one data point and confirmation testing is required.

For a better understanding of your year-round average radon concentration or when an initial test indicates 4.0 to 8.0 pCi/L, you may consider a long-term follow-up test - preferably performed for six months to a year. Long-term tests must be deployed for *a minimum of 91 days* and closed-building conditions are not required for test periods lasting longer than 90 days. You may use the result of this test to determine if this location needs mitigation.

Keven Stewart comment: I can see potential problems in buildings without air-conditioning, where people may cool their living quarters by opening windows or running box fans:

- If people are doing tests of 91 days or so primarily during the heating season, the absence of closed-building conditions will likely result in an underestimate of typical annual average exposures.
- Especially if longer short-term (e.g. 90-day) follow-up testing is planned for a heating season period, there is the practical difficulty of how people can be expected to maintain closed-building conditions all that time.

## 4.2 Time-Sensitive Protocol

<b>Time-Sensitive Testing Protocols</b> (corresponding to EPA's "Home Buyers and Sellers Guide to Radon")	
<i>TYPE OF TEST</i>	<i>What to do next if the location is 4.0 pCi/L or greater</i>
<p><b>Passive Devices:</b> (Passive devices do not provide hourly measurements)</p> <p><b>Simultaneous Testing:</b> Take two short-term tests at the same time in the same location for at least 48 hours. <b>Average the results.</b></p> <p style="text-align: center;">Or</p> <p><i>Andy George: Delete Sequential</i></p> <p><b>Sequential Testing:</b> Take an initial short-term test for at least 48 hours. Immediately upon completing the first test, do a second test in the same location as the first test. (The results of the first test should not be reported prior to completing the second measurement.) <b>Average the results.</b></p>	<p style="text-align: center;"><i>Fix the building if the average is 4.0 pCi/L or greater</i></p> <p style="text-align: center;"><i>Consider fixing between 2.0 and 4.0 pCi/L</i></p>
<p><b>Continuous Monitor (Active) Devices:</b> (These devices provide hourly measurements.)</p> <p>Test the room with a continuous monitor for at least 48 hours. <i>Cost effectiveness of this option is common only for small building complexes.</i></p>	<p style="text-align: center;"><i>Fix the building.</i></p> <p style="text-align: center;"><i>Consider fixing between 2.0 and 4.0 pCi/L</i></p>

**Comment:** See above comments

*Keven Stewart comment: A problem with the "Time-Sensitive Protocol": The strong "4 to 5 day" recommendation and rationale of 4.1.1 are not applied here. Especially in the light of 6.4.6, there is a real problem in ensuring that such testing would mean what it says. Of course, this part of the*

protocol and its weaknesses are not significantly different than what the EPA's *Home Buyer's and Sellers Guide to Radon* currently allows.

**Comment:** Request committee to comment

#### 4.2.1 Time-Sensitive Measurement Options:

These measurement strategies involve a single phase of testing and require enhanced quality control measures.

**4.2.1.1 Simultaneous Testing:** Take two short-term tests at the same time in the same location for at least 48 hours. The results of both measurements should be reported. Use the average of the two results to determine if this location needs mitigation.

**4.2.1.1.1 Quality control:** This option results in **100 percent** duplicates. The number of blank measurements needed is equal to **5 percent** of all the testing locations.

Bob Stilwell: Why no spikes?

**Comment:** See earlier comment

**4.2.1.2 Sequential Testing:** Take an initial short-term test for at least 48 hours. Immediately upon completing the first test, place a second test in the same location as the first test. (The results of the first test should not be reported prior to completing the second measurement.) The results of both measurements should be reported. Use the average of the two results to determine if this location needs mitigation. Some variance between the two results is expected.

**4.2.1.2.1 Quality control:** The required number of duplicate measurements is at least **10 percent** of all the testing locations. The required number of blank measurements is equal to **5 percent** of all the testing locations.

Andy George: Delete Sequential Test Option

Bob Stilwell: Why no spikes?

**Comment:** See earlier response to comments

**4.2.1.3 Continuous Monitor devices:** A continuous monitor is capable of providing and averaging reviewable hourly readings. Take an initial short-term test for at least 48 hours. This option may only be cost-effective for very small building complexes. However, continuous monitors might be chosen for areas of the building(s) where a more detailed assessment of radon fluctuations is appropriate (i.e. locations where significant fluctuations in pressure or ventilation might be expected). Use the average result of this test to determine if the location needs mitigation.

**4.2.1.3.1 Quality control:** The required number of duplicate measurements is at least **10 percent** of all the testing locations.

Bob Stilwell: include confirmation of proficiency test of operator/company, proper calibration, and proper background checks.

**Comment:** Obtaining this information is included in the recommendations for choosing a contractor and should be secured prior to signing a contract

## 5.0 Quality Control In Testing Multi-family Buildings

When testing Multi-family buildings, two types of *quality control (QC) measurements* must be implemented and evaluated. These measurements represent an “early warning

system” to identify problems that may have developed during the testing of Multi-family buildings.

- 5.1 Blanks and duplicates shall be part of a measurement professional’s quality assurance plan and must be reported.

Bob Stilwell: Why no spikes?

Comment: See earlier response to comment

Duplicate Measurements (side-by-side devices)	Blank Measurements (unexposed devices)
The number of duplicate measurements shall be equal to or greater than 10% of all testing locations (or as specified by the test strategy chosen)	The number of blank measurements shall be equal to 5% of all testing locations.  Field blanks (blanks deployed at the testing location) are not required. However, allocating 3% field blanks and 2% office/laboratory blanks is recommended.

Bob Stilwell: Justify not requiring field blanks. You're setting a dangerous precedent.

Comment: The committee had lengthy discussions on the appropriate blank procedure and compromised on this statement. The EPA protocol does not call for field blanks such as in testing protocol for other contaminants. They require only “office field” blanks. Those members of the committee who urged actual field blanks accepted this recommendation.

See APPENDIX A for additional information on QC. (editorial note: confirm Structure at publication)

- 5.2 Field blanks are generally not required to be deployed at the testing site. However, radon professionals should consider deploying 3% field blanks and 2% office blanks to evaluate background exposures throughout the sampling process. Office blanks remain in the office setting. Field blanks are taken to the site and left on site to parallel sampling conditions.

- 5.3 *Special considerations for blank devices in large deployments.* As the number of units to be tested in a complex increases, the need for specialized blank procedures also becomes greater. With a larger number of testing locations and devices, the investiture of time and money for the client and the professional becomes great enough that an early detection procedure should be included in the blanks deployment protocol. At a minimum of 25 units to be tested, testers should:

Comment: The concepts for this might be expressed better with a table rather than text.

Andy George: unnecessary expense.

Comment: Members of the committee believed the greater expense would be to conduct a large scale testing program and find that their blanks were compromised.

Bill Levy: 5.2 and 5.3 are unnecessary and the issue of spikes for a specific project is unworkable in a real world situation.. again the MF protocols should parallel the residential protocol.

Comment: This guidance was suggested to protect the tester and the client from conducting a huge testing program and find after testing has been completed that the blanks have been compromised.

Bob Stilwell: The concept of 3-3-3 for blanks is interesting. How do you justify only 3? That's too small a number to do stats with. 5 is about as low as you can get and still have confidence in the result.

Comment: The committee compromised on recommending prior testing and a reasonable number of QC testing devices.



Mark Veckman comment: I disagree. Spikes are a lab issue, not a tester issue. If spikes are required, then the lab should initiate a blind spike program as part of their QC. Having testers submitting spikes causes problems for both labs and testers. This is based on experience with submitting lead dust wipe spikes to labs. I don't do this anymore.

**Comment:** Spikes are required by testing professionals using passive devices, by the EPA and by good scientific procedure. The procedure for spiking passive devices is well-known and well-documented. One problem with lead spiking is that there are no standardized spike sources, so the technology is not comparable to radon spiking.

- Increase the number of blanks to 9 devices;  
Andy George: unnecessary expense.
- 3 blanks should be returned to the laboratory immediately so that elevated background concentrations will be evident prior to beginning device deployment;  
AG: unnecessary expense.
- 3 blanks should be treated as “office blanks” remaining in a known low-radon environment and returned to the laboratory with the sampling devices per normal procedure;  
AG: unnecessary expense.
- 3 blanks should be deployed in the field with the sampling devices to track handling procedures. These devices accompany the sampling devices and are opened onsite, immediately closed, and left closed on site. They are retrieved with the sampling devices and returned to the laboratory per normal procedure. AG: Keep

Bob Lewis comment: This section talks about opening the blanks onsite, however, Appendix A page 4, first paragraph says that “blanks are unwrapped (but not opened)...” I would not think it good to open any blank device.

**Comment:** This is a field protocol as opposed to the “office blank” protocol which is offered by EPA but committee members believe that the option for true field blanks should be suggested.

If more than 180 units will be tested in the complex, the standard 5% blanks number can be resumed, however, the practice of using pre-test blank evaluation and office plus field blanks should be continued. AG: ??

Committee discussion-Blanks: The committee discussed that blanks have the ability to identify problems along a variety of points in the chain of custody. Some have experienced that the most volatile points to be during transport and storage rather than on-site. Hence, “Office Blanks”. It was also noted that prior determination of transport and storage problems can save the invalidation of an entire test project if not identified until after on-site sampling. Others note that blanks that cover the entire test chain (including when the chain of custody is broken during the deployment period) are appropriate.

A similar discussion occurred during the promulgation of the “Interim” version of this document. Suggestions to the committee are welcome.

- 5.4 *Special considerations for spiked devices in large deployments.* As the number of units to be tested in a complex increases, the need for specialized spike procedures also becomes greater. With a larger number of testing locations and devices, the investiture of time and money for the client and the professional

becomes great enough that an early detection procedure should be included in the spike protocol.

- At a minimum of 25 units to be tested, testers should ensure that the result of one spiked device from the sampling program batch has been received and is satisfactory ( $\pm 30\%$  of the reference value) prior to beginning the sample deployment. *[AG: Why not 25%?]*
- At 50-units in the sampling program, 2 spikes should be processed as described above.

*[Andy George: I assume the lab that analyzes passive detectors does routinely - monthly spikes. So why bother with all these?]*

*[Bob Stilwell: This is the 1st place that discusses spikes. It should be before this! Also, allowing +/- 30% is higher than the EPA testing rounds allowed, at +/- 25%. Shouldn't we be able to do better at this stage?]*

*[Note: The results of spikes, blanks, and dupes are not needed with the results of the structure tests, but need to be run through proper QA/QC calculations/plotting/etc. and put into it's own report that goes into the client file. Maybe even give them a copy of the QA report as an addendum or appendix to the test report.]*

Committee discussion-Spikes: The document currently has not required spikes to be reported in the test report (with consideration for so many smaller test projects where costs would be prohibitive and that a company QC plan is required). Inclusion of the reporting of dupes and blanks did seem appropriate for any multifamily test project.

It is difficult to draw the line. Suggestions to the committee are welcome.

*[Bill Levy: field spikes are not a requirement of any other protocol, and will create problems the inclusion of this data will not help in a clients mitigation decision]*

**Comment:** Trudy: I believe you verified the 30% number as the existing criteria. For Andy and Bob below, recanting that might be helpful.

**Comment:** This is prior to the testing and specific to the project.

**Comment:** This has always been a standard part of a radon testing program (RPP) with passive devices.

**Comment:** For committee consideration: I believe we are trying to establish what QA controls are required and reported regardless of who is testing. We see an old, old question for spikes playing out here. Especially wherever practices are not regulated (including building owners doing their own testing), spikes are a significant endeavor for the owner, manager or small testing company. They traditionally rely on the lab and the labs requirement for these at proficiency programs, etc. Andy's comment acknowledges this reality and raises the question about where lines are drawn for when it is really a concern and when it is not. Should we consider a lab's statement of current QA in such regard as an alternative minimum for small project situations?

**Comment:** The committee believes the discussion of additional spikes specific to a very large testing program is appropriate in this section as it is not required separately for smaller testing programs, but rather is a part of the company's regular QC

**Comment:** The committee believes the purpose of the QC measurements are to ensure that the results delivered to the client are reliable. If the results of the QC measurements are not evaluated and graphed prior to the reporting, that standard of quality and assurance cannot be claimed.

**Comment:** Again, this was protection for the client in very large projects.

## 6.0 Conditions required during the test

**Long-term tests** (those lasting 91 days or more) do not require closed-building conditions.

**Short-term tests** are conducted for two days to 90 days; **closed-building conditions are required.** *AG: (2 to 7 days) more likely.*

**Purpose of Closed-building Conditions:** Closed-building conditions are required for short-term measurements to stabilize radon concentrations and entry rates and increase the reproducibility of the measurement. Without these controlled conditions, measurements can indicate higher or lower readings than are typically present.

*Bob Stilwell: I think you need to specify that long-term tests should be a follow up test method only.*

## 6.1 Closed-building Protocol

- Closed-building conditions shall be maintained throughout the test period and for 12 hours prior to the initiation of measurements lasting less than four days

Bob Stilwell: 1st bullet- re-order this to say closed conditions required 12 hrs before test begins, and must be maintained during entire test.

**Comment:** The sentence structure is awkward, but the current EPA guidance for the requirement is that the 12 hour prior closure is for tests lasting less than 4 days

- All windows on all levels of the building shall be kept closed and all external doors shall be kept closed (except for momentary entry and exit). This includes areas not being tested.

Bev Howell: Emphasis is needed for upper floors (untested areas) also.

**Comment:** The committee is open to suggestions.

**Comment:** Tried a short addition?

- Heating and cooling systems shall be set to normal, occupied operating temperatures; fan/blower controls shall be set to intermittent activity unless the system is designed to only run the fan continuously.
- Whole house fans shall not be operated.
- Occupants should avoid excessive operation of clothes dryers, range hoods, bathroom fans and other mechanical systems that draw air into and out of the building.

Bob Stilwell: define excessive. For a family with 6 kids, the dryer and bathroom fan run almost all day. That's not excessive for them.

**Comment:** The committee is open to suggestions. It could be a long paragraph and still be inappropriate for the situation.

- Solid, liquid, or gas fuel burning fireplaces shall not be operated unless they are the primary/normal sources of heat for the dwelling.
- Additional closed-building conditions
  - Window air-conditioning units shall only be operated in a re-circulating mode.
  - Equipment that supplies fresh air to the dwelling shall be deactivated unless it is an integral part of the HVAC system or supplies make-up air to a combustion appliance.
  - Window fans shall be removed or sealed shut.
  - Fans installed in attics to control only attic air and not whole-building temperature or humidity may continue to operate.
  - Air exchangers: Normal operation of permanently installed ventilation systems such as energy recovery ventilators (also known as heat recovery ventilators or air-to-air heat exchangers) may continue during closed-building conditions so long as the system is regularly maintained and continuously operational. Should such a system be labeled or intended to serve as a radon control system, see below under “Special considerations, Radon Mitigation Systems.”
  - New construction, renovations and repairs: Items that shall be completed or installed before the radon test is initiated include—
    - ❖ all insulation,
    - ❖ all exterior doors and hardware,
    - ❖ all windows,

- ❖ all fireplaces and fireplace dampers,
- ❖ all heating/cooling appliances (functioning and set to run at normal occupied temperatures),
- ❖ all ceiling coverings,
- ❖ all interior trim and wall coverings,
- ❖ all exterior siding, weatherproofing and caulking.
- ❖ Structural openings to the **exterior** as a result of incomplete construction, structural defect, disrepair, or the like shall be closed or repaired 12 hours prior to initiating the test.

## 6.2 Special considerations

Mark Veckman comment: Sometimes have no choice. Most of this testing will be completed during real estate Phase I site assessments. Difficult to control the weather.

- **Severe Weather:** Short-term tests lasting less than four days should not be conducted during unusually severe storms or periods of unusually high winds.
- **Radon Mitigation Systems:** Prior to beginning a test, a permanently installed active radon reduction system shall have been operating for at least 24 hours and shall continue to operate during the test period. In addition, Closed-building conditions shall be maintained 12 hours prior to initiating a valid test period and thereafter throughout test.

**Comment:** These are standard and long standing guidelines. Such conditions will result in client concerns regarding reproducible measurements. Since unusual events can affect a test, they are simple facts of life we must deal with.

Keven Stewart comment: Section III. 2.2, 6.1 and 6.4

The closed-building protocol (CBP) sounds great in theory, but I am interested in what experience exists with this being put into practice:

- I wonder if CBP correctly presumes how the building is used during the heating season. In some cases, open windows have been observed as normal occupant practice. Remember that actual radon exposure is a consequence of how people actually occupy their environments, not of how we might think they do according to some model.
- I did not see a “contingency” part in the protocols to deal with the imperfect situations likely to obtain in real life.
  - o What if one occupant does not follow CBP? Should all tests for that structure be discarded?
  - o Since 6.4.6 indicates that “the measurement professional is not responsible for inspecting closed-building conditions” other than at deployment and retrieval of detectors, should a monitoring protocol be established for the building manager to follow for establishing CBP 12 hours in advance of testing and for maintaining CBP for the duration of the testing period?
  - o Specifically, how should the documented experience in implementing such a protocol be used to support or oppose the validity of any testing that is performed?
  - o For example, consider that testing is in progress in a 20-unit building. One tenant, who has been traveling during the tenant-education period, returns home and promptly opens his windows to enjoy the night air. The next morning, the building manager identifies the problem and speaks with the tenant, who complies with the request to close the windows. Should the building tests be regarded as acceptable?

**Comment:** This has always been a problem in testing for radon when the person responsible for the building is not the client. Since the testing is being done for current and other residents to see if there *might* be a problem, CBP are necessary.

It is not possible to reproduce winter conditions in summer. It may seem odd but some homes demonstrate higher readings in summer. We are measuring a moving target even with long term tests. CBP is the critical control over the measurement. In most parts of the country, results under CBP are quite reproducible for the purposes of determining the need to fix.

Bob Stilwell: What about special considerations for passive systems? With the emphasis on radon prevention in new construction, this should be discussed. Or are you trusting the guidance on radon prevention in new construction to properly address this?

**Comment:** This is covered in some detail for required disclosure of known details in the reporting section. From there, the evaluation of all data achieved would normally be tempered with how high or low the data is for the considerations or retests and mitigation. It is not possible for anyone (without cameras) to watch all windows at all times on any building. Therefore they can not be liable for the impossible. The magnitude of failed compliance is often proportional to the affect on the readings when taking into account specifics of a building design and systems. An small open bathroom window would not normally change much about readings that are 10 pCi/L. An entire floor open could cause a 5.5 to read 10 or a 20 to read 10. Both have been experienced and are the reasons for CBP.

**Comment:** The testing guidance in E1465 is a brand new regiment of guidance and procedures. I has not been addressed here to date. It would be really nice to have consistency in all radon documents. We could review that text for inclusion.

### 6.3 Device Deployment Periods

**6.3.1 Short-Term Devices:** Short-term devices **shall** be deployed for two to 90 days. **AG: (2 to 7 days) more desirable since most commonly used.**

Since terminating a measurement at exactly 48 hours is often impractical, some flexibility is allowed:

6.3.1.1 For integrating or equilibrating devices, retrieval of devices after 46 hours is allowed (assuming Closed-building Protocol requirements are met).

6.3.1.2 For continuous monitors, the first four hours of data may be discarded or incorporated into the result using system correction factors (EPA 520-402-R-92-004; EPA 1992c). There must be at least 44 **contiguous** hours of usable data to produce a valid average. The “backing out” of data (i.e., removal of portions imbedded in the two days) to account for weather or other phenomena will invalidate the measurement. The periodic results shall be averaged to produce a result that is reported to the client and used to make mitigation decisions.

6.3.1.3 Termination of a short term test that is longer than two days should be done as close as possible to 24-hour increments to help ensure diurnal fluctuations in radon concentrations within a dwelling are reflected in the results evenly. **Keven Stewart comment: Write “24-hour increments”**

**Comment:** Done

6.3.1.4 If a monitor cannot integrate readings each hour or less or is not set to record readings each hour or less, **then it is functioning as an integrating device and is not considered a continuous monitor** under these protocols.

6.3.1.5 Due to difficulties in establishing appropriate controlled conditions and several other related concerns, the **consensus of stakeholders found that radon decay product measurements** require additional steps to create the conditions in residences that would allow them to be used to make radon mitigation decisions in homes. Therefore, the use of working level monitors and any conversions between pCi/L and WL will be subject to the conditions described in Appendix XXXXX. **(editorial note: confirm Structure at publication)**

**Bob Stilwell: WL tests should be discouraged for these reasons. See comment on 1.3.3.**

**Comment:** See earlier comments

**6.3.2 Long-Term Devices:** Long-term devices shall be deployed for a minimum of 91 days. It is **recommended that they be deployed for a minimum of six months** to reflect seasonal changes in radon levels and building operation. Closed-building conditions are not required, but are recommended. State Radon Offices may have information on seasonal variation.

Bob Stilwell: What about requiring at least half a long term test period to include the heating season? With the info on seasonal variation, ignoring this is bad. Unless you will require all long-term tests to be a full year? I like that.

**Comment:** Since the radon dynamic is different in different regions, the recommendation was to talk to the state radon officer for guidance.

**6.4 Test Condition Verification:** The test should include methods to prevent or detect interference with testing conditions or with the testing device itself. The measurement professional or homeowner should be able to verify or provide documentation asserting that testing conditions were not violated during the testing period. A test company's minimum requirements for verifying test conditions shall be fulfilled by the following:

6.4.1 Informing the person responsible for building operation of the required test conditions;

6.4.2 Obtaining or attempting to obtain a signed noninterference agreement; Mark Veckman comment: with the management company or Owner, not the individual residents.

**Comment:** See earlier comments

Bill Levy: this is not possible in a real world apartment testing situation and should be

Bob Stilwell: get the signed agreement from each and every unit

**Comment:** The committee appreciates the diversity of opinion on this issue and believes the attempt to get a signed document is part of the informational procedure.

6.4.3 Posting a *Radon Test in Progress* notification form;

6.4.4 Conducting a visual inspection of the dwelling upon placement to assure all closed-building conditions are intact;

6.4.5 Conducting a visual inspection of the dwelling upon retrieval of the detector including: Bill Levy: again real world conditions usually preclude an inspection of the apartment interior at device deployment or retrieval

**Comment:** The committee assumes the tester can enter the unit and observe an obvious open or closed condition or other problem (and document the condition if found).

Bob Stilwell: say that the visual inspection is to confirm that proper test conditions are being met, with inspection items including:

**Comment:** This section is titled: Test Condition Verification

6.4.5.1 Closed-building conditions are still being maintained,

6.4.5.2 Changes in the detector placement,

6.4.5.3 Condition of all tamper seals (See Section 6.5), and

6.4.5.4 Abnormal variations in any of the measurements made.

Bob Stilwell:  
6.4.5.1-verification that closed building.....  
6.4.5.2-verification of no changes.....  
6.4.5.3-inspection the condition .....

6.4.5.4-reviewig results for abnormal .....

6.4.6 The measurement professional is not responsible for inspecting for closed-building conditions 12 hours before the start of the test or between placement and retrieval of the detectors.

Andy George: The measurement professional is not responsible ~~if for inspecting for~~ closed building conditions were maintained 12 hours before the start of the test or between placement and retrieval of the detectors.

Bill Levy” this is a issue with the management not the residents in apartment testing

6.4.7 If, at the initiation of the test, the measurement professional discovers or observes that closed-building conditions were not maintained, one of the following options is required:

- The radon test can be postponed until at least twelve hours of closed-building conditions have been maintained prior to the test;
- The radon test period can be extended to four days or more with an appropriate passive integrating detector after closed-building conditions are initiated; (AG)
- For continuous monitors, device features or methods may be used to obtain an average reading that represents at least 48 hours of data collected after at least twelve hours of closed-building conditions have been maintained (e.g. a test may be run for 60 hours, the first 12 hours discarded and the last 48 averaged manually).

Bob Stilwell: last bullet- Ugh. That's a lot of work, and it will probably be less expensive for everyone if they just make everyone close the building up while they are there, then come back the next day to start the test.

**Comment:** The committee observes that helping to accomplish notification and reporting any observed violations falls inherently under the management’s responsibilities. The tester owns the responsibilities outlined in these paragraphs regardless if written or not. Identifying the limits of practicality for a tester responsibility has been found to be important to the tester and all other parties.

**Comment:** The committee believes this unduly limits the testing device choice. Discussion: The 4 day caveat is most appropriate for equilibrating devices where the first day of radiation collected is the least accounted for in the analysis. CRMs with computer capability or through data recalculation are dealt with below. Otherwise, devices such as Electrets and many CRM.s, are integrating evenly. Do we bite into this long running loose end?

**Comment:** There are several devices that have this capability already and data truncation can be accomplished with not too much work in a computer. This is an option as well, however, many testers find the 60 hour closure suits their situation.

## 6.5 Other controls and aids for detecting failed compliance or interference

Mark Veckman comment: For multifamily testing, this is generally not an issue. The resident has no vested interest in tampering; generally they cooperate because it is their health at risk. These are renters, not Owners. The anti-tampering agreement needs to be with the Owner or Management company.

**Comment:** See earlier comments. These options are simply observed and not listed as required.

- ❖ Placement Indicators: A position for the device can be chosen and noted so that, upon retrieval, any handling or covering of the device can be detected.
- ❖ Seals: Non-re-sealable caulks and/or tapes can be used to verify that devices have not been altered or moved; in addition, they can be used to verify that windows or non-primary exterior doors have not been opened during the test. If broken, seals may help determine if testing conditions were altered or a device was disturbed. For a seal to be effective, it needs at least the following unique qualities:



- The seal must adhere readily to a multitude of surfaces yet be easily removed without marring the surface; **Bill Levy: tamper seals etc are not feasible in most apartment testing settings as the access will be very limited and interior inspection of other rooms impossible**
- It needs to be non-re-sealable or show evidence of disturbance;
- It must be unique enough to prevent easy duplication; and,
- It should be visible enough to discourage tampering.

**Comment:** These options are simply observed and not listed as required. The guidance is to check CBP and that necessitates access to other rooms. Other testers have not had experiences where access was denied as a regular condition.

(Most paper or plastic tapes and caulks have only some of these qualities. There are, however, a number of seals manufactured specifically for radon testing. It would be advisable to use one of these products and follow the manufacturer's recommendations for installation. The best caulking to use as a seal is a removable weather-stripping caulk. This type of caulking adheres readily to most surfaces yet comes off easily without leaving a mark or being re-sealable.)

- ❖ **Control Monitors:** The inclusion of at least a few devices that provide hourly data for fluctuations in radon and environmental factors such as temperature, humidity and barometric pressure can be helpful to aid confidence that no unusual conditions affected the measurement results.

**Andy George comment:** I doubt if humidity or pressure will provide any solid correlations. Instruments that measure humidity and pressure are for commercialization purposes.

**Comment:** These options are simply observed and not listed as required. Hourly radon data can be very helpful. Others agree that environmental data most often provides little insight. Still, a dramatic shift in humidity in humid climates or a dramatic temperature change can be valuable information. Pressure in single story buildings can sometimes help assess the affect of storms. Since this section simply observes optional and additional control options, inclusion of possible features seems appropriate. We could highlight hourly radon and note other factors can occasionally be helpful.

## 7.0 Special Consideration for Large Disagreement between Duplicate (or Collocated) Results

Minor variation between the results of duplicate (collocated) devices is typical. However, if the variation is unusually large, it may indicate problems in the measurement system which could adversely affect the entire testing series.

One situation requires special attention: Where one test result is 4.0 pCi/L or greater and the test result of the collocated device is less than 4.0 pCi/L, **if the higher result is twice or more the lower result, a repeat test is required.**

**See Appendix A and Exhibit 8 for additional information on Duplicate (collocated) results.** (editorial note: confirm Structure at publication)

## 8.0 Documentation

Sufficient information about each measurement shall be recorded in a permanent log to allow for future data comparisons, interpretations, and reporting to residence managers. The device placement log and supporting documentation shall be maintained for at least five years after testing.

**Bob Stilwell:** The 5 year retention means that, for a building with low initial radon, the results are going to be thrown out at about the same time the next test should begin. Is that a good idea? It would be best to keep them for 6 or 7 years, so the results of the next test can be compared to the previous test. It's a pretty good bet that the management company/landlord will lose their copy of the report.....

**Comment:** Committee comment??? Maybe just leaving off a time limit is even better.

**Final report documentation shall include:**

- 8.1 **Test Site:** The address of the building(s) tested, including zip code.
- 8.2 **Testing Service** information:
  - 8.2.1 The company/measurement professional’s name, contact information and current certification ID number or equivalent state certification ID number as applicable,
  - 8.2.2 The name and identification number of the service or organization used to analyze devices.

- 8.3 **State Radon Office** contact information. **Bob Stilwell: thank you!!!!!!!**
- 8.4 **A summary of measurement results** and a statement outlining any recommendations concerning retesting or mitigation. Interpretations and recommendations both written and verbal shall be provided in accordance with this document and as appropriate to EPA’s *Home Buyer’s and Seller’s Guide to Radon*, EPA’s *Citizen’s Guide to Radon*, or State or other regulatory agency written documents.

**Comment:** While not in EPA’s Home Measurement Protocols, it was a loose end at 13<sup>th</sup> hour in closing of proceedings of the MAH Home protocol. The next round of MAH will likely see this approved, also.

**Bob Stilwell:** State requirements and required language are also a consideration with the report.

**Comment:** See re-write

- 8.5 **The report shall contain all valid individual measurement results.**
  - 8.5.1 When using continuous radon monitors, hourly readings shall be included.
  - 8.5.2 Measurements made in separate locations shall NOT be averaged. They must be reported individually.
  - 8.5.3 The average of collocated measurement devices shall be reported as well as the individual results. (Note: If the average of two measurements produces a result of 3.95 pCi/L, standard mathematical rules should be followed and such average shall be reported as 4.0 pCi/L.)

**Mark Veckman comment:** This appears to be incorrect. If the result is 3.95, then the result is reported as 3.9 because this is not equal to or greater than 4. If a single result is 3.99 it should be truncated and reported as 3.9; you can add all the trailing 9’s you want and the result is still less than 4.0. Same logic applies to duplicate averages. Only 1 significant figure. Excel may round up a display to show 4.0 at 3.95, but any Excel decision logic is based on the actual calculated value, no rounding. Should probably follow same rules. Base any decision logic on actual calculated values.

**Comment:** The committee refers to Bob Lewis’ comment and the standard mathematical rule for rounding up from a 5. Since it has have long been required to report in a single decimal digit, reporting a 3.99 as under 4.0 would not likely be defensible if an affected party called into question legal aspects of that interpretation. We observe this both for the tester’s position and for the validity of this document.

**Bob Lewis comment:** Should it be made clear that this rounding convention applies to all measurement results, and not just the one on either side of 4.0 pCi/L. I do understand the importance of that example.

- 8.5.4 Any quality control measurements shall be reported as such.
- 8.5.5 Radon gas results shall be reported to only one figure after the decimal (e.g. 3.2 pCi/L). **Keven Stewart comment:** This item is not a sub-item under 8.5.4 and should be numbered 8.5.5 instead.

**Deleted:** 4.1

**Comment:** Done

## 8.6 Device information:

Mark Veckman comment: This is excessive for multi family. I can't imagine having 100 drawings showing exact placement of a radon sample, nor pictures. A verbal description such as "living room end table by couch" should be sufficient. This consistent with the log sheet. Again, think about what a lawyer would do to a consultant who did not have drawings or pictures.

**Comment:** The guidance is that it is advisable, not required. To use this data for comparison purposes for future or past tests, add'l documentation is required.

- 8.6.1 Documentation of the locations of all devices deployed. It is advisable to diagram the test area noting the location and measurement results of the device. Supplemental photographic records for test locations are advised.

Bob Stilwell: Documentation of devices MUST include device ID number along with location. You need to be able to see that device XXXXXXXXXXXX was in room YYY, on the coffee table in the NW corner (or wherever). This is needed for planning short or long term follow up tests, when interpreting results, verifying QA/QC, or re-tests down the road.

**Comment:** The notation below shows an exhibit of what would be expected on a data sheet and the example includes device ID. 8.6.3 specifically covers the device number inclusion.

See **EXHIBIT 3** for an example *device placement log*.

- 8.6.2 The exact start and stop dates and times of the measurement exposure period
- 8.6.3 A description of the devices used including its identification/serial numbers.
- 8.6.4 A record of quality control measures associated with the test such as results of duplicate and blank measurements.
- 8.6.5 A description of any non-interference controls used and copies of signed non-interference statements.
- 8.6.6 Missing, lost and non-retrievable devices.

We could combine 8.6.1 and 8.6.3 if it seems important to emphasize the coupled intent prior to the guidance Exhibit reference.  
8.6.1 Locations and devices  
8.6.1.1 location text 8.6.1.2 serial numbers.

## 8.7 A description of any observed deviations from appropriate measurement procedures or other factors that may affect the measurement result, including:

- 8.7.1 Observed non-compliance with required conditions such as closed-building conditions, changes in the device's placement, whether any seal has been altered or test interfered with;
- 8.7.2 A description of the observed condition (open/closed or n/a) of any permanent vents such as crawl space vents or air supply to combustive appliances;
- 8.7.3 Units that were tested and vacant during the test period;
- 8.7.4 Un-testable locations.

## 8.8 Test Conditions

The Report shall contain sufficient information to allow clients to compare the data and interpretations to any future tests.

- 8.8.1 A description of any unusual or severe weather conditions shall be included
- 8.8.2 Any observed or discovered deviation from the required test conditions prior to or during the test period that the test company discovers, including deviation from a normal occupied temperature, shall be included
- 8.8.3 Any deviations from standard measurement procedures shall be included
- 8.8.4 Whether the responsible individual signed the noninterference agreement shall be included
- 8.8.5 Copies of signed noninterference agreements should be included
- 8.8.6 A description of any noninterference controls used should be included
- 8.8.7 A description of the condition of any permanent vents that allow outdoor air into the building, such as crawl space vents or combustion air supply to combustive appliances should be included. The report shall document for the client that the test may not reflect the client's risk from radon if the condition of the vents is altered from the condition existing during the test period.
- 8.8.8 If a permanently installed ventilation system, such as a heat recovery ventilator or air-to-air heat exchanger, is active during the test, the report shall document for the client that the test may not reflect the client's risk from radon if the systems are operated differently than during the test period.

8.9 **Mitigation System Status** (if applicable)

- 8.9.1 The test company shall include a statement in the test report if a mitigation system was observed in a dwelling during the placement or retrieval of the detector(s).
- 8.9.2 Whether the mitigation system fan was operating. **AG comment: Make sure it is operating during test.**
- 8.9.3 A statement may be included in the report that the test company offers no findings as to the proper operation of the system.

**Comment:**  
This seems implicit in the comment and is covered in 6.2

Keven Stewart: I suggest the addition of language much like that of 8.8.7 and 8.8.8 as follows:

- 8.9.4 If a mitigation system is installed in the building, the report shall document for the client that the test may not reflect the client's risk from radon if the system is operated differently than during the test period.

**Comment:** Good or redundant? Committee should vote.

8.10 **Statement of Test Limitations**

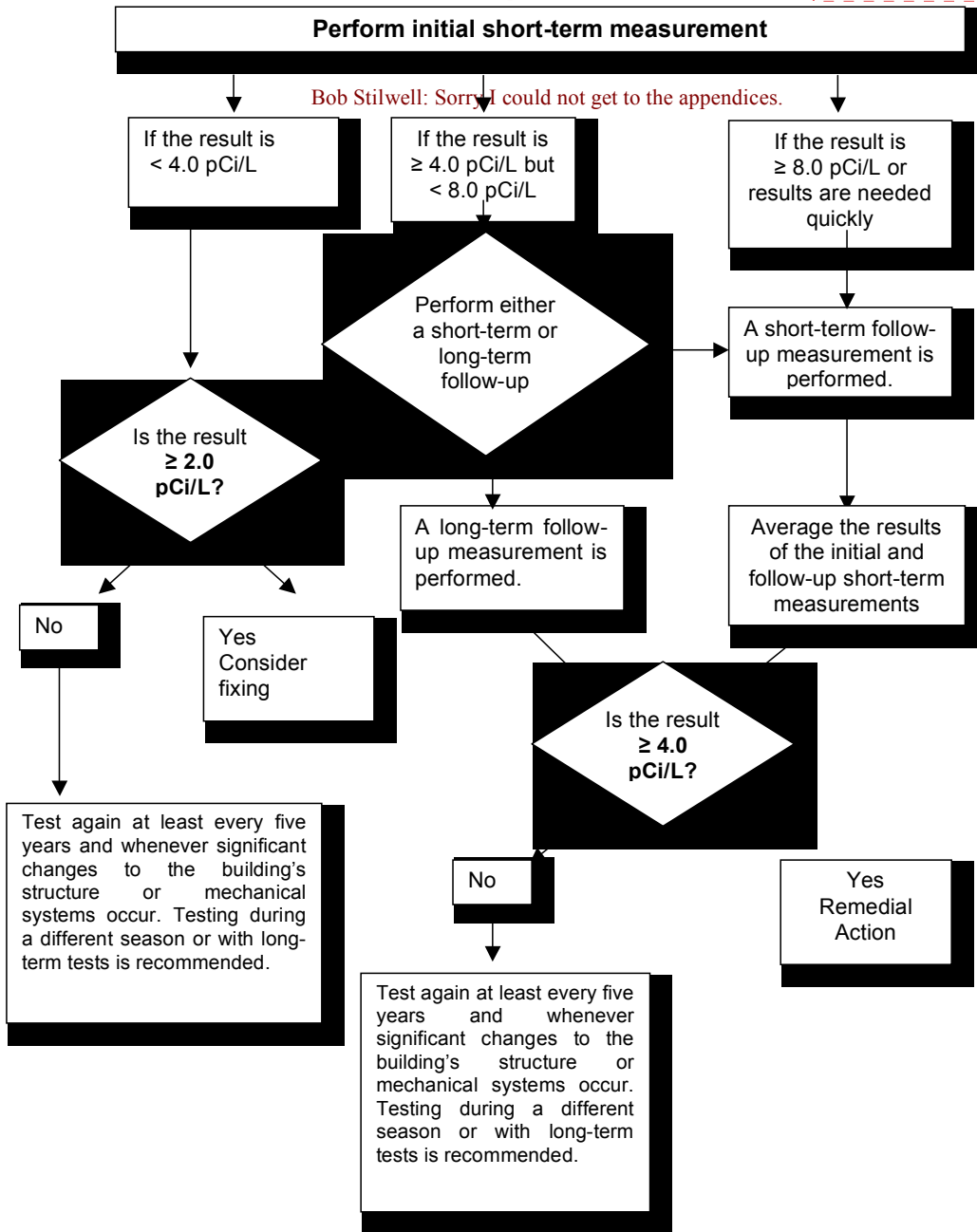
The report should describe the general limitations of the test.

- 8.10.1 An example is the following: “There is an uncertainty with any measurement result due to statistical variations and other factors such as daily and seasonal variations in radon concentrations in radon concentrations. Variations may be due to changes in the weather, operation of the dwelling, or possible interference with the necessary test conditions.”
- 8.11 **Recommendations for Actions and Retests** shall be included and should reflect guidance provided in the Introductory Guidance to Resident Managers (attached above) or as recommended or required by the state radon office for the location of buildings being tested.

# Extended Testing Process

Andy George comment: I believe this is obsolete due to all the experience we have had in the field.

Comment: Concern acknowledged above.



## Time-Sensitive Testing

Perform one of these short-term measurement options.

**Simultaneous Option:**  
Place two short-term test devices next to each other no less than 4 inches apart

**Sequential Option:**  
Place a short-term test device

**Continuous Monitor Option:**  
Place a continuous monitor test device.  
*(These devices must provide readings at least hourly)*

Average the results of the two measurements.

Place a second similar test device in the same location when retrieving the first device. **(Do not disclose any readings until the results of both devices are available.)**

Is the result  $\geq 4.0$  pCi/L?

**Yes**  
Immediate Remedial Action

**No**

Is the result  $\geq 2.0$  pCi/L?

**No**

**Yes**

Test again at least every five years and whenever significant changes to the building's structure or mechanical systems occur. Testing during a different season or with long-term tests is recommended.

Consider fixing.



## Appendix A

### DESCRIPTIONS OF MEASUREMENT DEVICES AND QUALITY CONTROL MEASURES

#### DESCRIPTIONS OF MEASUREMENT DEVICES

Integrating or Equilibrating Devices: A radon measurement system in which the sampling device, detector, and analysis system often do not function as a stand-alone unit. Integrating devices include electret ion chambers, alpha track monitors, and continuous monitors that are not set to, or are incapable of, recording radon concentration in time increments of one hour or less. Equilibrating devices include activated charcoal kits and liquid scintillation vials. *Integrating* and *Equilibrating* devices often require laboratory analysis.

Continuous Device: Test device that records reviewable measurements of radon or radon decay products (progeny) concentration in time increments of one hour or less.

#### Abbreviations for Devices referenced in this document

Integrating Devices	Continuous Devices
ES -- Electret Ion Chamber (short-term)	CR -- Continuous Radon Monitor
EL -- Electret Ion Chamber (long-term)	CW -- Continuous Radon Progeny Monitor
AT -- Alpha Track (filtered)	
Other--Designed or set to not record hourly	
Equilibrating Devices	
AC -- Activated Charcoal	
LS -- Charcoal Liquid Scintillation	

#### Equilibrating Devices

##### AC – Activated Charcoal Devices

ACs are equilibrating devices. The charcoal within these devices has been activated to increase its surface area which increases the ability to adsorb gases. The equilibrating nature of the activated charcoal allows continual adsorption and desorption of radon. During the entire measurement period (typically forty-eight hours to seven days), the adsorbed radon undergoes radioactive decay. ACs should be promptly returned to the laboratory after the exposure period (by service that guarantees delivery within two to three days at maximum). AC devices are analyzed by gamma-ray spectroscopy which measures the emissions of gamma rays from two short-lived decay products of radon,  $^{214}\text{Pb}$  and  $^{214}\text{Bi}$ .

##### LS – Charcoal Liquid Scintillation Devices

Charcoal liquid scintillation (LS) devices are equilibrating devices that function on the same principle as charcoal devices. LS devices adsorb radon onto the charcoal in a vial. LS devices must be resealed and sent to the laboratory for analysis promptly after the

exposure period (by service that guarantees delivery within two to three days). They are called “liquid scintillation” devices because they are analyzed by mixing the charcoal containing the radon with an organic cocktail and then counting, in a liquid scintillation counter, light pulses emitted due to the emission of alpha and beta particles from radon and its short-lived decay products.

## **Integrating Devices**

### **EL/ES – Electret Ion Chambers**

Electret-ion chamber devices (EL/ES’s) are integrating devices that allow radon to diffuse into a chamber through a filter. Radiation emitted from the decay of radon and its decay products produces charged particles (ions) within the chamber. The negative ions are attracted to the positive charged electret and discharge it. (Andy George) The electret is removed from the canister and its voltage measured with a special surface electrostatic voltmeter both before and after the exposure period. The difference between these two voltage readings is used to calculate the average radon concentration. The devices are analyzed by a certified individual or laboratory using a special electrostatic voltmeter that can measure the decrease in voltage.

EL/ES’s are designed to measure for short periods of time (e.g. 2 to 5 days) or for long periods of time (e.g. 9 months). The type of the electret (i.e. short or long-term) and chamber volume determine the usable measurement period. The electret readings are affected by ambient gamma radiation ionizing air inside the chamber, and the readings must be corrected for external gamma-rays.

### **AT – Alpha Track Devices**

An alpha track device (AT) is an integrating device consisting of a small piece of plastic or film (the sensor) enclosed in a housing with a filtered opening. Radon diffuses through the filter into the housing where it undergoes radioactive decay. This decay produces alpha particles that strike the sensor and generate submicroscopic damage called alpha tracks. The damaged portions of the plastic can be made visible by etching in a caustic solution, because the damaged areas are more soluble in caustic than the undamaged plastic. The etched areas can be seen using a microscope. The tracks are typically counted using computer recognition and automated scanning. The number of tracks per unit area is proportional to the integrated average radon concentration in pCi-days/liter. AT’s are most commonly used for measurements of 91 to 365 days.

### **Other Integrating Devices:**

Devices that use various other sensors and technologies for integrating data over time. If such device cannot integrate or record readings each hour or less or is not set to record readings each hour or less, then it is functioning as an integrating device.

## **Continuous Monitors**

### **CR and CW – Continuous Radon Monitors and Radon Progeny Monitors**

Continuous monitors are the only electronic devices mentioned in this list. They use various types of sensors. Some collect air for analysis with a small pump while others allow air to passively diffuse into a sensor chamber. All have electrical circuitry capable of producing and recording integrated radon concentrations for periodic intervals of one hour or less.

Continuous radon monitors measure radon gas. Continuous radon progeny monitors measure radon decay product concentrations and require a pump to sample air containing radon decay products onto a filter assembly. **AG: They are commonly called Continuous WL monitors. (There are no passive CWL monitors.)**

**Comment:** RPSIU;s and E-PERMS can test for progeny passively.

## DEVICE QUALITY CONTROL

Terminology associated with *quality control (QC)* is briefly explained below.

### **Duplicate (Collocated) Measurements**

Duplicates are pairs of devices or monitors deployed in the same location, side-by-side for the same measurement period. The purpose of duplicates is to evaluate precision or agreement between devices. (Note: Duplicates do not evaluate accuracy; for accuracy, see spiked measurements below.) Duplicates may help identify problems that may introduce error into the **large** test results. Duplicates are typically deployed at a rate of 10% of the measurement locations. When establishing a **large** testing service's overall quality control plan up to fifty duplicates per month are recommended. However, a specific testing program such as herein discussed for multi-family buildings may require additional duplicate measurements.

(Andy George)

In theory, field duplicates should provide the same radon result. Duplicate pairs of measurements greater than or equal to 4 pCi/L should produce a Relative Percent Difference (RPD) greater than 36% no more than 1% of the time. Greater than 1% duplicates above 4 pCi/L with an RPD greater than 36% indicates the measurement system is "out of control," and all measurements are questionable.

**See Appendix 8 for information on calculating the RPD and keeping control charts on that information.**

If one duplicate is equal to or greater than 4 pCi/L and the other below, the higher result may not be twice or more than the other. Such measurements must be repeated.

### **Blank Measurements**

Blanks are integrating or equilibrating devices that are not exposed to indoor air (i.e. not unsealed to permit radon to enter the device). Blanks help evaluate any detector response from sources other than radon exposure at a testing location such as in the manufacturing process, shipping, storage, handling and the like. Blanks are typically deployed at a rate of 5% of the measurement locations. When establishing a **large** testing service's overall quality control plan up to 25 blanks per month are recommended. However, a specific testing program such as herein discussed for multi-family buildings may require additional blank devices. **(AG)**

Blanks are unwrapped (but not opened) and immediately re-wrapped to give the appearance that they have been used in testing. The blanks are then shipped with the exposed devices so that the laboratory cannot distinguish them.

Since blanks are not exposed, their measurement value should not be above the lower limit of detection (LLD—the radon concentration below which the measurement system cannot accurately measure). Depending on the device, if one or more results are greater than the LLD, this may indicate defective devices, poor quality control or improper procedures. If a problem is identified, the device supplier should be contacted to evaluate and institute corrective procedures. (AG)

### **Spiked Measurements**

Spikes are devices that have been exposed in a NEHA-NRPP or NRSB-NRP approved chamber to a known concentration of radon (i.e. “spiked” with radon). Using spiked devices can help evaluate the accuracy of a laboratory analysis and/or how accurately devices supplied by a laboratory measure radon.

Deleted: (i.e. “spiked” with)

[Bob Lewis comment: “Spikes are devices that have been exposed in a NEHA or NRSB approved chamber;...”]

Comment: done

Bill Levy: this seems to mix the lab's protocol with a field requirement and add field requirement for "each batch" of radon devices to be spiked, again a field practical requirement

Comment: See earlier comments

Detectors from the same batch as those slated for the sampling program should be spiked and returned to the laboratory for analysis as near the sampling period as possible. Many devices are time sensitive and should be returned to the laboratory for analysis immediately after spiking. In general, spikes should be included at a rate of no less than 3 per 100 sampling locations. When establishing a large testing service’s overall quality control plan up to six spikes per month and a minimum of three per year are recommended. However, a specific testing program such as herein discussed for multi-family buildings may require additional spiked devices. If the result of a spike differs greatly from the spike’s known concentration, it may indicate that the devices are defective or the laboratory procedures are faulty. (AG)

Comment: This is not EPA guidance and needs much larger discussion if it is to be changed.

The results from spikes should be compared to the known value provided by the reference facility where they are spiked using the formula for Relative Percent Error (RPE) The RPE should be plotted on a control chart. EPA 402-R-95-012, *Guidance on Quality Assurance*, Appendix A, provides guidance on how to set warning and control limits. In general, the expectation is that the values of RPE fall between +10% and -10%, but the entire range of +20% to -20% is considered “in control.” Outside of +/-20% but inside +/-30% is the warning level and outside of +/-30% is the control limit.

**See Exhibit 9 for information on calculating Relative Percent Error.** (editorial note: confirm Structure at publication)

### **Quality Control for Continuous Monitors**

Continuous radon monitors require annual calibration and background checks. Cross-checks should be performed at least every six months. Duplicates using a continuous monitor or a co-located device that reads in the same units (pCi/L or WL) should be deployed in 10% of the measurement locations. The agreement of duplicate results should be calculated using the RPD as above and plotted on control charts.

[Andy George comment: We are talking about radon monitors (first phrase above). Why mention WL?]

[Bob Lewis comment: Second to last para. How is device defined? Is it another CR or could it be a charcoal or E-PERM?]

For more information on QC for continuous monitors, refer to National Radon Proficiency Program Guidance on Quality Assurance (EPA 402-R-95-012) in lieu of other consensus protocols that may be developed.

**Comment:** Committee=-want WL in there?

Maybe add: Collocating devices to seek an estimate of Equilibrium ratio utilizing devices that individually measure pCi/L and WL respectively are not duplicates for the purposes of Quality Control.

**Comment:** This is defined by "or co-located device that reads in the same units." There are advantages and disadvantages for same devices. Same devices aid precision verification. Devices deriving calibration from a different chain of verification aid bias verification even though the device mechanisms may introduce bias differences while making comparisons. Much like device inter-comparisons over the years, the comparisons should reveal less than 25% and normally less than 10% variation.

## Appendix B

### Radon Decay Product Measurement:

The scope of this measurement standards document includes reconciling previous standards documents and guidance publications and adding updated information that relates to home measurement in order to achieve a protocol deemed credible by the stakeholder delegates.

Items specific to radon decay product measurements in homes were reviewed and considered in an open forum as well as within the subcommittee of stakeholder delegates. Considerations particular to radon decay product measurements include specific controls for closed building test conditions and specific considerations for reporting test results and any conversions between units of measurement. At this time, existing documents were not found to adequately address these considerations and science has not been presented regarding establishing appropriate conditions for radon decay product measurements in homes.

Therefore, Appendix B has been designated as the location in this document for additional protocols specific to the measurement of radon decay products in homes. Scientific studies delineating appropriate protocols are being solicited for review and evaluation through the stakeholder process. Until completion of that process, the use of radon decay product measurements to make mitigation decisions in residences is not supported by this standard.

#### ***NOTICE***

*The committee is formally soliciting suggestions on the wording of the protocol that will standardize testing conditions in residences sufficiently to provide confidence in radon decay product measurements for residential real estate transactions and consumers' interest, and on wording for appropriately using conversion information and conversion factors. Since a comparatively small pool of existing protocol text exists regarding specific considerations for working level measurements, supporting scientific documentation will be needed for proposed wording in order to maintain the integrity of the document and confidence of those using the protocol.*

*The committee is looking forward to active participation from all interested parties in developing a protocol that will be respected by stakeholders across the spectrum.*

*All such submissions must be forwarded to [standards@aarst.org](mailto:standards@aarst.org) or faxed to (913) 273-0134 780-0139 in order to receive consideration. Submissions will then be posted by AARST staff for workgroup and committee review. (Comment: the consortium's Efax number)*

## Appendix C

### Other Measurement Considerations:

#### 1) Testing in *karst* Areas:

Mark Veckman comment: This might be better left out of the protocols and left to local professionals.

**Comment:** Committee members who reside in these areas believe it is critical to alert property managers and professionals to this issue.

The scope of this measurement standards document includes adding updated information that relates to home measurement in order to achieve a protocol deemed credible by the stakeholder delegates. Items specific to *karst* geology or topography were expressed in open forum as well as reviewed and considered within the subcommittee of stakeholder delegates.

While rare, homes in regions where *karst* geology or topography exists have been shown in studies to have potential for wide variations in radon concentrations. Confirming low results by repeating tests during different seasons and weather conditions or with long term testing may be especially important for such regions.

Considerations particular to *karst* geology or topography include the ability for consumers to readily identify if a home is located in an area that might be susceptible to wide variations in radon concentrations due to *karst* geology or topography. At this time, existing documents were not found to adequately address this consideration. Radon departments in some states may have information on the presence of *karst geology or topography* in their area and should be consulted for special testing considerations in those areas.

While draft protocols have been prepared, Appendix XXXX has been designated as the location for guidance and additional protocols specific to the measurement of homes located in areas of *karst* geology or topography. Scientific studies delineating applicable geological areas and appropriate protocols are being solicited for review and evaluation through the stakeholder process.

#### 2) Effects of Building Styles on Radon Concentration

#### 3) Effects of Emanation from Building Materials

#### 4) Testing of Upper Floors

Committee discussion: Some committee members have noted the upper floor problems seen in Florida, Georgia and Tennessee caused by building materials. Considerations have also been noted regarding European guidance. Discussion within committee has been limited to date. A determination regarding responsible guidance or requirements is in the beginning phases.

Mark Veckman comment: South Florida (S of Ft. Lauderdale) has a problem with uranium in cement building materials. I have had 5-6 sites with this issue. Standard mitigation techniques don't work. Leave this area up to local professionals. Maryland, Virginia, and DC don't have this issue.



Location	net radon flux pCi/sq M/sec	range found in other building with elevated radon
Apt 1201 utility room	0.304	0.150 – 0.750
Apt 1201 tile floor	0.0 increase	NA
Unfinished area	0.502	0.150 – 0.750
Column face	0.133	0.150 – 0.750

**Provided by Radon & Mold Professionals** John Cosgrove, CIE, CRMI Doug Wall, CIE, CRMI  
email: wallradon@comcast.net www.radonmoldhelp.com www.naplesmoldinspection.com

The 22 nd floor for sure but probably the 25 or 27 th floor. In most high rises the levels jump around, the 2nd and 4th floor can be high and not the 6th but then the 10th and 15th are high and so on. 2005 is probably the best year, these are from 06&07

Building & Apt #	Device Location	Device ID	Radon pCi/ L	Average Radon pCi/ L	Comment
------------------	-----------------	-----------	--------------	----------------------	---------

"only way to know is to test"

Doug

pdf	unit # is floor		Naples
16824	8787 bay colony #901	6.6	3-6-06
4539	6597 nicholas blvd #1404	4.9	6-13-2006
4265	410 flagship dr #806	7.5	6-15-06
8422	6597 nicholas blvd #1204	5.2	6-23-06
8590	6597 nicholas blvd #1504	4.2	7-7-06
27337	8111 Bay Colony #1704	5.7	8-14-06
11021	6597 nicholas blvd #501	4.3	8-16-06
26863	12701 masticque beach #1904	9.5	8-30-07 Ft myers
30490	6825 Grenadier blvd #1904	10.9	7-13-07< SPAN s tyle="mso-spacerun: yes"> Naples

--

**Provided by Bill Levy**

**Radon Flux (Emanation) from Concrete Surfaces** Testing for concrete slab radon flux was conducted on apartment 1201 AC utility room floor and on the ceramic tile floor surface inside the unit, on the slab in the unfinished kitchen area floor slab and on the vertical concrete column surface. A RadElec H E-Perm propriety test method was utilized. There are no existing standards or data relating to radon flux and to indoor radon levels.

**Radon Flux From Concrete**

**Conclusions** The evaluation did not discover a source of radon soil gas consistent with the measured indoor radon levels. A major contribution from some of the concrete building materials is suspected. Elevated indoor radon levels were not present in the ground floor areas tested as well as inside the elevator shaft enclosure.

A system to mitigate the radon utilizing Energy Recovery Ventilation (ERV) technology may present some challenges due to the A/C system design.

1201	A/C room	K181	10.6	10.6	
------	----------	------	------	------	--

1201	A/C room	K182	10.6		
1201 (B)	MBR	K183	10.2	10.2	
1201 (B)	MBR	K184	10.3		
South	Elev top	K185	2.5	2.5	
South	Elev top	K186	2.4		
S Gnd Flr	Unfin area	K187	0.8	1.0	
S Gnd Flr	Unfin area	K188	1.2		
1507	LR	K189	7.7		
1607	LR	K190	2.7		
1407	LR	K191	6.8		
1207	LR	K192	7.7		
1107	LR	K193	9.7		
1007	LR	K194	11.7		
907	LR	K195	8.1		
807	LR	K196	8.4		
607	LR	K197	9.7		
507	LR	K198	8.5		
307	LR	K199	6.7		
107	LR	K200	4.4		
1201	LR	CRM	8.5		
104	LR	CRM	8.0		
S Guest	RM	CRM	1.5		
S Hall	X 1201	J161	6.4	6.5	
S Hall	X 1201	J162	6.6		
S Hall	X 104	J163	3.9	4.0	A/c off ??
S Hall	X 104	J164	4.0		

**TABLE 1**

\*\* the radon test results shown in this report are intended only for use within the scope of this analysis, some radon tests were placed and retrieved by non-DOH certified individuals.

A Swedish protocol was distributed that entailed one device for each upper floor (or at least 20% of dwellings on each floor). Food for thought.

**Appendix Overview:** This Appendix intends to describe special situations. Not all have been reconciled or possibly even thought of yet within the committee. **Recommendations are welcome.**

## Appendix D

### Definition of Terms

<b>Active Radon Monitor:</b>	See <b>Continuous Radon Monitor</b> AG Comment: Delete
<b>Client:</b>	The individual or parties who hire(s) and/or pay(s) for the radon test.
<b>Collocated:</b>	Two <b>or more</b> measurements in the same location, or side-by-side (AG)
<b>Continuous Radon Monitor:</b>	Test devices that are capable of, and set to, record and review radon in time increments of one hour or less.
<b>Crawl Space:</b>	An open area beneath part or all of the livable space of a dwelling that typically has either a concrete slab or dirt floor. The dirt floor may be covered with gravel or a membrane. The crawl space can have an open height of a few inches to several feet. The crawl space can be storage space but is not living space, and may or may not be ventilated to the outside.
<b>Crawlspace Depressurization (CSD):</b>	For the purposes of this document, a radon reduction technique seeking to achieve lower air pressure in a crawlspace than in the rooms bordering and above the crawlspace. A soil depressurization fan draws air from the entire crawl space rather than from under a plastic membrane (as employed for Submembrane Depressurization that is preferred when practical). Crawlspace depressurization is intended to mitigate rooms bordering and above the crawlspace but not the crawlspace itself.
<b>Crawlspace Isolation (CSI):</b>	For the purposes of this document, isolation of crawlspace air from rooms bordering and above a crawlspace..
<b>Equilibrating Device:</b>	A radon measurement system in which the sampling device, detector, and analysis system do not function as a stand-alone unit. Equilibrating devices include activated charcoal kits and <u>activated carbon</u> liquid scintillation vials. These devices typically <del>require</del> laboratory analysis. (AG) <span style="float: right; border: 1px solid green; border-radius: 15px; padding: 2px;">Comment: Removal makes sentence meaningless</span>
<b>Exposure time:</b>	The length of time a device must sample for radon to get an accurate measurement. Also called “exposure period,” or “duration” <span style="float: right; border: 1px solid green; border-radius: 15px; padding: 2px;">Deleted: “exposure parameters,”</span>

of exposure.” | Andy George recommends deleting “exposure parameters” |

Comment: done

**Extended Testing:** An initial short-term test is followed up by a short- or long-term test if a radon concentration is found to be elevated. The decision to mitigate is based on the average of two short-term tests or the result of the long-term test.

**Integrating Device:** A radon measurement system in which the sampling device, detector, and analysis system often does not function as a stand-alone unit. Integrating devices include electret ion chambers, alpha track monitors, and continuous monitors that are not set to, or are incapable of, recording radon concentration in time increments of one hour or less. These devices most often require laboratory analysis. | Andy George comments that he is not aware of this type of CRM. Noted to delete and also to say these devices require laboratory analysis (always). |

**HAC Systems:** Heating and cooling (air conditioning) systems that are not designed to also supply fresh air ventilation. HAC systems are common to single-family residences. If they also provide fresh air ventilation, they are more technically referred to as HVAC systems.

Comment: The ProSeries III have been accepted by the EPA to test in real estate transactions if they are deployed as passive devices

**HVAC System:** Heating and cooling (air conditioning) systems that are additionally capable of supplying fresh air ventilation. If they do not supply fresh air ventilation, they are more technically referred to as HAC systems.

**Measurement Professional:** Any person, persons or entity who performs radon testing for remuneration. A measurement professional shall adhere to Section XXXX. Andy George: Certified Person?

**Mitigation system:** Any system designed to reduce radon concentrations in the indoor air of a building.

**Multi-family building:** A building with more than three attached dwellings.

Mark Veckman comment: A building with more than ~~three~~ four or more attached dwellings. |

Comment: See earlier comments

**Passive device:** See integrating device or equilibrating device.

**Picocurie (pCi):** One pCi is one trillionth (10E-12) of a curie, 0.037 disintegrations per second, or 2.22 disintegrations per minute.

**Picocurie per liter (pCi/L):** A unit of concentration of radioactivity corresponding to an average of one decay every 27 seconds in a volume of one liter, or 0.037 decays per second in a liter of air or water. 1 pCi/L = 37 becquerels per cubic meter (Bq/m<sup>3</sup>).

Andy George: A unit of concentration of radioactivity corresponding to ~~an~~

~~—average of one decay every 27 seconds in a volume of one liter, or 0.037 decays per second~~ or 2.22 decays per minute in a liter of air or water. 1 pCi/L = 37 becquerels per cubic meter (Bq/m<sup>3</sup>).

**Primary test location:** A location where test results will be used to make a mitigation decision. All relevant testing protocols must be followed for each primary testing location.

**Quality assurance (QA):** A complete program designed to produce results which are valid, scientifically defensible, and of known precision, bias, and accuracy. Includes planning, documentation, and quality control (QC) activities.

**Quality control (QC):** The system of activities to ensure a quality product, including measurements made to ensure and monitor data quality. Includes calibrations and backgrounds, duplicate, blank, and spiked measurements interlaboratory comparisons, audits, and other control activities.

**Radon (Rn):** A colorless, odorless, naturally occurring, radioactive, inert, gaseous element formed by radioactive decay of radium (Ra-228) atoms. The atomic number is 86. Although other isotopes of radon occur in nature, in this document, radon refers to the gas Rn-222.

**Relative Percent Difference (calculations):** The relative percent difference between a pair of duplicate measurement devices is calculated by dividing the difference between the two results by the average of the two results and multiplying by 100.

Note: The editor is uncertain if the most proper rendering is provided for these equations.

$$\frac{(\text{Result A} - \text{Result B})}{\left(\frac{\text{Result A} + \text{Result B}}{2}\right)} \times 100$$

Example:

Result A = 6

Result B = 8

$$8 - 6 = 2$$

$$8 + 6 = 14$$

$$\frac{2}{7} = 0.2857$$

$$\frac{2}{7} \times 100 = 29\%$$

**Relative Percent Error (calculations):** The relative percent error (RPE) is the difference between the known or reference concentration of radon used by a chamber to spike a device and the measured concentration of the spiked sample, expressed as a percentage of the known concentration. The RPE may be either a positive or negative number, indicating whether the measured concentration is higher or lower, respectively, than the known concentration. RPE is calculated by subtracting the known concentration from the measured concentration, dividing by the known concentration, and multiplying the result by 100%.

$$\frac{(\text{Result A} - \text{Result B})}{\text{Result B}} \times 100$$

Where Result A = the measured concentration  
 And Result B = the known or reference concentration

Example:

Measured concentration = 6

Known concentration = 8

$$6 - 8 = -2$$

$$\frac{-2}{6} \times 100 = -33\%$$

**Single Family Dwelling:** A residence or home intended to house a single family and requiring discrete testing location(s).

**Standard Operating Procedure:**

A written document which details an operation, analysis, or action whose mechanisms are prescribed thoroughly and which is commonly accepted as the method for performing certain routine or repetitive tasks.

**Test Interference:** The altering of test conditions prior to or during the measurement in order to change the radon or radon decay product concentrations, or the altering of the performance of the measurement equipment.

**Time Sensitive:** A measurement strategy that involves a single phase of testing, requiring enhanced quality control measures. Time-sensitive tests included Simultaneous, Sequential, and Continuous Monitor ~~(Active)~~ Device testing. ~~(AG)~~

**Comment:** These terms were discussed and active was to be used as ell

**Other terms may be appropriate for inclusion in this section.**



## Appendix E

### CHECKLIST FOR SELECTING A SERVICE

#### *Selecting a Measurement Service*

1. Contact your State Radon or EPA Regional Office (Appendix B, C or D) and request a list of State-Licensed or NEHA-NRPP or NRSB certified professionals.
2. Verify the state license (or NEHA-NRPP or NRSB certification) of the professionals performing the tests and the firms analyzing the detectors by requesting a copy of their current License or Certification Card.
3. Consider checking their references and business history regarding complaints or regulatory actions and any resolutions with your State Radon Office, Better Business Bureau, and State Office of Consumer Protection.

#### *Requesting a Cost Estimate*

4. Invite the measurement professional to walk through your building(s) before formulating their estimate. Request that they complete *Steps 1 through 4* of APPENDIX F. These steps serve as a guide for estimating the number of detectors needed and the time that is required to test your building.

#### *Developing a Contract*

5. After selecting a measurement contractor, request that they prepare a contract detailing the terms described in the proposal. Carefully read the contract before signing. Consider including the following in the contract:
  - A limit on the time required to report the measurement (often within 30 calendar days after completion of testing).
  - A description of exactly what work will be done prior to and during the testing period, the time and logistics required to complete the work, and the total cost of the job including all applicable taxes, permit fees, down payment (if any), and terms of payment.
  - A statement that the measurements will meet the standards herein or as recognized by your State, the USEPA, or nationally recognized radon certification program. A statement that they adhere to a QA and QC plan. **AG**
  - An outline of the responsibilities of each party in the event that measurements do not fully meet these standards. When the fault is the contractor's, provisions might include re-testing affected dwellings at no cost to the property owner. When the fault is beyond the control of the contractor (i.e. occupants losing detectors, occupant non-compliance, occupants refusing access, etc.) provisions might include a description of possible remedies and related additional expense.
  - A statement that liability insurance and applicable worker's compensation coverage is carried by the organization in the event of injury to persons or damage to property during the measurement process.

## Appendix F

### PROCEDURAL CHECKLIST FOR TESTING

The following procedural checklist represents a step-by-step guide for conducting a radon testing program for a multi-family, residential building. The reader should be familiar with the issues discussed in SECTIONS II and III of this document before using this checklist. In addition, the reader should review and understand each section of this checklist before proceeding through the steps. **Andy George comment:** Test professional instead of “reader”?

#### Planning a Test

**Comment:** This protocol is also designed for a Property Manager or owner who chooses to test his own property.

1. Develop a floor plan that identifies all the testing locations that are in contact with the ground, are above a crawl space or as otherwise required herein for test locations. Note, the residential manager or head maintenance person may have floor plans available. You might consider scheduling a time with maintenance personnel to “walk through” the building complex to identify testing locations.  
**Mark Veckman comment:** Also, get a list of units in contact with the ground or over crawl spaces from property management.
3. Mark an “X” on the floor plan for areas appropriate for testing.  
**Mark Veckman comment:** Suggest this be deleted. Will end up with non-professionals making decisions on testing locations. Better left to the professional placing the devices.
  - a. Note any obstacles that may prevent access or appropriate test conditions. (i.e. Is there a personal lock on door and no key available to open the door?)
  - b. Make appropriate considerations for detector placement within the area to be tested.
    - Will you need any special material (e.g. tape, thumb tacks, scissors, string, etc.) to place the device?
    - What technique will you use to detect tampering?
3. Choose a test strategy that fits your situation (Extended or Time Sensitive Protocols). Take note of quality control requirements for the strategy chosen.
4. **Duplicates:** Mark a “D” on your floor plan for each testing location expected to receive a duplicate measurement. One duplicate measurement is required for every ten measurement locations unless a 100% duplicate testing strategy has been chosen (**See Extended or Time Sensitive protocols.**) **AG; Eliminate Sequential and Extended?**
5. **Blanks:** Account for blank measurements (5% of test locations). For example: Randomly mark a “B” on your floor plan for locations that will receive blanks. Avoid placing a “B” in a testing location that already contains a “D”. This strategy for recording duplicates and blanks will enable you to intersperse these QC measurements on the log sheets so that the laboratory analyzing your detectors will not be able to identify which recorded measurements are blanks and duplicates.

**Comment:** Committee believes this statement has just been made

**Comment:** Again, this protocol is not solely for the professional

**See EXHIBIT 2 at the end of this appendix for an EXAMPLE FLOOR PLAN.**

6. Choose the appropriate device and verify that it is suitable for the times projected for deployment.
7. Purchase devices and schedule pre-test QC measurements if appropriate.

#### **Scheduling the Deployment/Retrieval of Detectors**

7. Schedule a time with the maintenance personnel for deployment and retrieval of detectors. Provide the number of days that will be needed to deploy and retrieve the detectors so that the maintenance personnel can make the necessary arrangements in their schedules for placement and retrieval at close to 24 hour increments for short term tests.
8. Prepare Resident Notifications (i.e. advance notices for residents, non-interference agreements and “test in progress” signs, etc.)
9. Ensure that reasonable advance notification is provided to residents of the dwelling regarding likely deployment/retrieval dates, required test conditions and other information as appropriate.

**See EXHIBITS 6 and 7.**

10. Reconfirm your scheduled deployment date(s) and time(s) with the maintenance personnel no later than 2 to 3 days prior to testing.

#### **Preparing Deployment Documentation**

8. Prepare log sheets and floor plan drawings.
    - ❖ Record the name of the building that you are testing in the space provided on the top right corner of each device placement log sheet (hereafter, log sheet).
    - ❖ Using your floor plan as a reference, record the apartment number or other identifier in the appropriate column of the log sheet for each testing location in the order that you plan to test.
    - ❖ For testing locations marked with a “B,” indicating a blank detector, record a “B” in the “Room #/Name” column and “Location” column just below the testing location marked with a “B”
    - ❖ For testing locations receiving duplicate pairs (i.e. locations marked with a “D”) record a “D” in the “Room #/Name” column and “Location” column just below the room receiving duplicates.
- See EXHIBIT 4 SAMPLE DEVICE PLACEMENT LOG for a sample log sheet.**
- ❖ Note the *location* where you plan to place the detector for each apartment or enclosed space.

#### **Deploying the Detectors**

9. Before entering a testing location, verify its room number or name with the one on the log sheet.
10. Place the detector and record the detector's serial number in *Serial # column*. Record the date and time of deployment.
11. Place the "Radon Survey In Progress" notice and compliance statement in a conspicuous place. (See EXHIBIT 7.)
12. Remember to place two detectors or *duplicates* in testing locations preceding a log entry containing a "D". When recording the deployment time for duplicates, consider adding a few minutes (e.g. 2 to 5 minutes) to the starting time so that the laboratory will not know they are duplicates.
13. If *blanks* are not actually deployed, it is still important to record plausible deployment dates, times and locations for these devices. *Blanks* may be stored off-site, in an office of the building being tested for radon, or placed on site with other test devices.
14. Identify the name of the person placing/retrieving test devices in the space provided at the end of each log sheet.

[Keven Stewart comment: There is currently nothing here that specifically ensures CBP is begun at the appropriate time and maintained from then throughout the duration of the test. I believe that there should be something explicit to this effect in the checklist.]

#### Retrieving the Detectors

**Comment:** Since this can be either professional or Property manager or no one, the resident's information is the primary tool to ensure CBP

15. When picking up each detector, check its location and serial number with what was recorded during deployment. Note any discrepancies, test interference or non-compliance of required conditions in the *Comments column* of the log sheet. If the serial number does not agree with the one listed, change the number to the "new" one and note the change as a comment.
16. Record the date and time of retrieval in the log sheet for each device. Do the same for *duplicates and blanks*.
17. Identify the name of the person placing/retrieving test devices in the space provided at the end of each log sheet.

#### Preparing Detectors for Analysis

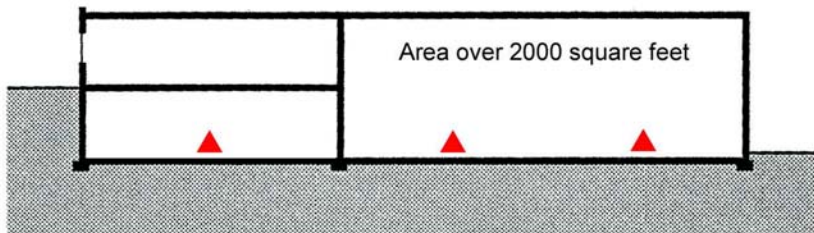
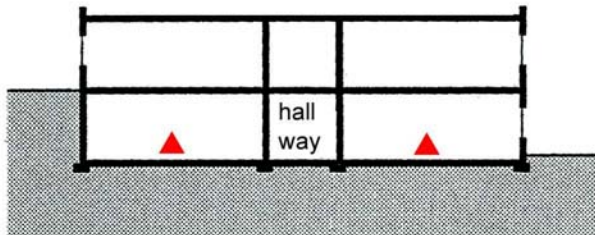
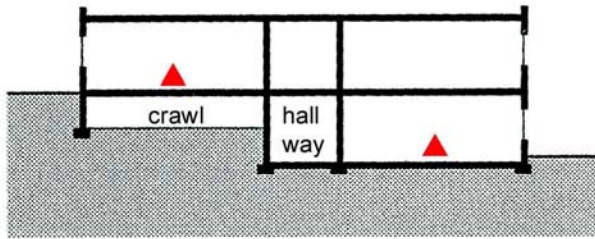
18. The laboratory analyzing the detectors should not be able to recognize *blanks* or *duplicates*. For example, after retrieving the exposed detectors, *blank* devices must be mixed in with the exposed detectors for shipment. Therefore, any seals on the blanks must be broken (in some cases, the detector must be opened and immediately closed) and resealed in the same manner as the deployed detectors. Log sheets provided to the laboratory should also obscure which devices are *blanks* and *duplicates*.
19. ~~Ship~~ Deliver detectors to the analyzing laboratory within their stated timeframe. (AG)

#### Preparing Report Documents

20. Compile test data into a report form (See Section 8.0). (editorial note: confirm Structure at publication)

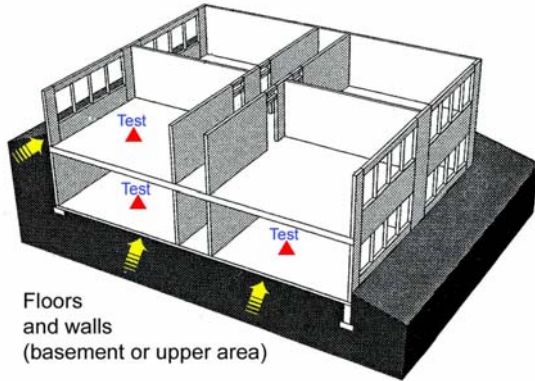
## EXHIBIT 1a

### TEST LOCATION EXAMPLES

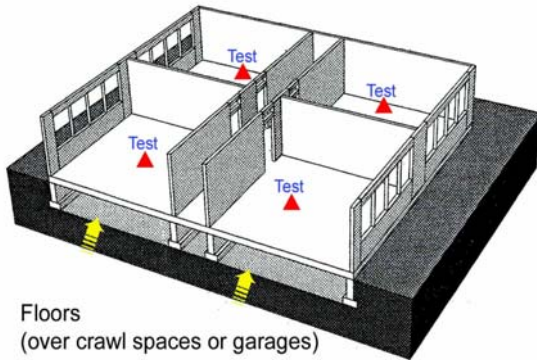


Devices must be placed at least 20" above the floor. See section 3.6 "Choosing a location within a Room" for other details.

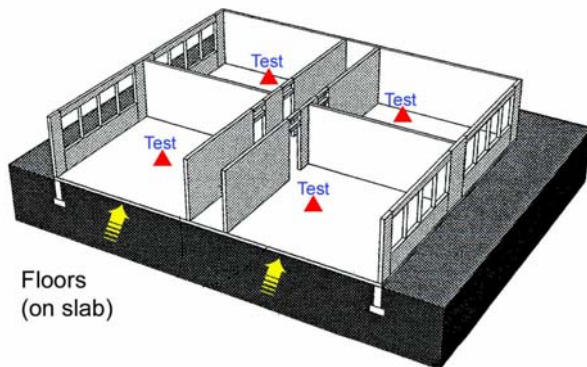
## EXHIBIT 1b TEST LOCATION EXAMPLES



Floors  
and walls  
(basement or upper area)



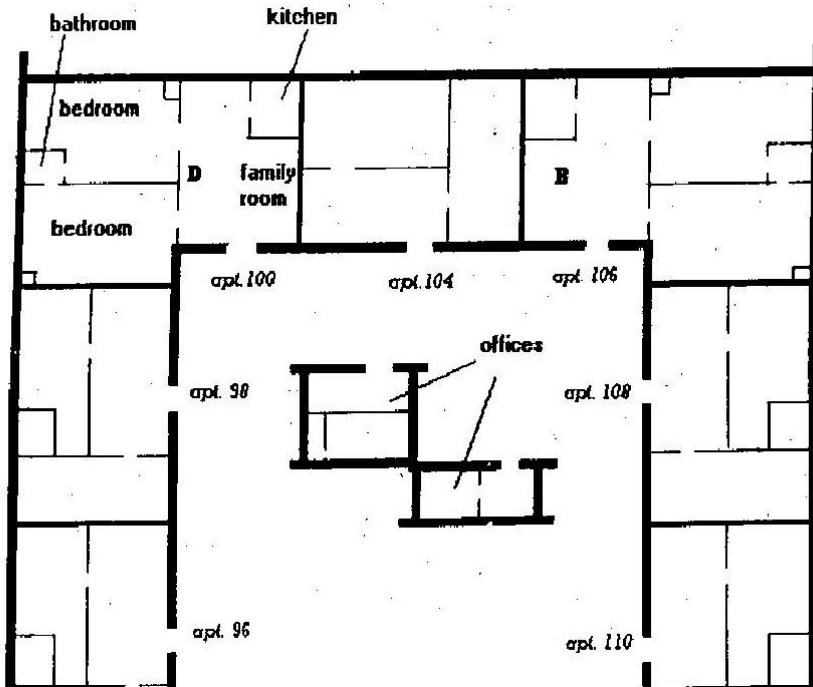
Floors  
(over crawl spaces or garages)



Floors  
(on slab)

Devices must be placed at least 20" above the floor. See section 3.6 "Choosing a location within a Room" for other details.

EXHIBIT 2  
SAMPLE FLOOR PLAN



(First Floor of a Garden Apartment)

**EXHIBIT 3**

**SAMPLE  
DEVICE PLACEMENT LOG**

Testing Contractor: \_\_\_\_\_

\_\_\_\_\_

Building Name/Address: \_\_\_\_\_

\_\_\_\_\_

Contact Information: \_\_\_\_\_

\_\_\_\_\_

Apartment or Room#/Name	Location Room	Location In Room	Serial #	Start Date	Start Time	Stop Date	Stop Time	Comments	Results

Name or person placing detectors: \_\_\_\_\_

Name or person retrieving detectors: \_\_\_\_\_

**EXHIBIT 4**



## SAMPLE OF DATA ENTRY

Testing Contractor: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Building Name/Address: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Contact Information: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Apartment or Room #?Name	Location Room	Location in room	Serial #	Start Date	Start Time	Stop Date	Stop Time	Comments	Result
100	fam room	S.Wall	65093	11/1/93	3.22 pm	11/5/93	4.34 pm		
D	D		93277		3.26		4.37		
104	fam room	S wall	17349		3.31		4.42		
106	fam room	S wall	84758		3.33		4.44		
B	B		09543		3.35		4.46		
108	fam room	N wall	69299		3.37		4.47	detector was moved	
110	fam room	N wall	59021		3.11		4.51		
112	bedroom	bookshelf	48770		3.45		4.53		
114	fam room	N wall	56673		3.47		4.56		
116	Living room	Corner table	80173		3.50		4.58		
118	fam room	N wall	28556		3.52		5.01		
120	fam room	N wall	74305		3.55		5.03		
140	Living room	Bookshelf	97033		3.58		5.06		
D	D		86848		4.02		5.08		
142	fam room	E wall	96026		4.05		5.12		
144	fam room	E wall	19485		4.08		5.17		
146	fam room	E wall	67809		4.12		5.21		

Name or person placing detectors: \_\_\_\_\_

Name or person retrieving detectors: \_\_\_\_\_

**EXHIBIT 5  
EXAMPLE OF INFORMATION  
PROVIDED TO A LABORATORY**

Tracking quality control independently from a laboratory is a component of a quality assurance program. Several methods exist to prevent a laboratory from identifying quality control measurements (i.e. duplicate and blank detectors). This is only one example of how to obscure quality control measurements from the laboratory.

Apartment or Room #?Name	Location	Serial #	Start Date	Start Time	Stop Date	Stop Time	Comments	Result
		65093	11/1/93	3.22 pm	11/5/93	4.34 pm		
		93277		3.26		4.37		
		17349		3.31		4.42		
		84758		3.33		4.44		
		09543		3.35		4.46		
		69299		3.37		4.47		
		59021		3.11		4.51		
		48770		3.45		4.53		
		56673		3.47		4.56		
		80173		3.50		4.58		
		28556		3.52		5.01		
		74305		3.55		5.03		
		97033		3.58		5.06		
		86848		4.02		5.08		
		96026		4.05		5.12		
		19485		4.08		5.17		
		67809		4.12		5.21		

**EXHIBIT 6**  
**SAMPLE NOTICE OF INSPECTION**

Mark Veckman comment: This is unnecessarily alarming. Just tell the residents to keep the doors and windows closed during the testing and to refer any questions to management. Management can distribute the EPA Booklet in response to inquiries.

**Comment:** The committee discussed the most effective way to gain cooperation. The experience of the committee was to catch attention early on.

Bev Howell: Another notice sample is needed for upper floors (for situations where they are not the units being tested yet closed windows are still needed).

**Comment:** Committee?

Dear Resident,

Radon gas is the leading cause of lung cancer in the United States after cigarette smoking. Radon is a naturally occurring radioactive gas that can be present in some homes at concentrations that are dangerous to you, your family and pets.

An important step is being taken to lower your risk of lung cancer from radon in your home. A radon test is being scheduled for the property.

Radon test devices will be placed in your home for several days to take a reading. Test devices are not dangerous in any way and a sample test device is available at our office for you to examine if you wish. Copies of EPA's *A Citizen's Guide to Radon* are available upon request or you can contact your State Radon Office or EPA regional office for additional information on radon.

It is important that we can gain access to place test devices and that required test conditions are maintained.

***Required Closed-building conditions***

- o Closed-building conditions must be maintained for 12 hours prior to the initiation of the test and during the test.
- o All windows on all levels and external doors must be kept closed (except for momentary events such as normal entry and exit) before and during the test period.
- o Heating and cooling systems must be set to normal occupied operating temperatures and their fan/blower controls must be set to normal intermittent activity unless continuous activity is a permanent setting. Window air conditioning units must only be operated in a recirculating mode. Equipment that supplies fresh air to the dwelling must be deactivated except for make-up air to combustion appliances.
- o Whole house fans must not be operated. Window fans should be removed or sealed shut. Wood burning fireplaces must not be operated unless they are the primary sources of heat for the dwelling. Avoid excessive operation of clothes dryers, range hoods, bathroom fans and other mechanical systems that draw air out of the building.

Tentative device placement

Day \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

*We will request your signature and any comments on a form left with the test device.*

Tentative device pick-up

Day \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

We thank you for your cooperation in helping to assure safe and healthy homes. For any concerns or questions please contact \_\_\_\_\_

Sincerely, \_\_\_\_\_

**EXHIBIT 7**

**SAMPLE FORM: Radon Survey in Progress – compliance statement**

**Radon Survey in Progress**

Dear Resident,

**Radon gas is the leading cause of lung cancer in the United States after cigarette smoking. Radon is a naturally occurring radioactive gas that can be present in some homes at concentrations that are dangerous to you, your family and pets.**

**An important step is being taken to lower your risk of lung cancer from radon in your home. A radon test is being scheduled for the property.**

It is important that required test conditions **stated below** are maintained.

Please sign this form and add any comments to help ensure accurate tests:

<p><b>To the best of my knowledge, the required conditions stated below were kept during the test.</b></p> <p><b>Occupant X</b> _____ <b>Date</b> _____</p> <p>Comments if any: _____</p> <p>_____</p> <p>_____</p>
---

Device Pick-up Day \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

***Required Closed-building conditions***

- Closed-building conditions must be maintained for 12 hours prior to the initiation of the test and during the test.
- All windows on all levels and external doors must be kept closed (except for momentary events such as normal entry and exit) before and during the test period.
- Heating and cooling systems must be set to normal occupied operating temperatures and their fan/blower controls must be set to normal intermittent activity unless continuous activity is a permanent setting. Window air conditioning units must only

be operated in a recirculating mode. Equipment that supplies fresh air to the dwelling must be deactivated except for make-up air to a combustion appliance.

- Whole house fans must not be operated. Window fans should be removed or sealed shut. Wood burning fireplaces must not be operated unless they are the primary sources of heat for the dwelling. Avoid excessive operation of clothes dryers, range hoods, bathroom fans and other mechanical systems that draw air out of the building.

We thank you for your cooperation in helping to ensure safe and healthy homes. Sincerely, \_\_\_\_\_ Phn (XXX) XXX-XXX

**Dear Reviewers:**  
**The following sections are being considered for deletion due to document length and in some cases more current information can be achieved with website links.**

Mark Veckman comment: Just show the web site links.

Bob Lewis: Delete these appendices.

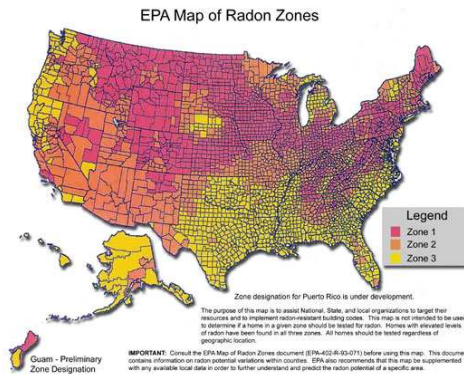
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## APPENDIX XXX Delete?

### Use of the U.S. EPA's Zone Map

In 1988, the U.S. Congress mandated the U.S. Environmental Protection Agency to develop a map showing the areas of the country having the highest likelihood of elevated radon concentrations. The adjacent map was developed using data on the presence of uranium (the parent product of radon) from flyovers in the 1970's, random sampling information from residents' testing, and evaluation by state geologists,



The map's primary purposes were:

1. to supply builders with information on which areas of the country would most likely require passive radon systems to be installed during the building process;
2. to allow states to target their resources in areas that had the highest probability of elevated radon concentrations; and
3. to give code officials data on whether to require passive radon systems in their building codes.

The map was never intended to influence whether people test. The map carries the following disclaimer:

The purpose of this map is to assist National, State, and local organizations to target their resources and to implement radon-resistant building codes. This map is not intended to be used to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones. All homes should be tested regardless of geographic location.

Zone 1 (red) areas are most likely to have dwellings with elevated radon concentrations.

Zone 2 (orange) areas are expected to have dwellings with elevated radon concentrations.

Zone 3 (yellow) areas are less likely to have dwellings with elevated radon concentrations.

Because no one can predict which homes in these three zones (red, orange, yellow) will have elevated radon concentrations, the only way to find out is to test. Thus, the guidance is to test ALL homes regardless of their geographical location.

**APPENDIX XXX Delete?**  
**STATE/INDIAN NATION RADON CONTACTS**

<b>STATE</b>	<b>PHONE #</b>	<b>STATE</b>	<b>PHONE #</b>
ALABAMA	334-206-5391	NEW YORK	800-458-1158
ALASKA	907-474-7201	N. CAROLINA	919-733-4984
ARIZONA	602-255-4845	N. DAKOTA	701-328-5188
ARKANSAS	501-661-2301	OHIO	614-644-2727
CALIFORNIA	800-745-7236	OKLAHOMA	405-702-5165
COLORADO	800-846-3986	OREGON	503-731-4014
CONNECTICUT	860-509-7367	PENNSYLVANIA	800-237-2366
DELAWARE	302-739-4731	RHODE ISLAND	401-277-2438
D.C.	202-535-2999	S. CAROLINA	800-768-0362
FLORIDA	850-245-4288	S. DAKOTA	605-773-3151
GEORGIA	800-745-0037	TENNESSEE	800-232-1139
HAWAII	808-586-4700	TEXAS	512-834-6688
IDAHO	208-332-7319	UTAH	801-536-4250
ILLINOIS	217-782-1325	VERMONT	802-865-7730
INDIANA	800-272-9723	VIRGINIA	804-786-5932
IOWA	512-242-5902	WEST VIRGINIA	304-558-2981
KANSAS	785-296-1535	WISCONSIN	608-267-4796
KENTUCKY	502-564-4856	WYOMING	800-458-5847
LOUISIANA	800-256-2494	PUERTO RICO	809-767-3563
MAINE	207-287-5676	<b>GUAM</b>	<b>671-475-1611</b>
MARYLAND	800-872-3666	ALL INDIAN PUEBLO COUNCIL	505-881-2254
MASSACHUSETTS	413-586-7525	CHEROKEE NATION	918-458-5496
MICHIGAN	800-723-6642	CHICKASAW NATION	405-436-2603



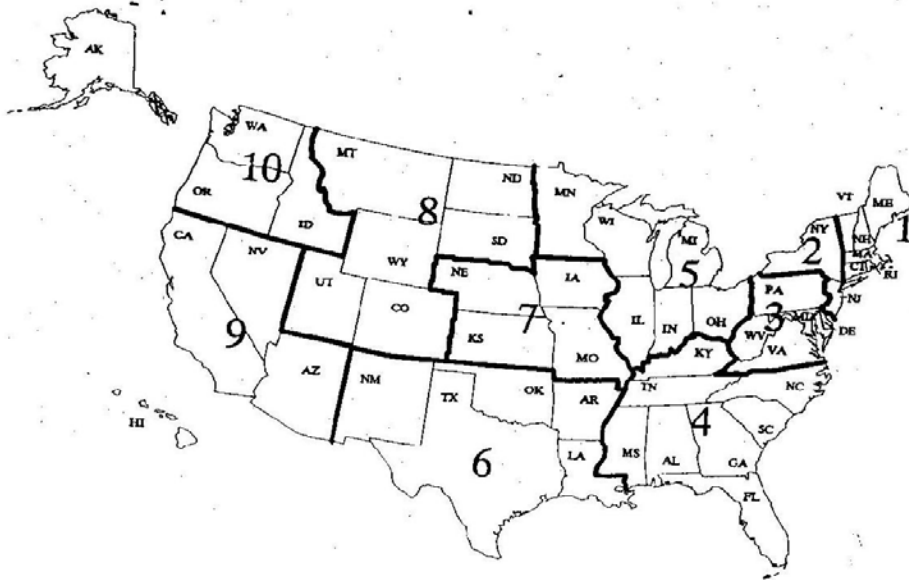
MINNESOTA	<b>800-798-9050</b>	HOPI TRIBE	<b>602-734-2441</b>
MISSISSIPPI	<b>800-626-7739</b>	INNER TRIBAL COUNCIL	<b>602-248-0071</b>
MISSOURI	<b>800-669-7236</b>	JICARILLA APACHE TRIBE	<b>505-759-3242</b>
MONTANA	<b>406-444-6768</b>	NAVAJO NATION	<b>602-871-7754</b>
NEBRASKA	<b>800-334-9491</b>	ONEIDA INDIAN NATION	<b>315-361-6300</b>
NEVADA	<b>702-687-5394</b>	SENECA NATION	<b>716-532-0024</b>
NEWHAMPSHIRE	<b>603-271-4674</b>	ST. REGIS MOHAWK TRIBE	<b>518-358-3141</b>
NEW JERSEY	<b>609-984-5425</b>	FOR INDIAN NATIONS IN THE STATES OF MN,WI,MIL IN AND OH	<b>312-886-6063</b>
NEW MEXICO	<b>505-827-1080</b>		

**APPENDIX XXX Delete?**

**EPA REGIONAL OFFICES**

**Map of EPA Regions**

Each of the 50 United States, as well as the District of Columbia, the Virgin Islands, and Puerto Rico, has been assigned to one of 10 Federal Regions. This map shows the Regional assignments for the 50 States. Puerto Rico and the Virgin Islands are assigned to Region 2. The District of Columbia is in Region 3. Identify your Region on the map below and refer to next page for a telephone number and address. Or visit the website [epa.gov/regions](http://epa.gov/regions)



Guam

## Addresses and Phone Numbers for EPA Regional Offices

### REGION 1

RADIATION PROGRAM MANAGER  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
JOHN F KENNEDY FEDERAL BUILDING  
BOSTON, MA 02203-2211  
PHONE: 617-565-4502

### REGION 2

CHIEF, RADIATION AND INDOOR AIR BRANCH  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
290 BROADWAY (AWM-RAD)  
NEW YORK, NY 10007-1866  
PHONE: 212-637-4013

### REGION 3

RADIATION PROGRAM MANAGER  
RADIATION PROGRAMS SECTION (3AT12)  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
841 CHESTNUT STREET  
PHILADELPHIA, PA 19107  
PHONE: 215-597-8326

### REGION 4

RADIATION PROGRAM MANAGER  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
61 FORSYTH.  
ATLANTA, GA 30365  
PHONE: 404-347-3907

### REGION 5

RADIATION PROGRAM MANAGER  
(AT-18J)  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
77 WEST JACKSON BOULEVARD  
CHICAGO, IL 60604-3507  
PHONE: 312-886-6175

### REGION 6

RADIATION PROGRAM MANAGER  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
1445 ROSS AVENUE (6T-AG)  
DALLAS, TX 75202-2733  
PHONE: 214-665-7223

### REGION 7

RADIATION PROGRAM MANAGER  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
726 MINNESOTA AVENUE  
KANSAS CITY, KS 66101  
PHONE: 913-551-7020

### REGION 8

RADIATION PROGRAM MANAGER  
(8ARTRP)  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
999 18<sup>TH</sup> STREET, SUITE 500  
DENVER, CO 80202-2405  
PHONE: 303-293-1709

### REGION 9

RADIATION PROGRAM MANAGER  
(A-1-1)  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
75 HAWTHORNE STREET  
SAN FRANCISCO, CA 94105  
PHONE: 415-744-1048

### REGION 10

RADIATION PROGRAM MANAGER  
(AT-082)  
ENVIRONMENTAL PROTECTION AGENCY  
1200 SIXTH AVENUE  
SEATTLE, WA 98101  
PHONE: 206-553-7660

## APPENDIX XXX Delete?

Mark Veckman comment: Just show the web site links and refer readers who want more info to the links.

### About NEHA-NRPP or NRSB Certification

In the NEHA-NRPP and NRSB private radon proficiency programs, professionals providing measurement services are identified for achieving various levels of proficiency.

- ❖ **Analytical providers (NEHA-NRPP), Laboratory and Radon Measurement Specialists (NRSB)** have demonstrated proficiency that includes the capability to provide detector(s); perform the analysis of detectors that have been exposed to radon; plan radon tests; operate a quality assurance plan; place and retrieve detectors; and report and interpret the test result to the customer.
- ❖ **Standard service providers (NEHA-NRPP)** obtain detectors from an analytical service and return them for analysis. They have demonstrated proficiency that includes the capability to plan radon tests; operate a quality assurance plan; place and retrieve detectors; and report the test results to the customer.
- ❖ **Radon Measurement Technicians (NRSB)** obtain detectors from an analytical service and return them for analysis. They work under the supervision and quality assurance program of a certified Radon Measurement Specialist or Accredited Radon Laboratory. They have demonstrated proficiency that includes placing and retrieving detectors.
- ❖ **Radon Mitigation professionals:** NEHA-NRPP and NRSB provide certification programs for verifying proficiency of radon mitigation professionals.

Verification of current certification can be obtained by requesting a copy of the confirmation letter or card issued to the measurement professional by the certifying organization. Verification can also be achieved on the organizations' websites (radongas.org or nrsb.org).

Measurement professionals that are certified have either: A) demonstrated the ability to conduct radon measurements with a particular detector and to make analyses according to **quality assurance principles**; or B) work in conjunction with or have their devices analyzed by a company or individual that is certified for analytical services. In addition, professionals that are certified have agreed to follow approved measurement procedures including appropriate quality assurance procedures when measuring indoor concentrations of radon.

Certified measurement companies or individuals use a **quality assurance plan** that covers their organization's activities. QAPs help ensure reliable measurements for all clients by evaluating measurement quality. They contain a schedule for implementing the elements of the QAP and for tracking each detector with a **chain-of-custody**.

<b>Professional Designations and QA performed within their organization.</b>		
<b>Analytical Service Providers (NEHA-NRPP)</b>	<b>Standard Service Providers (NEHA-NRPP)</b>	<b>Radon Measurement Technicians (NRSB)</b>
<b>Radon Measurement Specialists (NRSB)</b>		
Duplicate Measurements	Duplicate Measurements	Works under the plan of a Radon Measurement Specialist
Blank Measurements	Blank Measurements	
Spiked Measurements	Spiked Measurements	
Calibration Measurements		

(Duplicate and Blank Measurements taken to provide an “early warning system” during a Multifamily Measurement Program are integrated with these other components of a measurement professional’s long term quality assurance plan.)

If we keep this section, Andy George had notes/updates on credential titles.

### **The National Environmental Health Association National Radon Proficiency Program**



<http://www.radongas.org>

### **National Radon Safety Board**



<http://www.nrsb.org>