Appendix A

Ohio Radon Measurement Protocol

A. Measurement Location

1. Short-term or long-term measurements shall be made in each lowest structural area suitable for occupancy.

   a. Measurements shall be made in rooms that can be regularly occupied by individuals, such as family rooms, living rooms, dens, playrooms and bedrooms.

   b. Radon detection devices of any type should not be placed in areas of high humidity, such as bathrooms, kitchens, laundry rooms, or spa rooms. Measurements made in areas of high humidity shall not be used as representative measurements and shall not be the basis for a decision to, or not to, mitigate the radon level within a building.

   c. When the level of the home being tested is over two thousand square feet, an additional test location is required for each two thousand square feet of the level being tested.

   d. Measurement devices shall be placed in the general breathing zone and shall be:

      i. Undisturbed during the measurement period;

      ii. At least three feet from doors, windows to the outside, or ventilation ducts;

      iii. Out of the direct flow of air from the ventilation duct;

      iv. At least one foot from exterior walls;

      v. Twenty inches to six feet from the floor;

      vi. At least four inches away from other objects horizontally or vertically above the detector;

      vii. At least four feet from heat, fireplaces and furnaces, out of direct sunlight, etc.; and

      viii. At least ten feet from sump pits.

e. Measurement devices may be suspended in the general breathing zone and, if suspended, shall be twenty inches to six feet above the floor and at least one foot below the ceiling.

f. Measurements made in closets, cupboards, sumps, crawlspaces or nooks within the foundation shall not be used as representative measurements and shall not be the basis for a decision to, or not to, mitigate the radon level within a building.

B. Measurements

1. A short-term measurement shall range in duration from forty-eight hours to ninety days, depending upon the measurement device used. Unoccupied homes shall be tested with the heating, ventilation, and air conditioning (HVAC) system set and operating throughout the measurement interval in the normal range, such as seventy-two degrees fahrenheit plus or minus five degrees fahrenheit.

a. Short-term measurements shall be made under closed-building conditions. In measurements lasting more than seven days and less than ninety days, closed-building conditions shall be maintained as much as possible while the measurement is in progress.

b. Closed-building conditions shall begin at least twelve hours prior to the beginning of the measurement period for measurements lasting less than ninety-six hours.

c. The following conditions shall be complied with during closed-building conditions:

i. Operation of permanently installed HVAC systems shall continue during closed-building conditions. Licensees shall inform the resident in writing that operation of dryers, range hoods, bathroom fans and other mechanical systems that draw air out of the building may adversely affect the measurement results;

ii. In buildings having permanently installed radon mitigation systems, the mitigation system should be operating during the measurement interval. Licensees shall indicate on the test report if the mitigation system was operating or not.

iii. Air conditioning systems that recycle interior air may be operated during closed-building conditions;

iv. All windows shall be kept closed;

v. All external doors shall be closed except for normal entry and exit. Structural openings due to disrepair or structural defects shall be repaired to correct their condition prior to initiation of closed-building conditions. All exterior windows and doors shall be inspected by a licensee at the placement and retrieval of the detectors and the result of the inspection documented for the measurement file;

vi. Whole-house fans shall not be operated. Portable window fans shall be removed from the window or sealed in place. Window air conditioning units shall only be operated in a recirculating mode. If the building contains an air handling system, the air handling system shall not be set for continuous operation unless the air handling equipment is specifically used for radon control and is so labeled;

vii. Fireplaces or combustion appliances, except water heaters and cooking appliances, shall not be operated unless they are the primary sources of heat for the building; and

viii. Ceiling fans, portable dehumidifiers, portable humidifiers, portable air filters and window air conditioners shall not be operated within twenty feet of the detector.

d. Short-term measurements of less than ninety-six hours shall not be conducted during severe storms or periods of sustained high winds (thirty miles per hour or more). Licensees shall check and document local weather forecasts prior to placing short-term measurement devices when the measurement period is less than ninety-six hours. The National Weather Service defines a severe storm as a storm that generates winds of fifty-eight mph or 0.75 inch diameter hail and that may produce tornadoes, not necessarily in that order.

e. The licensee shall document that instructions describing closed-building conditions in paragraph (B)(1) of this appendix were provided for the person who controls the building in accordance with paragraphs (D)(1) and (D)(2) of this appendix.

2. The licensee shall advise the resident in accordance with addendum A to this appendix.

3. Any follow-up measurements shall be conducted in the same location as the initial measurement, provided the initial measurement was performed in accordance with acceptable measurement placement protocol.

4. The results of both initial and follow-up measurements and the average of duplicate measurements shall be reported. The average shall be considered appropriate as the basis for determining the need for mitigation.

C. Options for Time-Sensitive Testing

1. When testing for a real-estate transaction or in situations where quick decisions are needed to protect current and future occupants of a home, at a minimum, test the lowest level that could be occupied.

2. Option 1: Simultaneous Testing

   a. Simultaneous testing shall be comprised of two indoor radon measurements conducted simultaneously with similar passive radon measurement devices. See addendum C to this appendix.

   b. Simultaneous tests shall be:

      i. Collocated and spaced four to five inches apart;

      ii. Exposed for the same measurement period; and

      iii. Result reported in picocuries per liter (pCi/l).

   c. The results of each individual measurement and the average of the simultaneous measurements shall be reported. Results reported in picocuries per liter (pCi/l).

   d. Simultaneous measurement results that are both less than four picocuries per liter should agree with a relative per cent difference (RPD) of less than sixty-seven per cent. RPD is the difference between the two results divided by the average of the two results times one hundred. If the RPD is greater than sixty-seven per cent, the licensee shall investigate and document the results.

e. When one of the measurements is equal to or greater than four picocuries per liter and one is less than four picocuries per liter, and the higher result is greater than twice the lower result, the client shall be informed of the large discrepancy and the simultaneous measurements repeated.

f. Simultaneous measurement results that are both equal to or greater than four picocuries per liter should agree with a RPD of less than thirty-six per cent. If the RPD is greater than thirty-six per cent, the licensee shall investigate and document the results.

g. The precision of simultaneous measurements shall be monitored and recorded in the quality assurance records. The analysis of data from simultaneous measurements shall be plotted on control charts. If the precision estimated by the user is not within the precision expected of the measurement method, the cause of the problem shall be investigated and corrective action taken in accordance with the licensee's director-approved quality assurance program.

3. Option 2: Continuous Monitor Testing

a. This option requires an active continuous monitor that has the capability to integrate and record data in accordance with the specifications in paragraph B of Appendix B to this rule.

b. The minimum test measurement period shall be forty-eight hours. The first four hours of data from a continuous monitor may be discarded or incorporated into the result using system correction factors. However, there shall be at least forty-eight contiguous hours of usable data to produce a valid average.

i. The "backing out" of data (i.e., removal of any portions imbedded in the forty-eight contiguous hours of monitoring) shall invalidate the measurement.

ii. The periodic results shall be averaged to produce a result that is reported to the client.

4. Additional Requirement for Time-Sensitive Testing such as Real-Estate Testing

a. The measurement exposure time shall be a minimum of forty-eight hours.

b. Measurement licensees shall establish controls consistent with the devices used in their measurements to prevent interference and document those controls in accordance with paragraph (L)(1) of this appendix.

D. Noninterference Agreement

1. The buyer, seller, occupant, real estate professional or other individual in control of the property shall sign a noninterference agreement indicating an understanding of the testing conditions, and that any test interference that is detected will be documented in the report and will invalidate the measurement results.

2. If such an agreement cannot be or will not be signed by the buyer, seller, occupant, real estate professional or other individual in control of the property, the licensee shall document on the agreement why the signature was not obtained. The agreement shall be retained for inspection by the director.

E. Notification of Radon Measurement In Progress. The licensee shall post at every building entry and in a conspicuous location a notification of radon measurement in progress. The notice shall be posted upon initiation of a radon measurement. A copy of a notification of radon measurement in progress is provided in addendum D to this appendix.

F. Multifamily Building Measurements. Licensees shall submit standard operating procedures for the performance of multifamily building measurements. This subsection does not apply to measurements in an individual condominium unit.

1. Initial measurements shall be short-term measurements of at least forty-eight hours to ninety days, depending on the device used, and shall be made in regularly occupied rooms in contact with the soil, whether the contact is slab-on-grade, a basement, a berm, a room above a crawlspace or any combination.

a. Regularly occupied rooms include bedrooms, offices, dens, family rooms, work areas and play rooms.

b. A minimum of one detector shall be placed per every two thousand square feet of open floor area.

2. Regularly occupied rooms shall be tested simultaneously.

   a. The licensee shall ensure that each occupant/resident is provided information regarding necessary test conditions.

   b. The licensee shall perform and document a surveillance of the building to determine the rooms needing testing prior to placement.

3. Follow-up Measurements

   a. Follow-up measurements shall be performed in every room with a short-term, initial measurement result of four picocuries per liter or greater, unless measurements are made during a real-estate transaction. See addendum A to this appendix.

   b. If performing measurements in accordance with paragraph (C), "Options for Real-Estate Testing," follow-up measurements are not required. See addendum B to this appendix.

4. During both initial and follow-up measurements, the HVAC system shall be operated normally. An understanding of the design, operation and maintenance of a building's HVAC system and how it influences indoor air conditions is essential for understanding, managing and developing a measurement strategy in multifamily buildings.

5. The licensee shall recommend in writing to the management, owners, or representatives of the multifamily building that a decision to mitigate be based on addendum A or addendum B to this appendix, as applicable.

6. Measurements in multifamily buildings shall be performed in accordance with paragraphs (A) to (E) and (H) to (N) of this appendix.

   a. A device placement log and floor plan shall be finalized for each multifamily building in which radon or radon progeny measurements are made.

   b. All measurement results, including duplicate and blank measurements and spikes, shall be noted on the device placement log including the device serial number.

7. Requirements for Specific Designs of Multifamily Buildings

a. Slab-on-Grade Design. Measure a regularly occupied room in each unit in contact with the ground.

b. Crawlspace Design. Measure a regularly occupied room directly in each unit above an enclosed crawlspace.

c. Basement Design. In addition to measuring a regularly occupied basement room in each unit, measure a regularly occupied room in each unit above the basement that has at least one wall with contact with the ground.

G. Measurements in Schools and Commercial Buildings. The licensees shall submit standard operating procedures for the performance of school and commercial building measurements.

1. Initial measurements shall be short-term measurements of at least forty-eight hours to ninety days, depending on the device used, and shall be made in all frequently occupied rooms in contact with the soil, whether the contact is slab-on-grade, a basement, berm, a room above a crawlspace or any combination.

a. Frequently occupied rooms include classrooms, offices, conference rooms, gymnasiums, auditoriums, cafeterias and break rooms.

b. Testing need not be conducted in infrequently used areas such as storage rooms, stairwells, restrooms, utility closets, elevator shafts or hallways.

c. A minimum of one detector shall be placed per every two thousand square feet of open floor area.

d. Schools and commercial buildings shall only be tested for radon during periods when the HVAC system is operating as it does normally when the buildings are occupied, even if the testing occurs when school is not in session or during long holidays. School testing shall only be conducted between October 1 and March 31.

2. All frequently occupied rooms shall be tested simultaneously.

a. The licensee shall ensure that the teacher or frequent adult user of the room being tested is aware of the detector.

b. The licensee shall perform and document an on-site surveillance of the building to determine the rooms needing testing prior to placement.

3. Follow-up measurements shall be performed in every room with a short-term, initial measurement result of four picocuries per liter or greater. See addendum A to this appendix

4. During both initial and follow-up measurements, the HVAC system shall be operated normally.

5. The licensee shall recommend in writing to the school or commercial building management, owners or representatives that a decision to mitigate not be based on initial measurement results.

6. Measurements in schools and commercial buildings shall be performed in accordance with paragraphs (A) and (B) of this appendix.

   a. Measurements in schools and commercial buildings of less than ninety-six hours duration shall be performed under closed-building conditions as described in paragraph (B)(1) of this appendix.

   b. Duplicate measurements shall be performed and shall represent ten per cent of all the detectors deployed, or a maximum of fifty detectors, whichever is less, within the building.

   c. Blank measurements shall be performed and shall represent five per cent of all the detectors deployed, or a maximum of twenty-five detectors, whichever is less, within the building.

   d. Spike measurements shall be performed and shall represent three per cent of all the detectors deployed, or a maximum of six detectors per month, whichever is less.

   e. A device placement log and floor plan shall be finalized for each school or commercial building in which radon measurements are made. All measurement results, including duplicate and blank measurements and spikes, shall be noted on the device placement log and floor plan (as applicable), including the device serial number.

7. Requirements for specific designs of schools and commercial buildings

a. Slab-on-Grade Design. Measure all frequently occupied rooms in contact with the ground.

b. Open-Plan or Pod Design. If sections of a pod have moveable walls that can physically separate them from other sections, measure each section separately. If moveable walls are absent or inoperable, measure the pod as one room placing detectors every two thousand square feet.

c. Crawlspace Design. Measure all rooms directly above an enclosed crawlspace.

d. Basement Design. In addition to measuring all frequently occupied basement rooms, measure all frequently occupied rooms above the basement that have at least one wall with contact with the ground.

H. New construction testing conditions

1. Newly constructed buildings shall not be tested for radon unless the installation of the following items is completed:

a. All insulation;

b. All exterior doors with associated hardware;

c. All windows;

d. All fireplaces and fireplace dampers;

e. All heating, air conditioning, and plumbing appliances;

f. All ceiling covers;

g. All interior trim and coverings for the exterior walls;

h. All exterior siding, weatherproofing and caulking;

i. All interior and exterior structural components; and

j. Any interior or exterior work that may adversely affect the measurement validity.

2. Unoccupied homes shall be tested with the HVAC system set and operating in the normal range, such as seventy-two degrees Fahrenheit plus or minus five degrees Fahrenheit.

I. Postmitigation testing

1. Postmitigation measurements shall not be conducted if temporary radon reduction measures are in use.

2. Postmitigation measurements shall be conducted to determine a system's effectiveness after a permanent radon-reduction system has been fully operational for at least twenty-four hours but not later than thirty days following completion and activation of a mitigation system. The mitigation system shall be operated normally and continuously during the entire measurement period.

3. Postmitigation measurements shall be conducted in accordance with paragraphs A, B, and C of this appendix.

J. Temporary radon-reduction measures

1. Temporary radon-reduction measures include:

a. The introduction of unconditioned air into the building;

b. Closure of normally accessible areas of the building; or

c. Lowering the thermostat below its normal use range, such as seventy-two degrees Fahrenheit plus or minus five degrees Fahrenheit.

2. Any of the conditions listed in paragraph (J)(1) of this appendix shall invalidate measurement results. The licensee shall not conduct a measurement until the conditions have been corrected. The licensee shall inform the client and other parties involved in a real-estate transaction that these conditions invalidate the measurement results.

3. Any improper radon-reduction efforts that may affect the measurement results identified prior to, during, or after initial, follow-up, real-estate or postmitigation measurements shall invalidate the measurement results. The licensee shall not conduct a measurement until the improper conditions have been corrected.

4. Postmitigation measurements shall not be conducted if any improper radon-reduction efforts that may affect the measurement results are identified.

K. Prohibited conditions for radon measurements

1. Short-term radon measurements of less than ninety-six hours shall not be conducted during severe storms or periods of sustained high winds (thirty miles per hour or more). Licensees shall check and document local weather forecasts prior to placing short-term measurement devices when the measurement period is less than ninety-six hours. The National Weather Service defines a severe storm as a storm that generates winds of fifty-eight mph, or 0.75 inch diameter hail and that may produce tornadoes, not necessarily in that order.

2. Radon measurements of any duration shall not be made during renovation of a building, especially renovations involving structural changes, or during renovations of the HVAC systems or any change that disturbs the normal airflow of the building. When renovations are planned, radon measurements should be made prior to renovations and immediately upon the completion of renovations.

L. Quality assurance for radon measurements

1. Licensees shall abide by the quality assurance program (QAP) described in rules in this chapter.

2. Measurements not performed in accordance with paragraphs A, B, and C of this appendix shall be considered inappropriate for the purpose of determining the need for mitigation or the effectiveness of a mitigation service.

M. Measurement Documentation

1. All records required by this chapter are an auditable part of the licensee's file.

2. Licensees shall ensure that sufficient information on each measurement is recorded in a permanent record to allow for future data comparisons, interpretations and reporting to clients.

3. Licensees shall keep the following information in a measurement record that shall be maintained for inspection for a minimum of five years.

Additional method-specific documentation is outlined in appendix B to rule 3701-69-07 of the Administrative Code.

a. A complete copy of the radon test report;

b. A description of any noninterference controls used and copies of noninterference agreements completed in accordance with paragraph (D) of this appendix; and

c. A record of any quality-control measures associated with the test, such as the results of simultaneous measurements, diagnostic measurements, duplicate measurements, spikes, and calculations associated with the measurements.

N. Measurement Results

1. Measurement results shall be reported in the units that the device measures.

2. Any measurement results based on radon gas shall be reported to no more than one decimal place.

3. All valid individual measurement results shall be reported.

4. When using continuous radon monitors, hourly readings shall be included.

5. Measurements made in separate locations shall not be averaged.

6. The average of collocated measurement devices shall be reported, as well as the individual results.

7. Any quality-control measurements shall be reported as such.

O. Measurement Reports

1. Licensees shall return radon measurement results to the occupant, the owner of the building, his/her representatives or the client within thirty days after retrieving exposed devices or within fourteen days of receiving results from a laboratory. As a minimum, the measurement report shall contain:

a. Measurement results reported in accordance with paragraph N.

b. The exact start and stop dates and times of the measurement period.

c. The address of the building measured, including the zip code.

d. A description of the measurement device used, its manufacturer, model or type, and serial numbers or other unique device identification numbers.

e. The names and Ohio radon license numbers of the licensees placing and retrieving the devices.

f. The name and Ohio license number of the laboratory analyzing the device, if applicable.

g. A statement describing recommendations concerning retesting or mitigation provided to the occupant, the owner of the building, his/her representatives or the client in accordance with addendum A or addendum B to this appendix, as appropriate.

h. A statement of whether a mitigation system was observed in the building during placement or retrieval, including whether the mitigation system was operating.

i. A statement describing any observed tampering, interference or deviations from the required measurement conditions.

j. A description of the condition of any permanent vents that allow outdoor air into the building, such as crawlspace vents or combustion air supply to combustive appliances.

k. A description of any severe weather conditions.

l. The exact locations of all measurement devices deployed and any information that would allow for future data comparisons and interpretations. Licensees shall provide the exact locations by one of the following methods:

    i. A diagram of the footprint of the building identifying the windows and doors, finished and unfinished areas, room use, furnaces, water heaters, dryers, combustion appliances, crawlspace vents, fireplaces, mitigation systems, floor drains and foundation types, indicating the front of the

home and any other pertinent information that may affect the measurement.

ii. A copy of addendum E to this appendix for each foundation type measured.

2. Laboratories receiving an exposed device that has been delivered for analysis shall return results to the client within thirty days. At a minimum, the measurement report shall contain:

a. Measurement results reported in accordance with paragraph N of this appendix.

b. The exact start and stop dates of the measurement period.

c. The address of the building measured, including the zip code.

d. A description of the measurement device used, its manufacturer, model or type, and serial numbers or other unique device identification numbers.

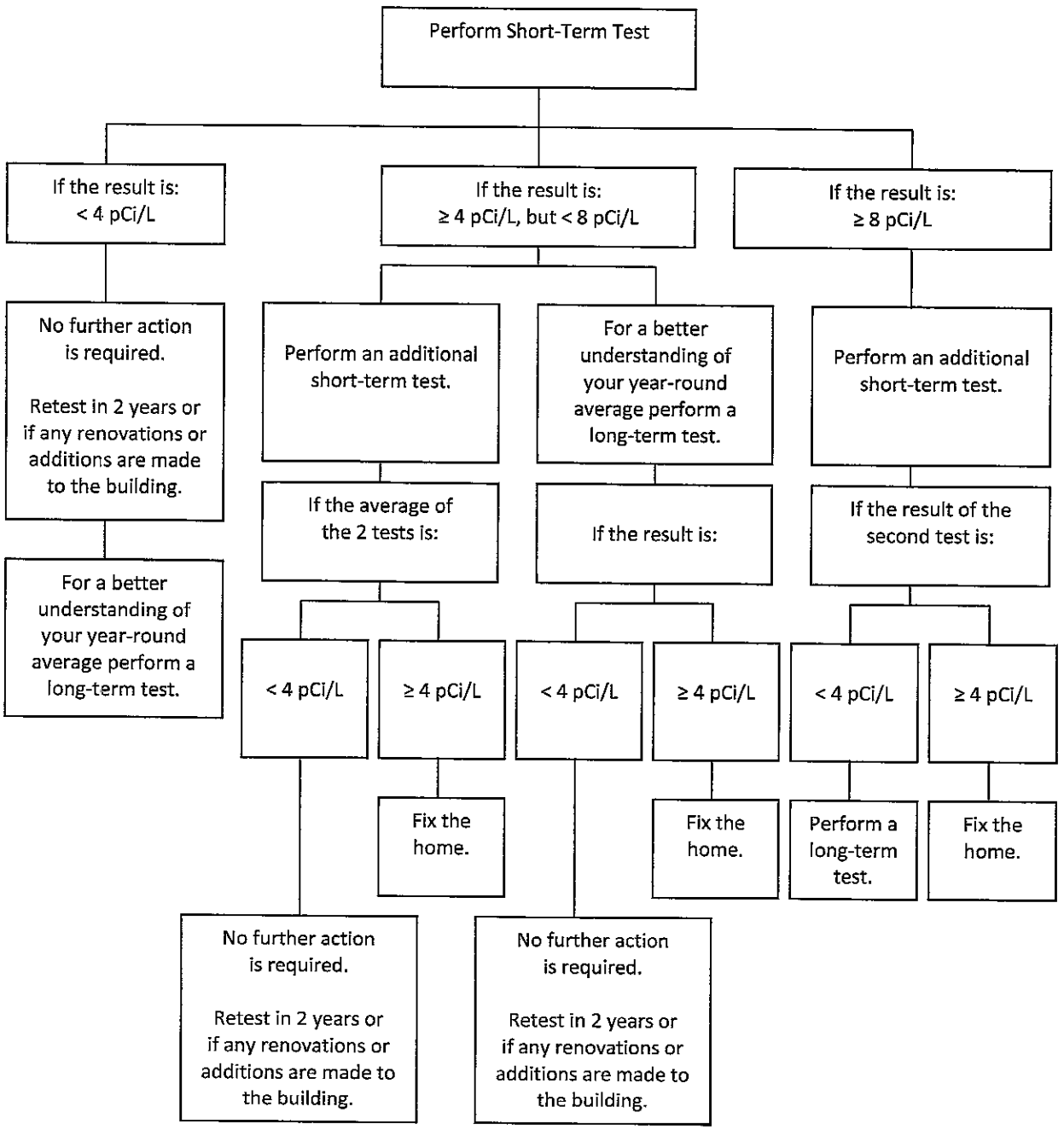
e. The name and Ohio license number of the laboratory analyzing the device.

Appendix A

Addendum A

Recommended Testing Strategy for Home Environment Measurements (Buildings Not Involved in a Real-Estate Transaction)

The first step is to perform a short-term measurement[1] in the lowest structural areas[2].



Appendix A

Addendum A

Notes:

1 Short-term tests may last between two and ninety days; most last between two and seven days. Examples of short-term detectors used in home environment testing include activated charcoal canisters, liquid scintillation vials, electret ion chambers and continuous monitors. Examples of long-term detectors used in home environment testing include alpha-track detectors and electret ion chambers.

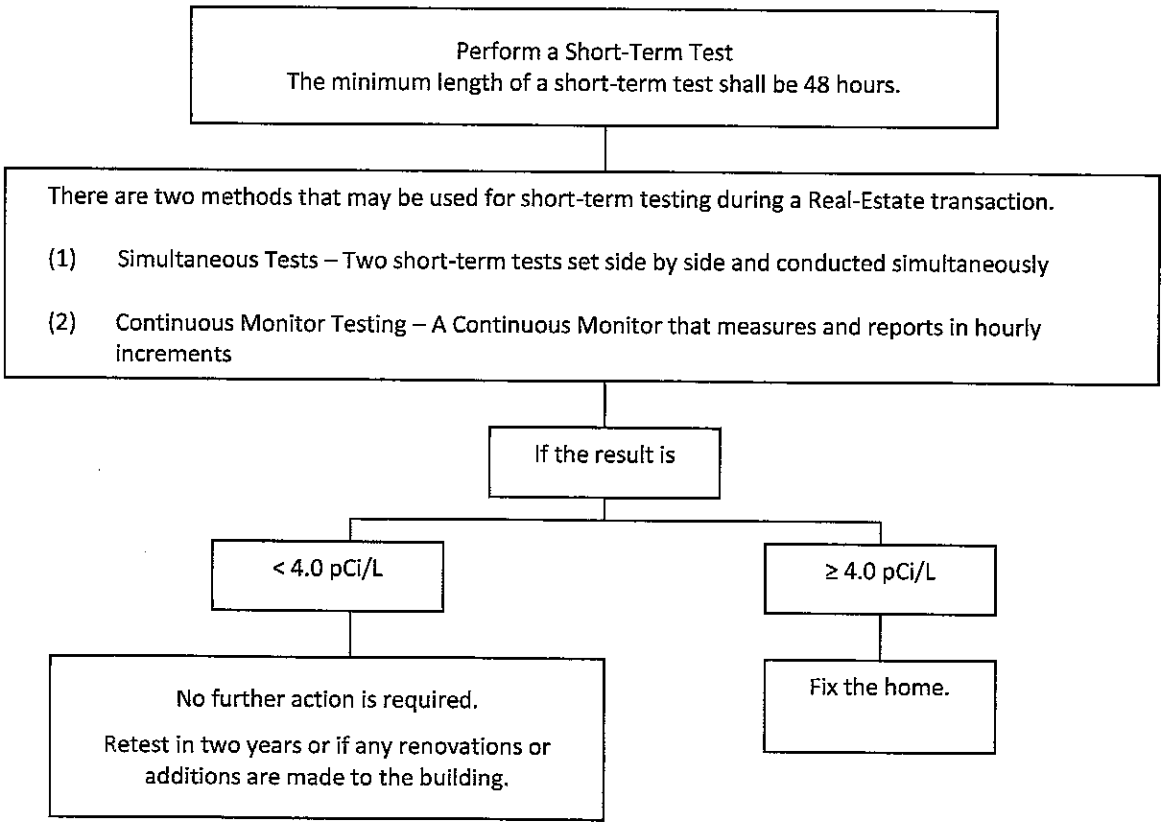
2 Conduct a short-term test in each of the lowest structural areas suitable for occupancy in the home. For example, if the home is a split-level building with one or more foundation types, test in the basement, in a room over the crawlspace, and in a slab-on-grade room. In accordance with this protocol, measurement licensees are required to test in each of the foundation types.

Appendix A

Addendum B

Recommended Testing Strategy for Measurements in Buildings Involved in Real-Estate Transactions

The first step is to perform a short-term measurement[1] in the lowest structural area.



Notes:

1 Short-term tests may last between two and ninety days; most last between two and seven days. Tests between seven and ninety days are usually impractical for real-estate transactions, but are fine for homeowners assessing their own radon situation. Examples of short-term detectors used in home environment testing include activated charcoal canisters, charcoal liquid scintillation vials, electret ion chambers and continuous monitors.

Appendix A

Addendum C

Radon and Radon Decay Product Measurement Method Categories

A (pCi/L)		B (WL)	
AC	Activated charcoal adsorption		
AT	Alpha-track detection	CW	Continuous working level monitor
LS	Charcoal liquid scintillation		
CR	Continuous radon monitor		
EL	Electret ion chamber; long-term		
ES	Electret ion chamber; short-term		

Appendix A

Addendum D

Notification of Radon Measurement in Progress

This worksheet may be used in accordance with rule 3701-69-07. The template below may be pasted onto company letterhead or used as a model for your own notification. All of the information shown below shall appear on each notification that is posted in accordance with rule 3701-69-07.

Radon Measurement in Progress

This notice is posted in accordance with
rule 3701-69-07 of the Ohio Administrative Code.

Tampering with a radon measurement will invalidate the measurement.

Removal of this notice, except by the licensed Radon Professional named below,
is considered tampering.

Date: _____

Location: _____

Name of Licensed Radon Professional (print):

Name of Licensed Radon Professional (signature):

Ohio License Number: _____

Contact Number: cell _____ office _____

Appendix A

Addendum E

Diagram of Room Worksheet for Radon Measurements

This worksheet may be used in accordance with rule 3701-69-07. The template below may be pasted onto company letterhead or used as a model for your own worksheet. All of the information shown below shall appear on each worksheet, and a copy of each worksheet shall be retained as a permanent record and included as part of a measurement report in accordance with rule 3701-69-07.

Placement of Measurement Devices

Short-term or long-term measurements shall be made in each lowest structural area suitable for occupancy. For example, a split-level building with a basement, a slab-on-grade room and a room over crawlspace shall have measurements made in each of the three foundation types.

Measurement devices shall (check all that apply):

☐ Be made in rooms that can be regularly occupied, such as family rooms, living rooms, dens, playrooms and bedrooms.

☐ Not be placed in areas of high humidity, such as bathrooms, kitchens, laundry rooms, spa rooms.

☐ Be undisturbed during the measurement period.

☐ Be at least 3 feet from doors, windows to the outside, or ventilation ducts and out of the direct flow of air from the ventilation duct.

☐ Be at least 1 foot from exterior walls.

☐ Be 20 inches to 6 feet from the floor.

☐ Be at least 4 inches away from other objects horizontally or vertically above the detector.

☐ Be at least 4 feet from heat, fireplaces and furnaces, out of direct sunlight, etc.

Appendix A

Addendum E

Diagram of Room Tested The following information shall be included:

1) Locations of all exterior walls, windows and doors. Annotate the direction of north or the front of the building.

2) Factors that may affect the measurement, including but not limited to crawlspace vents, sumps, fireplaces, combustive appliances, floor drains, furnaces, dryers, water heaters and mitigation systems.

3) Include measurements (to the nearest inch) from the testing device to two separate walls.

4) Current room use (e.g.: family room, bedroom, unfinished basement, playroom).

5) Address.

6) Device Serial Number.