Radon Guidance Training

Radon Risks in Existing Buildings

May 26, 2021

Developed by Kyle Hoylman, President at AARST and Chair at Standards Consortium.

ECONOMETRICA, INC.

Radon Sources and Entry Points



Radon Entry Points:

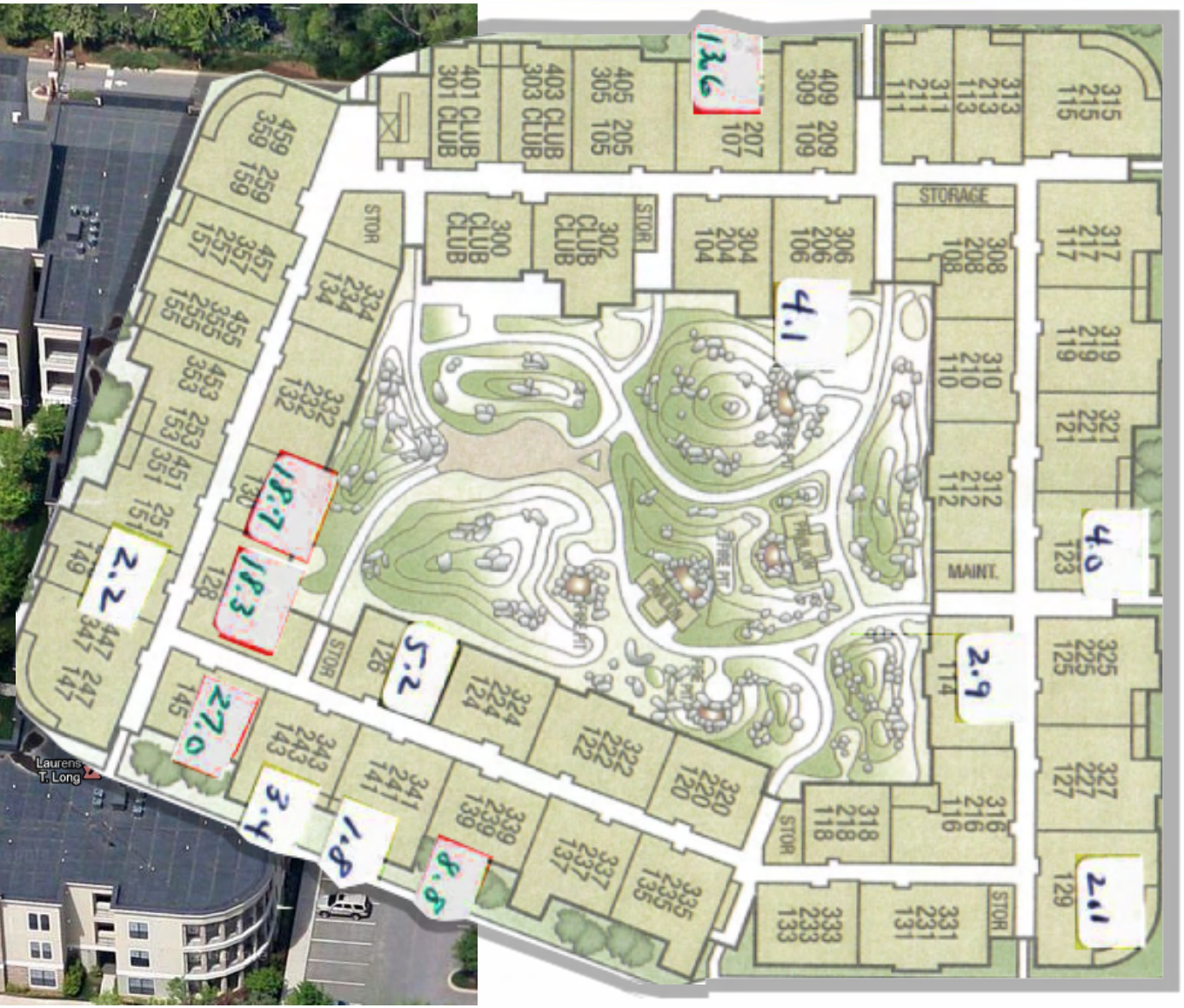
1. Floor cracks.
2. Construction joints.
3. Wall cracks.
4. Suspended floor gaps.
5. Wall cavities.
6. Water supply.
7. Sump crock, plumbing penetrations.

Indoor Air Contribution Sources:

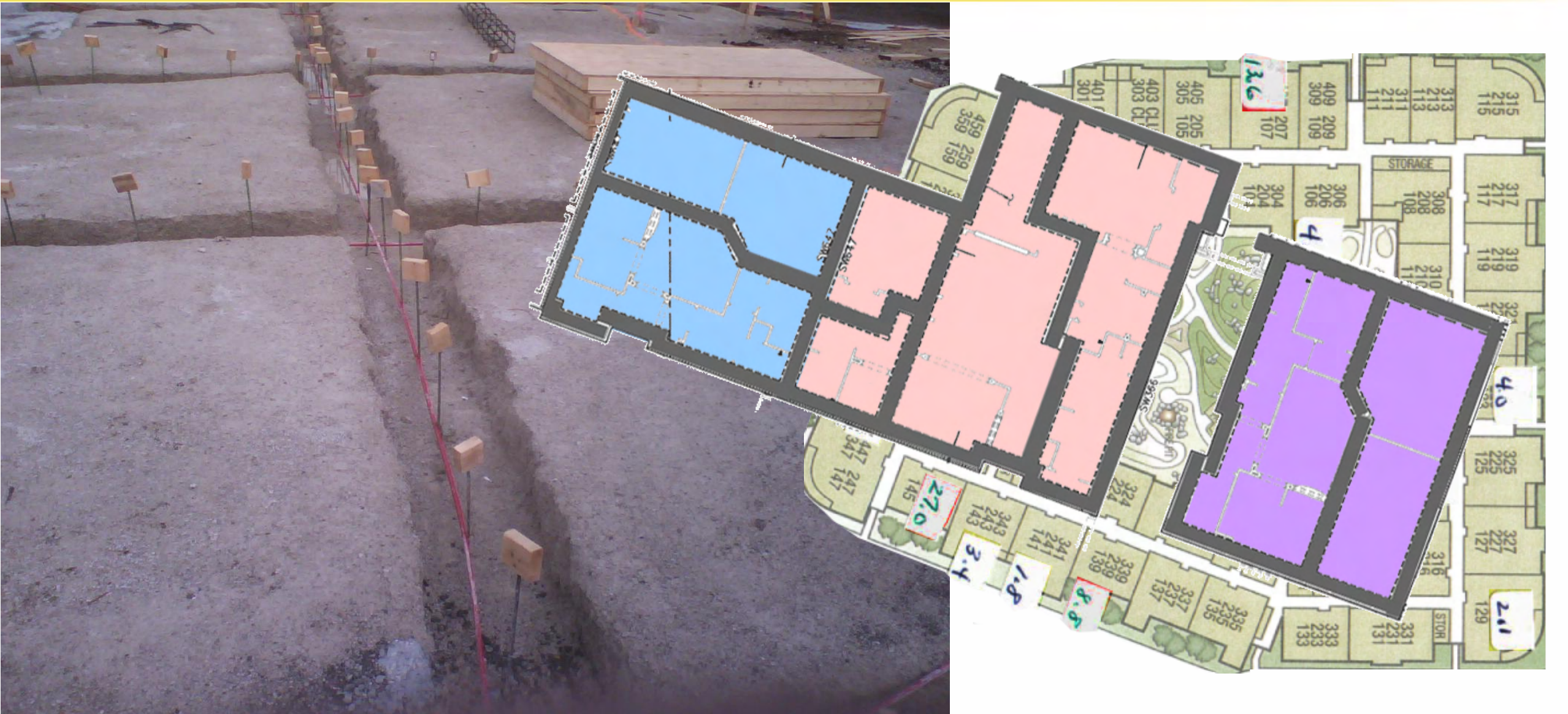
■ Soil gas: 90–95% ■ Emanation: 3–5%
■ Water supply: 1–2%

Preferential Pathways





Preferential Pathways (cont.)



Radon Measurement – Overview

- Qualified Radon Professional (QRP).
- Multifamily Measurement Standard (MAMF).
- Building Characterization.
- Measurement Devices.
- Measurement System Quality Assurance (QA).
- Measurement Process.
- Measurement Planning.
- Measurement Conditions.
- Measurement Notifications.
- Measurement Costs.
- Public Housing Authority (PHA) Measurement Options.

Qualified Radon Professional (QRP)

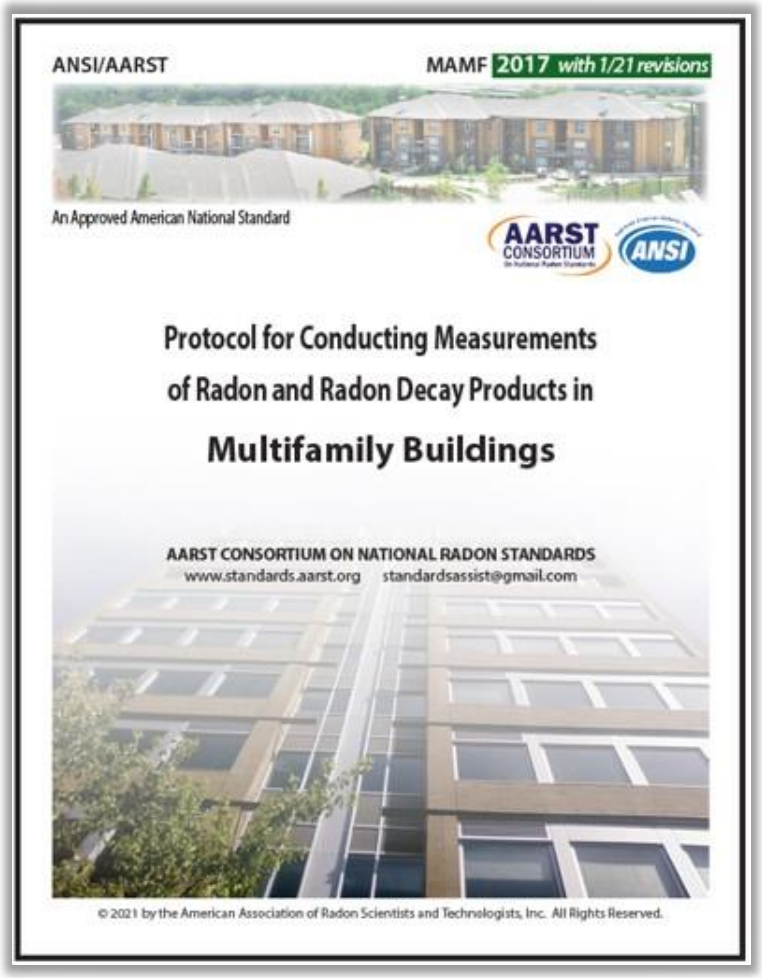
- Credentialed by National Radon Proficiency Program (NRPP) or National Radon Safety Board (NRSB) and certification/licensure for state where work is being done, if applicable.
- Direct (onsite) supervision for all radon testing and mitigation activities.
- Responsible for all radon reporting, testing and mitigation supervision, and operation, maintenance and monitoring (OM&M) supervision.



RADON TESTING

Environmental Law Institute | Database of State Indoor Air Quality Laws – Radon Excerpt | eli.org 40 states with radon law(s) in effect

Multifamily Measurement Standard (MAMF)

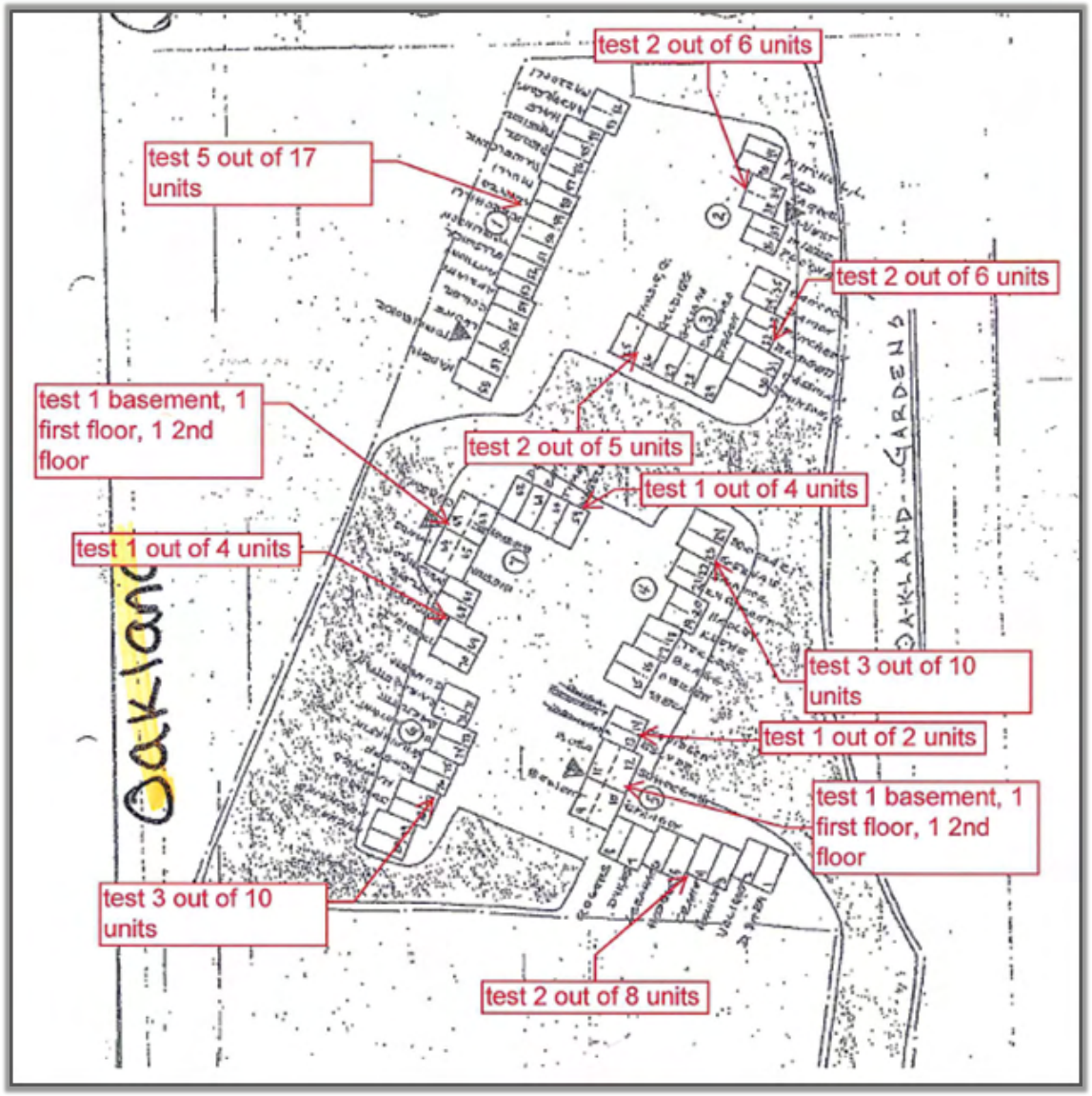


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Key Components:

- QRP.
- Ground Floor (100%) v. Upper Floor (10%).
- Residential v. Non-Residential.
- Occupied v. Non-Occupied.
- Exemptions.
- Extenuating Factors.
- Radon Zone.
- Measurement Conditions.
- Measurement Notifications.
- Mitigation Threshold $\geq$ 4.0 pCi/L.

Building Characterization



Meriden, CT, Example
7 Buildings, 80 Residential Units

Building Characterization (cont.)

Meriden, CT, Example

25% Initial	100% Follow-Up
1: 2/5 units > EPA action level	1: 13 units > EPA action level
2: 1/2 units > EPA action level	2: 5 units > EPA action level
3: 4/4 units > EPA action level	3: 8 units > EPA action level
4: 0/3 units > EPA action level	**4: 8 units > EPA action level**
5: 0/7 units > EPA action level	**5: 8 units > EPA action level**
6: 1/3 units > EPA action level	6: 9 units > EPA action level
7: 1/5 units > EPA action level	7: 3 units > EPA action level

- 100% follow-up assessment of the buildings identified 16 residential units in 2 buildings.
- Total of 44 additional residential units identified through full characterization.

Building Characterization (cont. 2)

Lexington, KY, Example

- 10% screening of 1 unit in 18 buildings, total of 144 ground contact residential units (Freddie).
- 14 residential units in 14 buildings > EPA action level – Policy requirement to mitigate 14 residential units.
- 100% assessment of ground contact units conducted – 108 of 144 residential units > EPA action level (16 units greater than EPA respirator rate, none on initial screening list).
- Client chose to mitigate 108 residential units, Freddie required 14 residential units – Liability consideration.

Average Probability (%) of Partial Sampling Missing a Unit in a Building* With ≥ 4 pCi/L With Various Sampling Percentages

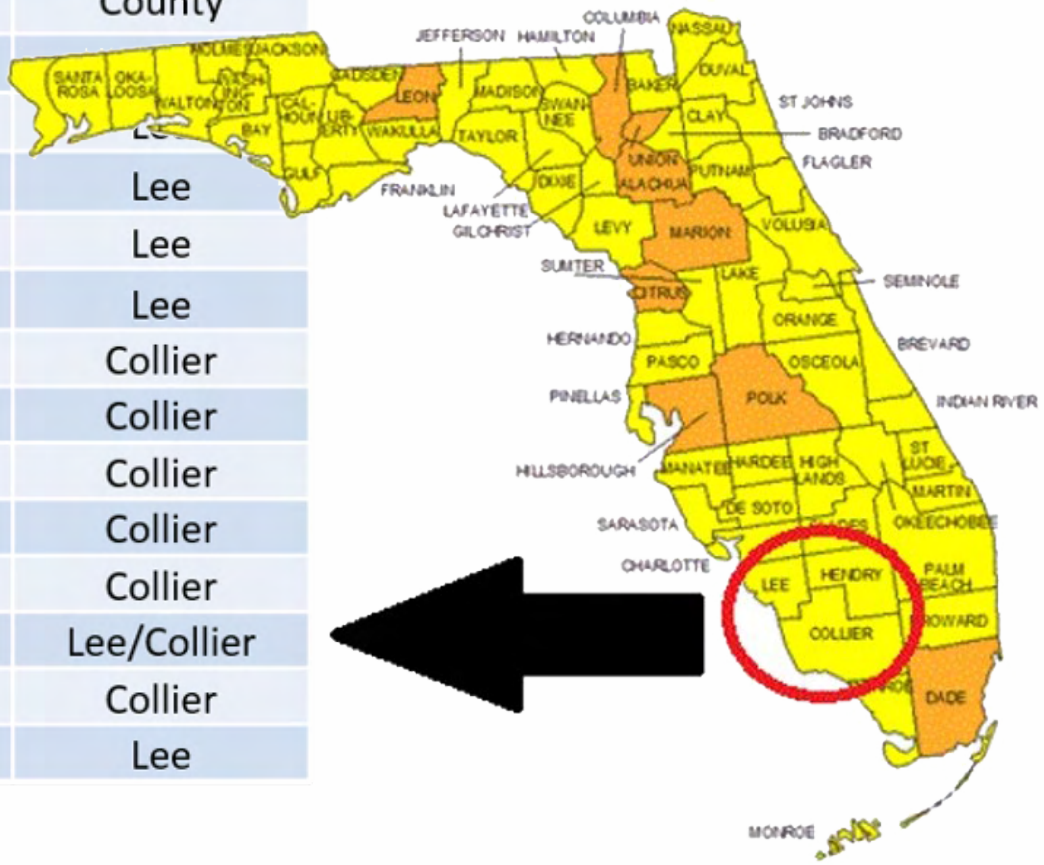
Number of Ground Contact Units	Number of Buildings	10% Sampled	25% Sampled	50% Sampled	75% Sampled	90% Sampled
05–06	45	58	34	19	4.7	0.0
07–08	71	55	36	15	4.6	0.0
09–10	40	65	39	24	8.5	3.8
11–12	37	52	41	21	8.1	2.8
13–14	14	51	35	20	7.4	2.2
15–16	20	47	32	15	5.0	1.3
17–18	15	59	39	21	8.1	1.9
19–20	12	69	46	23	8.9	2.6
21–26	22	52	34	18	6.7	2.3
All	276	58%	38%	19%	6.5%	1.7%

*Ground contact units only. Includes buildings with at least 1 unit ≥ 4 pCi/L.
Note that for 90% sampling, all units are tested for buildings with 9 or fewer units.
Source: *Evaluating and Assessing Radon Testing in Housing: Report to HUD*, January 2021.

Building Characterization (cont. 3)

Florida Radon Map

Radon Zip Code Data Results:			21-Feb-19
Source: http://www.floridahealth.gov/environmental-health/radon/radon-menu.html			
Zip	Measurements	% Elevated	County
33904	225	23.10%	
33908	1925	41.10%	
33919	521	28.20%	Lee
33967	273	16.80%	Lee
33990	156	26.90%	Lee
34104	1376	34%	Collier
34108	4728	27.10%	Collier
34109	3368	29.40%	Collier
34110	3713	29.50%	Collier
34112	1630	32.20%	Collier
34119	3993	24%	Lee/Collier
34120	1331	32.20%	Collier
34135	3737	27.90%	Lee



Building Characterization (cont. 4)

April 16, 2021 | ** LABORATORY ANALYSIS REPORT ** | Pg 1 of 3

P5179 / KYLE HOYLMAN

Kit Number	Start Date	Start Time	End Date	End Time	Temp.	Facility	Building	Room	Project ID	Floor	Result
9614255	2021-04-07	9:00 am	2021-04-09	9:00 am	75	NORTH COURT VILLAS	CLUB HOUSE	BUSINESS CENTER		1	< 0.3
9614287	2021-04-07	9:00 am	2021-04-09	9:00 am	75	NORTH COURT VILLAS	CLUB HOUSE	LEASING OFFICE		1	< 0.3
9619602	2021-04-07	11:00 am	2021-04-09	11:00 am	75	NORTH COURT VILLAS	3	319		1	4.9
9619604	2021-04-07	10:00 am	2021-04-09	10:00 am	70	NORTH COURT VILLAS	1	1114		1	4.1
9619605	2021-04-07	11:00 am	2021-04-09	10:00 am	70	NORTH COURT VILLAS	3	312		1	5.1
9619606	2021-04-07	10:00 am	2021-04-09	10:00 am	70	NORTH COURT VILLAS	2	2111		1	4.2
9619607	2021-04-07	9:00 am	2021-04-09	9:00 am	75	NORTH COURT VILLAS	CLUB HOUSE	FITNESS CENTER		1	1.6
					70	NORTH COURT VILLAS	1	1112		1	8.4
					70	NORTH COURT VILLAS	2	219		1	5.6
					70	NORTH COURT VILLAS	3	311		1	3.1
					75	NORTH COURT VILLAS	3	3112		1	3.2
					70	NORTH COURT VILLAS	5	511		1	14.0
					70	NORTH COURT VILLAS	2	239		3	< 0.3
					75	NORTH COURT VILLAS	2	215		1	5.8
					75	NORTH COURT VILLAS	1	121		2	1.3
					75	NORTH COURT VILLAS	1	121		2	1.0
					75	NORTH COURT VILLAS	3	313		1	5.7
					75	NORTH COURT VILLAS	2	215		1	6.2
					75	NORTH COURT VILLAS	3	323		2	2.3
					75	NORTH COURT VILLAS	3	316		1	16.1
					70	NORTH COURT VILLAS	2	233		3	0.7
9619622	2021-04-07	11:00 am	2021-04-09	10:00 am	70	NORTH COURT VILLAS	2	233		3	0.6
9619623	2021-04-07	11:00 am	2021-04-09	11:00 am	75	NORTH COURT VILLAS	3	318		1	5.0
9619624	2021-04-07	11:00 am	2021-04-09	11:00 am	75	NORTH COURT VILLAS	3	317		1	< 0.3

Frisco, TX

- Zone 3
- 35 of 72 Locations > 4.0 pCi/L
- Highest Concentration = 16.5 pCi/L

Building Characterization (cont. 5)

March 9, 2021 | ** LABORATORY ANALYSIS REPORT ** | Pg 1 of 2

P5179 / KYLE HOYLMAN

Kit Number	Start Date	Start Time	End Date	End Time	Temp.	Facility	Building	Room	Project ID	Floor	Result
10020201	2021-03-02	2:00 pm	2021-03-04	1:00 pm	70	ROSEHILL WEST APARTMENTS	1925	C		1	2.3
10020204	2021-03-02	1:00 pm	2021-03-04	1:00 pm	70	ROSEHILL WEST APARTMENTS	1917	C		1	< 0.3
10020205	2021-03-02	1:00 pm	2021-03-04	1:00 pm	70	ROSEHILL WEST APARTMENTS	1905	F		2	< 0.3
10020206	2021-03-02	1:00 pm	2021-03-04	1:00 pm	75	ROSEHILL WEST APARTMENTS	OFFICE BUILDING	LEASING OFFICE		1	< 0.3
10020207	2021-03-02	1:00 pm	2021-03-04	1:00 pm	75	ROSEHILL WEST APARTMENTS	OFFICE BUILDING	MAINTENANCE OFFICE		1	< 0.3
10020253	2021-03-02	3:00 pm	2021-03-04	2:00 pm	75	ROSEHILL WEST APARTMENTS	1964	D		1	5.8
						ROSEHILL WEST APARTMENTS	1949	C		1	1.2
						ROSEHILL WEST APARTMENTS	1951	C		1	9.0
						ROSEHILL WEST APARTMENTS	1951	B		1	6.9
						ROSEHILL WEST APARTMENTS	1949	D		1	1.9
						ROSEHILL WEST APARTMENTS	1954	A		1	5.4
						ROSEHILL WEST APARTMENTS	1949	D		1	2.0
						ROSEHILL WEST APARTMENTS	1951	A		1	10.2
						ROSEHILL WEST APARTMENTS	1951	D		1	0.8
						ROSEHILL WEST APARTMENTS	1951	G		2	2.1
						ROSEHILL WEST APARTMENTS	1964	B		1	5.6
						ROSEHILL WEST APARTMENTS	1954	F		2	2.5
						ROSEHILL WEST APARTMENTS	1959	A		1	12.0
						ROSEHILL WEST APARTMENTS	1959	D		2	2.2
						ROSEHILL WEST APARTMENTS	1964	G		2	1.1
						ROSEHILL WEST APARTMENTS	1944	F		2	2.3
10020274	2021-03-02	2:00 pm	2021-03-04	3:00 pm	75	ROSEHILL WEST APARTMENTS	1951	C		1	6.8
10020276	2021-03-02	2:00 pm	2021-03-04	2:00 pm	75	ROSEHILL WEST APARTMENTS	1954	B		1	6.6
10020277	2021-03-02	3:00 pm	2021-03-04	2:00 pm	75	ROSEHILL WEST APARTMENTS	1964	A		1	7.1

Fayetteville, NC

- Zone 3
- 18 of 51 Locations > 4.0 pCi/L
- Highest Concentration = 12.0 pCi/L

Building Characterization (cont. 6)

In the south Texas areas, multiple studies and measurements have indicated that radon does not pose a health hazard because of the lack of uranium in the soil. Notwithstanding, radon testing was requested for this investigation and reportedly required by HUD.

Methodology/Approach:

The nine monitors (Data Sheet AT-100 Radon Alpha Track Detector®) were placed in approximately 18" deep holes scattered throughout the Copper Pointe Apartment construction grounds. The sensors were placed into the holes and the holes covered for seventy-two hours. At least twelve buildings, slab on grade, will be constructed.

The language in Section 9.5.C.2.a requiring a radon report at either the pre-application or the Firm Commitment application applies only to reporting radon testing conclusions for existing buildings as part of a substantial rehabilitation or refinance application. For new construction projects, preconstruction testing is not possible. Accordingly, a report by a radon professional is required only after testing has been conducted at completion of construction and prior to final endorsement in accordance with Section 9.5.C of the MAP Guide. Applications must include the radon zone and a description of the radon mitigation system in the architectural plans, as HUD relies on the project architect to design and incorporate any required radon mitigation system. HUD requires the architect to seek technical advice from a radon specialist should the architect believe it necessary in their professional judgment or if it is required by the relevant mitigation standard.



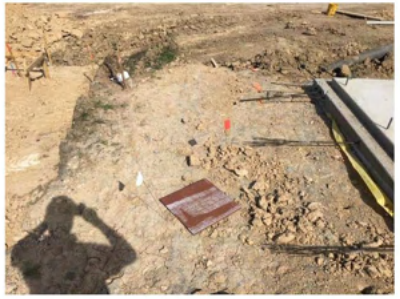
2. Construction Site



3. Sample by Building 12 prior to lid removal



4. Sample by Building 1



5. Covered Sample



6. Covered Sample


Clay
Shale
Limestone Rock Shelf
Top Soil
Radium/Radon Volume
Not Concentration

Measurement Devices





Device Types:

- Deployment Periods.
- Short-Term.
- Long-Term.
- Active Devices.
- Continuous Radon Monitors.
- Passive Devices.
- Activated Charcoal Absorption.
- Alpha Track.
- Electret Ion Chamber.
- Liquid Scintillation.

Measurement System QA

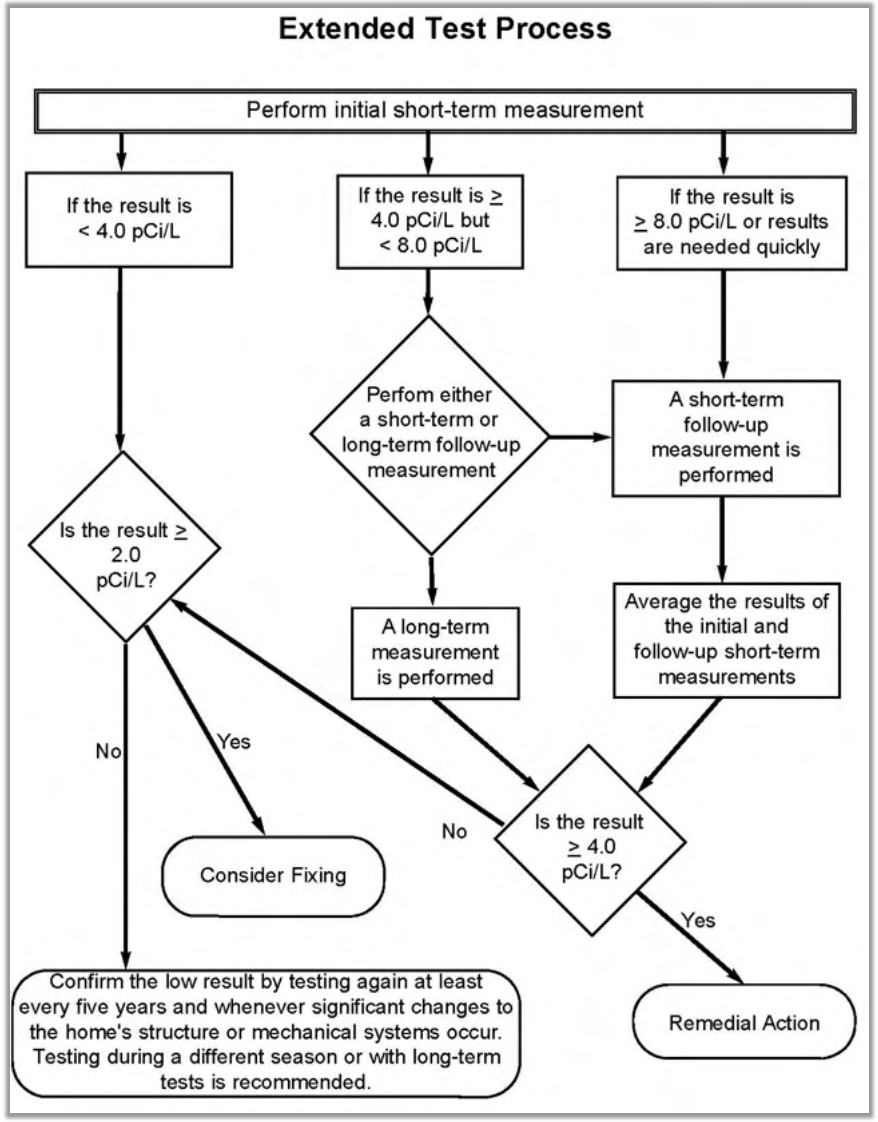


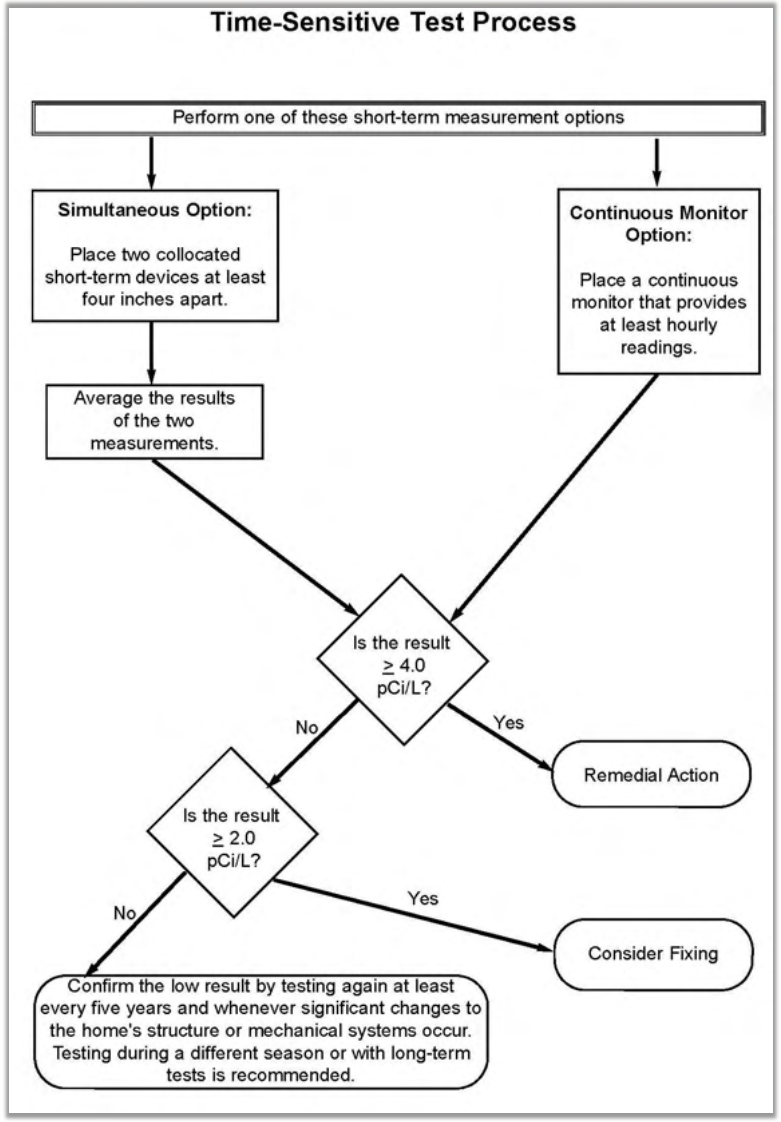
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Key Components:

- Accuracy, Precision, Bias.
- Active Devices.
- Calibration.
- Cross-Checking (10%).
- Passive Devices.
- Spiking (3%).
- Duplicate (10%).
- Blank (5%).
- QA Investigations.
- QA Records Retention.

Measurement Process





Measurement Planning

MANAGEMENT COMMITMENT

To the extent reasonably possible, I, on behalf of _____, commit to helping ensure that building conditions required to achieve reliable radon tests are met, as portrayed herein.

Client or Authorized Agent Name: _____

Signature: _____ Date _____

BUILDING ONSITE SUPERVISOR COMMITMENT

To the extent reasonably possible, I commit to helping ensure that building conditions required to achieve reliable radon tests are met, as portrayed herein, by accepting the following responsibilities:

1) **Prior Notifications:** Notices will be distributed to all tested, non-tested dwellings and posted in publicly accessible areas such as in corridors, elevators and offices in a timely manner, no later than required by local law for gaining access to a dwelling or not later than the day before testing; and
2) **Access:** Access will be provided to each location being tested within a building with intent to access all locations within a building on the same day for both the event of placing test devices and a second event for retrieving test devices.

Onsite Logistics Supervisor —Name: _____

Signature: _____ Date _____

BUILDING OPERATIONS STAFF COMMITMENT AND ATTESTATIONS

To the extent reasonably possible, I commit to helping ensure that building conditions required to achieve reliable radon tests are met, as portrayed herein, by accepting the following responsibilities:

1. **Building Preparation**: I accept responsibility that, no later than 12 hours prior to testing, each building scheduled for testing will be reviewed for compliance with closed-building requirements.
2. **Compliance Verification:** I accept responsibility for taking actions that could include adjustments to HVAC units and repairs, such as for broken windows, where completion is required no later than 12 hours prior to testing. Verification will be provided as initialed below or initialed on a log sheet to be provided.

HVAC Operations Supervisor—Name: _____

Signature: _____ Date _____

Building address(s) _____ Date completed _____ Initials ___

Building address(s) _____ Date completed _____ Initials ___

Building address(s) _____ Date completed _____ Initials ___

Actions required at least 12 hours prior to initiating the test

Building Component →	Action Required
Windows **Exterior doors** (except for momentary entry and exit) **Other openings to the exterior** as a result of disrepair incomplete construction or structural defect.	Close or seal on all levels of the building, including areas not being tested Exception: Do not close openings to outside air designed to provide air needed for combustion appliances.
Heating and cooling systems	Set to operate at normal occupied temperatures: 65˚ - 80˚ F (18˚ - 27˚ C). Note—Maintenance inspections of HVAC systems are recommended, but not required.
Variable Outdoor Air Ventilation Systems (if any) Automated or manually operated systems that seasonally vary outdoor air ventilation for energy savings or comfort, for: — individual rooms and dwellings — multiple rooms and dwellings; or — the whole building. Such systems include: Manually operated dampers, Energy Economizer systems, Energy Recovery Ventilators (ERV) and Evaporative cooling systems.	Close outside air inlet dampers or set to minimum outdoor air intake settings that apply at all times of the year when a building is *significantly occupied*. For other systems, such as window air conditioners, dampers to outside air shall be closed.
Variable Air Volume (VAV) Systems (if any) Systems that temper room temperatures using thermostats to vary the volume of heated or cooled air coming into rooms.	Set all thermostats to between 65-80˚ F (18-27˚ C) in all rooms that are served by the system.
Return-Air Ducts laid In Soil (if any) Where return-air air ductwork is located under a slab, or otherwise laid in soil.	**Alert the testing company immediately**
***HVAC setback* in non-residential locations** If non-residential rooms are operating with *HVAC setback* temperatures during nights or weekends that are outside of normal occupied temperatures of 65˚and 80˚ F (18˚ - 27˚ C).	Alter to retain temperatures within the range of 65˚and 80˚ F (18˚ - 27˚ C) **Or, contact the testing company**

Measurement Conditions

Table 4-A ESSENTIAL CLOSED-BUILDING PROTOCOL REQUIREMENTS	
Windows	**Keep closed** on all levels of the building including areas not being tested
Exterior doors (except for momentary entry and exit)	
Heating and cooling systems	**Set to normal** occupied operating conditions with normal temperatures between 65˚and 80˚ F (18˚ - 27˚ C)
Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings	**Set to the lowest seasonal ventilation**
Bathroom fans	**Operate normally**
Exhausts Systems (that temporarily draw air from the building such as from laundries, workshops, community kitchens or for local control of fumes)	**Avoid excessive operation**
Fireplaces (that burn solid, liquid or gas fuels unless a primary/normal source of heat for the building)	**Do not operate**

Table 4-C ADDITIONAL CLARIFICATION ON CLOSED BUILDING PROTOCOL REQUIREMENTS FOR SPECIFIC COMPONENTS	
Windows and Doors on all levels of the building including areas not being tested	
Broken windows or doors	Seal closed
Interior partition or stairway doors	No special requirements
Exterior doors into non-residential rooms	Keep closed (except for momentary entry and exit of individuals who customarily enter the building)
Garage doors and doors leading into a garage	Keep closed (except for momentary entry and exit).
Small Appliances	
Ceiling fans and portable fans	Do not blow fans directly towards testing devices
Window fans	Remove or seal shut and do not operate
Humidifiers and dehumidifiers	Operate normally
Crawl Spaces	
Passive *crawl space* vents	Set vents to the condition that prevails during the greatest amount of time each year
Crawl space humidity control systems	Operate normally
Mechanical Systems	
Passive vents for combustion air makeup	Leave open
Combustion appliance fans	Operate normally
Fans installed in attics to ventilate only attic air	
Window air conditioners	Operate in recirculation mode only
Evaporative cooling systems	Do not operate and do not cover

Measurement Notifications

Radon Survey in Progress

Dear Residents,

An important step is being taken to protect your health. Radon testing is being conducted for this building.

Radon is a naturally occurring radioactive gas that can be present in some buildings at concentrations greater than recommended. Testing for radon is recommended for all homes. Radon gas is the second leading cause of lung cancer and the leading cause of lung cancer for nonsmokers in the United States.

The only way to know what the radon concentrations are for any building is to test.

Radon testing is scheduled for:

Building(s): _____

Building Area(s): _____

Test Deployment: Day_____ Date _____ (please close windows the night before)

Test Completion: Day_____ Date _____ Time: Before close of business hours

Please help to maintain these required test conditions throughout the building (12 hours prior the test and during the test).	
Windows	**Keep closed** on all levels of the building including areas not being tested
Exterior doors (except for momentary entry and exit)	
Heating and cooling systems	**Set to normal** occupied operating conditions with normal temperatures between 65˚and 80˚ F (18˚ - 27˚ C)
Systems that temporarily ventilate with outdoor air for seasonal comfort or energy savings	**Set to the lowest seasonal ventilation**
Bathroom fans	**Operate normally**
Exhausts Systems (that temporarily draw air from the building such from laundries, workshops, community kitchens or for local control of fumes	**Avoid excessive operation**
Fireplaces (that burn solid, liquid or gas fuels unless a primary/normal source of heat for the building)	**Do not operate**

For general health information:

Copies of EPA's *A Citizen's Guide to Radon* can be found online at **www.epa.gov/radon**.

For inquiries or reporting concerns.

Contact Person: _____ Phone: _____

We thank you for your cooperation in helping to ensure a safe and healthy building.

Radon Testing Scheduled

Dear Residents,

An important step is being taken to help protect the health of all occupants in this building. Radon testing is being conducted in portions of this building.

Radon is a naturally occurring radioactive gas often found in soil that can be present in buildings at concentrations greater than recommended.

The only way to know what the radon concentrations are for any building is to test.

Starting Day: _____ Date_____ **(Windows must be closed the night before)**

Ending Day: _____ Date_____ Ending Time: Close of business hours.

Access into your unit is: [ ] required on _____
[ ] not required

Please help to maintain these required test conditions throughout the building (12 hours before the test and during the test).	
Windows	**Keep closed** on all levels of the building including areas not being tested
Exterior doors (except for momentary entry and exit)	
Heating and cooling systems	**Set to normal** occupied operating conditions with normal temperatures between 65˚and 80˚ F (18˚ - 27˚ C)
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Contact Person: _____ Phone: _____

We thank you for your cooperation in helping to ensure a safe and healthy building.

Measurement Costs

Average radon testing and/or mitigation costs in single family, multifamily, and large buildings developed for FHA insured properties.

- Single Family Residential Buildings
  - Average cost range for testing - $100 to $275 per unit
  - Average cost range for mitigation - $1,500 to $3,000 per unit
- Multifamily and Large Buildings
  - Average cost range for testing - $50 to $80 per unit
  - Average cost range for mitigation - $2,500 to $4,000 per unit

Notes:

- Average testing cost range assumes one short term device deployed over one foundation area, required QA controls are implemented.
- Average mitigation cost range assumes use of sub-slab depressurization mitigation technology, and all mitigation costs are included: (1) diagnostic design testing; (2) mitigation system installation; (3) post-mitigation testing; and, (4) final report with OM+M program plan.
- The costs for radon testing and/or mitigation in a specific geographical location may vary.

PHA Measurement Program Options

Challenge

- Building an effective radon management program with limited resources.

Solution

- Section 2.1.5.1 of MAMF requires direct onsite supervision by the QRP.

HOWEVER

- Section 2.1.5.2 of MAMF provides guidance for utilizing non-qualified persons for radon measurement under QRP supervision.
  - May assist in the placement and retrieval of devices.
  - Names and qualifications recorded in project QC documentation.
  - Work plan assigning tasks and worker training.

PHA Measurement Program Options (cont.)

In Practice

- QRP develops measurement and QA plan for project.
- QRP provides training on device deployment and retrieval to non-qualified persons – training log and project QC documentation updated.
- QRP is onsite to provide direct supervision of device deployment and retrieval.
- QRP logs devices and maintains chain of custody to lab.
- QRP reviews laboratory results and develops measurement report.
- QRP updates and maintains QA measurement system documentation.



Notes

- Verify approach meets applicable state laws/regulations.

Contact Information

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Chair, Standards Consortium

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All Contact Information

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Justin Gray	Office of Public and Indian Housing (PIH)	justin.w.gray@hud.gov