

Radon Measurement Overview

This unit provides basic information on radon and radon decay product (RDP) measurement. After learning the content of this chapter and completing the corresponding reviews and hands on assignments, you should be able to:

- ☐ Understand the role of a radon measurement service provider
- ☐ Define measurement units for radon gas and RDP measurements
- ☐ Describe the difference between Radon vs. RDP Measurements
- ☐ List the 7 primary opportunities when a radon test might take place
- ☐ Identify the four measurement options (duration)
- ☐ Summarize the three measurement methods
- ☐ Identify the two measurement protocols and the options for real estate testing
- ☐ List the device placement and deployment protocols
- ☐ Identify the measurement devices used for grab sampling
- ☐ Identify closed building conditions
- ☐ List the Post-Mitigation test protocols
- ☐ Summarize the New Construction Test Protocols
- ☐ Compare and Contrast the Protocols for Analysis and Interpretation

Review

- 1) The purpose of Radon Measurement
 - a) To determine if radon mitigation is necessary in order to protect current and future occupants of a home.
- 2) The purpose of Radon Measurement Protocol
 - a) To consistently produce, to the extent possible, reliable and repeatable radon measurements.
- 3) The Primary Responsibilities of a Radon Measurement Service Provider
 - a) Ensure compliance and mandatory test conditions prior to testing
 - b) Deploy and retrieve measurement devices according to state and/or national protocols
 - c) Observe key areas of possible radon entry
 - d) Report measurement results
 - e) Recommend appropriate course(s) of action
 - f) When required by law in some states, report on visual observations of the proper installation/operation of mitigation systems that may affect occupant health and safety; or
 - g) When not required by law and permissible by national standards, provide a statement indicating that the test company offers no findings as to the proper operation of the mitigation system.
- 4) Some Unique Situations When a Professional Might Test for Radon
 - a) Concerned Homeowner [Non-Real Estate Transaction, Extended Test Protocol]
 - b) Real Estate Transaction [Time Sensitive Protocol]
 - c) Retest – When a new test is required due to an invalid initial test; or when the initial test is more than 2-5 years old.
 - d) Diagnostic – Conducted for research or mitigation strategy
 - e) Post-mitigation – To determine the effectiveness of a mitigation system
 - f) New Construction – After all work is complete on a newly built home.
- 5) Initial Measurements
 - a) Short-term tests
 - b) 2 – 90 days
 - c) Can be used as initial tests or follow-up tests
 - d) Closed-building conditions must be met for test durations of less than 7 days and closely adhered to for 7-90 day tests.
 - e) Typically used in all categories of tests: Concerned Homeowner, Real Estate, Commercial & School and multifamily dwelling tests.
 - f) Long-term tests
- 6) Follow-Up Measurements
 - a) Tests that confirm initial short term results (usually not conducted in real estate transactions)
 - b) Can be short term (if initial test result was over 8 pCi/l)
 - c) Can be long term (if initial test result was 8 pCi/l or less)
 - 90+ days
 - Conducted under normal living conditions.
 - Typically used to confirm an initial short-term test or to determine year round averages.

- Typically used in Concerned Homeowner tests.
- 7) Retests
 - a) Conducted when a previous test was invalid.
 - 8) Diagnostic tests
 - a) Typically used by radon mitigation professionals only to determine entry points and sources of radon to determine design and strategy of mitigation system
 - b) No specific building protocol. Follow manufacturer directions.
 - c) Example: Grab Samples
 - 9) Post-mitigation tests
 - a) To determine if mitigation was successful
 - b) Use short-term testing protocol.
 - 10) Three measurement methods
 - a) Time Integrated [Radon Gas]
 - 2 days – 1 year
 - Active or Passive devices
 - Sample over a period of time and integrate the results to an average.
 - b) Continuous [Radon Gas]
 - An active monitor that takes time-integrated, hourly readings over a sampling period.
 - c) Grab Sampling [Radon Decay Products]
 - Collecting air sample typically below the slab, over a very short period of time, usually only a few minutes.
 - A diagnostic tool to determine entry sources and pathways
 - Helps mitigation strategy and design
 - Not to be used to determine the need for mitigation.
 - 11) Two radon gas measurement protocols:
 - a) Time-Sensitive Testing – To accommodate residential real estate transactions
 - b) Extended Testing - Concerned homeowners, commercial, school, multifamily building
 - 12) Methods used for Grab Sampling
 - a) Lucas Cell
 - Alpha Scintillation Cell
 - A flask ranging in size from about 0.1 to 2.0 liters in volume
 - Flask has a zinc sulfide phosphor coating on the interior and a counting window on its bottom surface to prevent RDPs and other background radiation from entering the cell a filter is attached to the cell's air inlet when filling with a sample of air.
 - Scintillation cells can be either a single valve type or a double valve flow through type.

- (1) Single valve cells
 - (a) Evacuated with a pump and purged with nitrogen or low radioactivity air several times
 - (b) Reduces background radiation within the cell.
 - (c) A vacuum is created in a low background cell then the valve is simply opened to admit air from the sample location.
 - (2) Double valve cells
 - (a) Flushed with nitrogen or low radioactivity air typically outdoor air.
 - (b) The turbulence from high flow, extended duration flushing appears to enhance cell recovery by removing attached RDPs from cell walls.
 - (c) Both valves are opened and an air volume equal to at least 10 cell volumes is pumped through the cell.
 - (d) Both valves are then closed to hold the sample.
 - (e) For greatest accuracy the radon sample is allowed to reach secular equilibrium with its RDPs.
 - (i) This requires about a four-hour wait after collection.
 - (ii) The cell's clear window is then placed in contact with a photomultiplier tube, in order to count light pulses from the interaction of the alpha particles (emitted from radon and its RDPs) as they strike the zinc sulfide coating.
- b) Kusnetz Method
- Air pump used to collect RDPs on a filter
 - (1) Filter paper is known to clog frequently
 - The air pump must be calibrated to obtain accurate airflow over the sampling time interval (normally around 5 minutes).
 - RDP sample taken by a scintillation counting system for about 10 minutes
 - Total alpha activity is measured between 40 and 90 minutes.
 - The sample collection filter is placed on a tray against a zinc sulfide phosphor disc.
 - The tray is then placed in the counting chamber against the photomultiplier tube counting surface.
 - The photomultiplier tube counts light pulses occurring from the interaction of the alpha decays and the zinc sulfide phosphor.
 - A calibration-based conversion factor allows the counts collected over the analysis time interval to be converted directly to WL.
 - Requires the use of either a standard alpha-emitting source or an RDP sample traceable to a National Institute of Standards and Technology (NIST) standard.
- 13) Closed Building Conditions
- Keep closed
 - Windows, except when being momentarily opened/closed during a home inspection.
 - Doors leading to the garage, except for normal exit/entry
 - Doors leading to the outside, except for normal exit/entry
 - Fireplace Dampers
 - Do not operate:

- Whole House Fans
 - Window Fans [seal shut]
 - Fireplaces [except when serving as the primary source of heat]
 - Any system that temporarily draws air into or out of the building
 - Evaporative Coolers [aka Swamp Coolers]
 - Portable Window Air Conditioners in Fan or Vent Mode
- Operate Minimally:
 - Clothes Dryers
 - Range Hoods
 - Bathroom Fans
- Operate Normally:
 - Permanently Installed HVAC Systems
 - Normal operating condition/temperature: 65 – 80 degrees
 - Dehumidifiers, Humidifiers
 - Central Vacuum Systems
 - Portable Air Cleaners
 - Crawlspace dehumidification system vents
 - Attic Fans
 - Permanently Installed HRV/ERV Systems
 - Radon Mitigation Systems
 - Portable Window Air Conditioners in Recirculation Mode
- Structural openings due to disrepair or structural defects must be repaired.

14) Post-Mitigation Testing

- Conducted under standard protocols.
- Conduct the test in the same location as the pre-mitigation test(s) when possible.
- Conduct an additional post-mitigation test in the lowest livable area above any crawlspace that is structurally isolated from the occupiable or tested rooms; and in the lowest livable area above each other unique structural area.
- Post-mitigation tests should be initiated no sooner than 24 hours and no more than 30 days after a system has been installed and operational.
- Systems should be retested every 2 years.

15) Requirements for New Construction Testing

- All insulation
- All exterior doors with associated hardware installed
- All windows
- All fireplaces and fireplace dampers
- All heating, air conditioning, and plumbing appliances
- All ceiling covers
- All interior trim and coverings for the exterior walls
- All exterior siding, weatherproofing and caulking
- All interior and exterior structural components

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

16) Analysis of Results from Passive Devices

- The results of both measurements and the average of the simultaneous measurements must be reported.
- These results are considered appropriate as the basis for determining the need for mitigation.
- The precision of simultaneous measurements must be monitored and recorded in the quality assurance records. The analysis of data from simultaneous measurements must be plotted on range control charts. If the precision estimated by the user is not within the precision expected of the measurement method, the cause of the problem must be investigated and corrective action taken in accordance with the quality assurance program.

17) Analysis of Results from Continuous Devices

- The minimum test exposure/deployment period must be 48 hours.
- The first 4 hours of data from a continuous monitor may be discarded or incorporated into the result using system correction factors. 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 44 contiguous hours of monitoring) is not permitted and invalidates the measurement.
- Short-term tests should be terminated as closely as possible to 24-hour increments to avoid the effects of diurnal cycles on indoor radon concentrations.
- Assuming closed-building conditions were maintained for 12 hours prior to deployment, a Continuous Radon Monitor may be retrieved after no less than 46 hours. This is NOT a best practice and a minimum 48-hour test should be conducted whenever possible.

The following chart provides guidance on the interpretation of measurement results and recommendations for actions. Actions should be taken based on the following guidance and in accordance with state-specific regulations, when available.