Muscogee (Creek) Nation
Office of Environmental Services

Quality Assurance Project Plan (QAPP)

Indoor Air Quality Program (IAQP)

CAA § 105 PPG – Radon Risk Reduction in Tribal Facilities

State Indoor Radon Grant (SIRG)

FY 2023-2025

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Approval Page

QAPP - Radon Risk Reduction in Tribal Facilities

Plan Prepared by: Kristy Lawson, Environmental Specialist II

The following individuals have reviewed and approved the Radon Testing Quality Assurance Project Plan for the Muscogee (Creek) Nation Reservation. By signing, each person verifies that the document meets the requirements of 40 CFR 30, 31, and 35 for assistance agreements.

Muscogee (Creek) Nation:

Name: David W. Hill
Title: Muscogee (Creek) Nation / **Principal Chief**

Signature: David W. Hill Date: 10-22-2024

Name: James Williams
Title: Environmental Director / **Overall QAPP Manager**

Signature: James Williams Date: 10-17-24

Name: Judith Ausmus
Title: Environmental Specialist II / **QAPP Manager**

Signature: Judith E. Ausmus Date: 10/15/24

Name: Kristy Lawson
Title: Environmental Specialist II / **Project Manager**

Signature: Kristy Lawson Date: 10/15/24

U.S. Environmental Protection Agency – Region 6

Name: Aunjanee Gautreaux
Title: Project Officer – CAA 105 PPG – EPA Region 6

Signature: Aunjanee Gautreaux Date: 10/30/24

Name: Brenton Gildner
Title: Division Quality Assurance Officer – EPA Region 6

Signature: MICHAEL GILDNER Digitally signed by MICHAEL GILDNER Date: 2024.10.30 14:25:37 -05'00' Date: 10/30/24

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List of Acronyms

AARST	Association of Radon Scientists and Technologists
AC	Activated Charcoal
ANAB	ANSI National Accreditation Board
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AT	Alpha Track
ATD	Alpha Track Detector
BIA	Bureau of Indian Affairs
CAA	Clean Air Act
CAD	Charcoal Adsorption Devices
CDC	Center for Disease Control
CE	Continuing Education
CFR	Code of Federal Regulations
C-NRPP	Canadian National Radon Proficiency Program
CRM	Continuous Radon Monitor
DQA	Data Quality Assessment
DQI	Data Quality Indicators
DQO	Data Quality Objective
ELC	Ecosense Learning Center
EPA	Environmental Protection Agency
GIS	Geographic Information System
GSA	General Services Administration
HUD	Housing and Urban Development
HVAC	Heating, Ventilation, and Air-Conditioning
IAQP	Indoor Air Quality Program
ID	Identification
IEC	International Electrotechnical Commission
IRAA	Indoor Radon Abatement Act
ISO	International Organization for Standardization
IEMA	Institute of Environmental Management and Assessment
LLD	Lower Limit of Detection

LS	Liquid Scintillation
LT	Long-Term
MCN	Muscogee (Creek) Nation
MCNOES	Muscogee (Creek) Nation Office of Environmental Services
NEHA	National Environmental Health Association
NELAP	National Environmental Laboratory Accreditation Program
NRPP	National Radon Proficiency Program
NRSB	National Radon Safety Board
OES	Office of Environmental Services
pCi/L	picocuries per liter
PII	Personal Identifiable Information
PQAO	Primary Quality Assurance Organization
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Check/Control
RH	Relative Humidity
RPD	Relative Percent Difference
RPE	Relative Percent Error
RRNC	Radon Resistant New Construction
RRTC	Regional Radon Training Centers
SIRG	State Indoor Radon Grant
SOP	Standard Operating Procedures
ST	Short-Term
UPS	United Parcel Service
USPS	US Postal Service
WIC	Women, Infants, and Children
WL	Working Level

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Table of Contents

1.0 Project Management (Group A)

*The elements in this group **(Table 1: (Group A) – Project Management Elements)** address project management, including project history and objectives, roles and responsibilities of the participants, etc. These elements document that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been reported.*

Table 1: (Group A) - Project Management Elements

A1	Title and Approval Sheet
A2	Table of Contents
A3	Distribution List
A4	Project/Task Organization
A5	Problem Definition/Background
A6	Project/Task Description
A7	Quality Objectives and Criteria
A8	Special Training/Certification
A9	Documents and Records

1.1 Title and Approval Page (EPA QA/R-5 A1) / Section 1

On the Title and Approval Page, include the title of the plan, the name of the organization(s) implementing the project, the effective date of the plan, and the names, titles, signatures, and approval dates of appropriate approving officials may include:

- *Organization's Project Manager*
- *Organization's QA Manager*
- *EPA Project Manager*
- *EPA QA Manager*
- *Others (e.g., field operations manager, laboratory managers, State and other Federal agency officials)*

The Title and Approval Page resides on pages 1 and 3.

1.2 Table of Contents (EPA QA/R-5-5 A2) / Section 2

*Provide a Table of Contents for the document, including sections, figures, tables, references, and appendices. Apply a document control format **(Figure 1: Example Document Control Format)** on each page following the Title and Approval Sheet when required by the EPA Project Manager and QA Manager.*

Figure 1: Example Document Control Format

Section No. _____
Revision No. _____
Date _____

The Table of Contents resides on pages 7 and 8.

1.3 Distribution List (EPA QA/R-5 A3) – Section 3

List the individual and their organization who need copies of the approved QA Project Plan and any subsequent revisions, including all persons responsible for implementation (e.g., project managers), the QA manager, and representatives of all groups involved. If equivalent electronic information systems can be used, paper copies need not be provided to individuals.

Table 2: Distribution List (EPA and MCNOES)

Name	Title	Organization	Contact Information
Aunjanee Gautreaux	Project Officer – Region 6	USEPA	gautreaux.aunjanee@epa.gov (214) 665-7127
Brenton Gildner	Division Quality Assurance Officer	USEPA	Gildner.Brenton@epa.gov (214) 665-7376
James Williams	MCNOES Program Director	MCNOES	jwilliams@muscogeenation.com 918-549-2587
James Hayes	Environmental Specialist II / Grant Manager	MCNOES	jhayes@muscogeenation.com 918-549-2582
Judith Ausmus	Environmental Specialist II / Quality Assurance Manager	MCNOES	judith.ausmus@muscogeenation.com 918-549-2579
Sonny Hill	Environmental Specialist II / Finance	MCNOES	rhill@muscogeenation.com 918-549-2578
Kristy Lawson	Environmental Specialist II / Project Manager / Quality Assurance Officer	MCNOES	klawson@muscogeenation.com 918-549-7729
Michael Fish	Environmental Specialist I / Field Technician	MCNOES	mifish@muscogeenation.com 918-549-2589
Barry Barnett	Environmental Specialist I / Field Technician	MCNOES	babarnett@muscogeenation.com 918-549-2543
Eli Barnett	Environmental Specialist I / Field Technician	MCNOES	elbarnett@muscogeenation.com 918-549-7792

The individuals in this list will be notified/receive copies of any QAPP revisions or amendments during the project. Revisions and amendments must be approved before implementation and distribution. Please note that if the Primary Quality Assurance Organization (PQAO) for which the QAPP is being prepared includes multiple organizations, the distribution list for the QAPP may need to be abridged. In this case, include the above information for the key project personnel, including upper management and QA staff, from all organizations within the PQAO.

1.4 Project Organization (EPA QA/R-5 A4) / Section 4

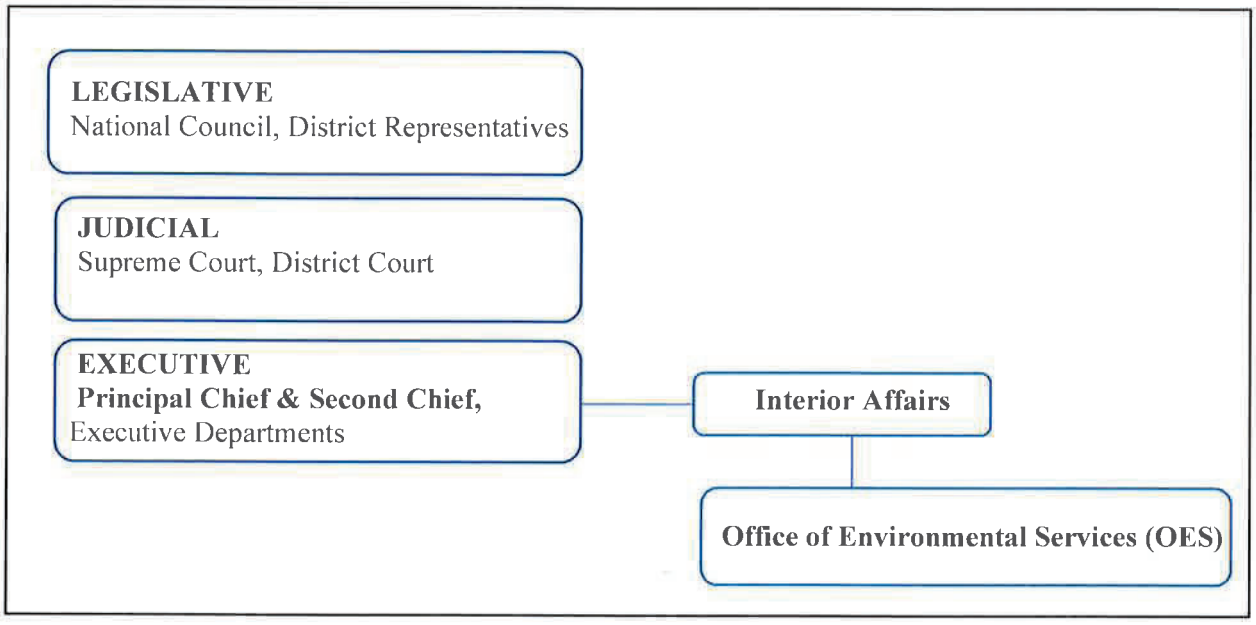
Identify the individuals or organizations participating in the project and discuss their specific roles and responsibilities. Include the principal data users, the decision-makers, the project QA manager, and all persons responsible for implementation. The project Quality Assurance Manager must be independent of the data-generating unit. (This does not include being independent of senior officials, such as corporate managers or agency administrators, who are nominally, but not functionally, involved in data generation, data use, or decision-making.) Identify the individual responsible for maintaining the official, approved QA Project Plan. Provide a concise organizational chart showing the relationships and lines of communication among all project participants. Include other data users outside the organization generating the data but for whom the data are intended. The organization chart must also identify subcontractor relationships relevant to environmental data operations, including laboratories providing analytical services.

1.4.1 Muscogee (Creek) Nation - Tribal Organization

The Muscogee (Creek) Nation (MCN) is a self-governed Native American tribe in Oklahoma. The MCN is one of the Five Civilized Tribes and is the fourth largest tribe in the U.S., with over 100,000 citizens. The government side of the tribe consists of an executive branch, a legislative body, and a tribal court system, as seen in ***Figure 2: Tribal Organization of the Muscogee (Creek) Nation***. The MCN is diverse and has many facets, including culture, tourism, gaming, businesses, health, environment, and higher learning institutions.

The MCN Department of Interior Affairs implements and manages numerous tribal resources, including transportation, land, natural resource management, and tribal construction. Departments under the Interior Affairs Office include the Division of Agriculture and Natural Resources, Environmental Services, Federal Roads, Geographic Information System (GIS), Oil & Gas, Realty Trust Services, Risk Management, Tribal Construction, Tribal Driveways, and Transit.

Figure 2: Tribal Organization of the Muscogee (Creek) Nation



1.4.2 Muscogee (Creek) Nation Office of Environmental Services (MCNOES) – Indoor Air Quality Program (IAQP)

The Radon Risk Reduction in Tribal Buildings Project will be managed and implemented by the MCNOES IAQP staff, who will rely on an independent laboratory for analytical services. ***Figure 3: Individuals Participating in the MCNOES Radon Risk Reduction in Tribal Buildings Project*** provides a visual breakdown of tasks assigned to each member. The Project Manager will be the primary contact and oversee the project, assign duties relative to the project, and review the QAPP. MCNOES IAQP staff will help with the preparation of the QAPP; prioritization of homes and public buildings to be tested; test kit deployment, retrieval, and shipment to the laboratory; receipt and evaluation of laboratory data; creation and maintenance of a radon database; re-test determinations; re-test deployment, retrieval and shipment to the laboratory; preparation of progress and final reports to the EPA Project Officer.

- **The MCNOES Program Director (James Williams)** will supervise the project's overall organizational and managerial aspects.

- **Grant Manager** (James Hayes): This position will assist the AQP Manager in planning and executing the grantmaking process by working with the finance team to stay within the annual budget, supporting program staff in researching funding opportunities, managing documents and deadlines, and helping track grantee results.

- **Quality Assurance Manager (QAM)**: (Judith Ausmus, Environmental Specialist II) will oversee and review all work products submitted by the Project Manager(s). In addition, the QAM will oversee the statutory requirements of this project.

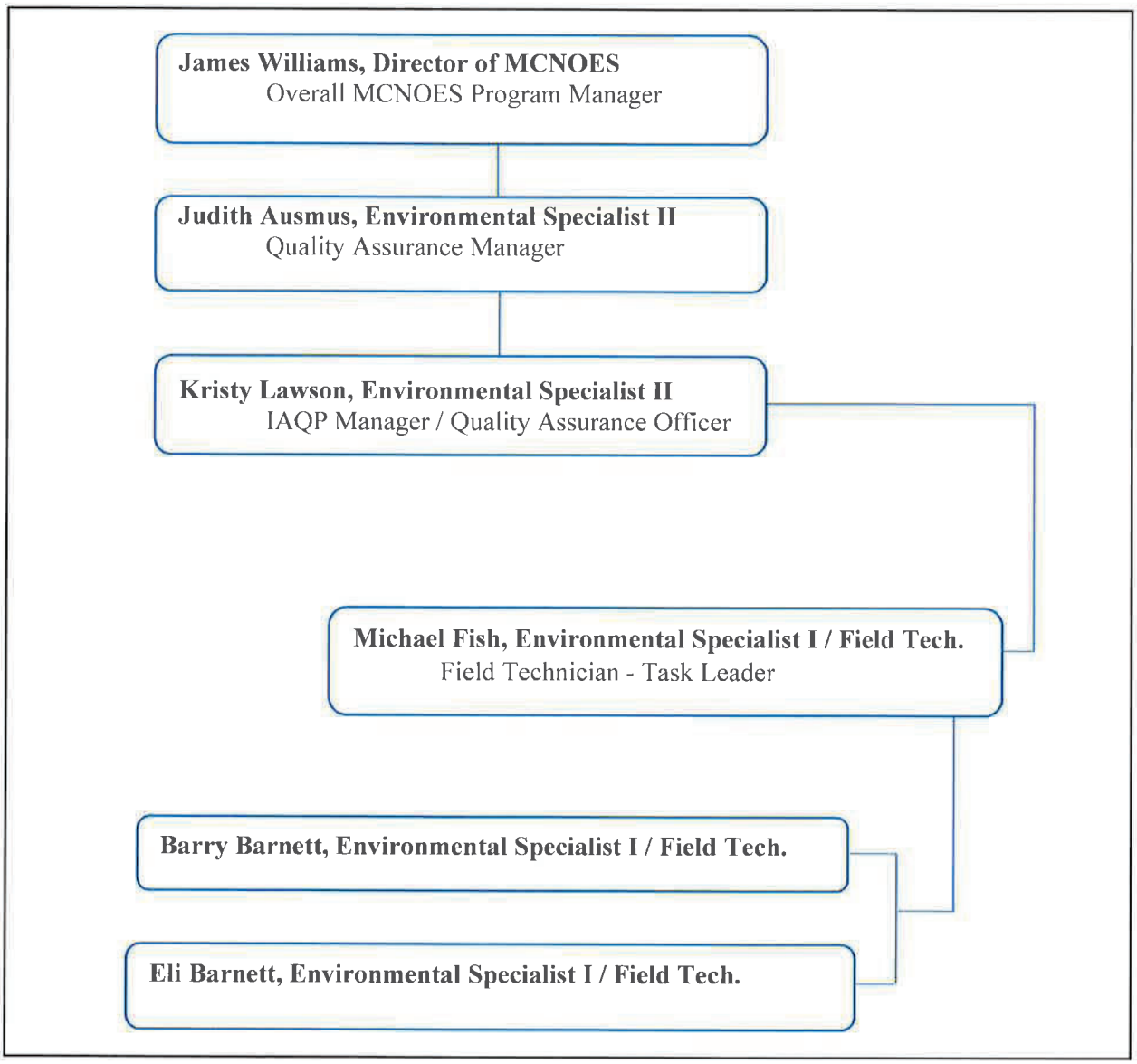
- **Finance Manager** (Sonny Hill): This person will facilitate communication between the MCNOES and MCN Financial Department to ensure quarterly funding is drawn down. The Finance Manager's responsibilities include assisting with writing budget proposals for various MCNOES grants.

- **The Project Manager / Quality Assurance Officer (QAO)** (Kristy Lawson, Environmental Specialist II) will oversee and monitor technical activities performed by the project Field Technician / Task Leader, Michael Fish. The QAO will collect and verify data from the laboratory following the requirements of this QAPP. The QAO will also ensure that the vials, detectors, and devices are properly located and functioning and process and analyze the data.

- **Field Technicians** (Michael Fish, Barry Barnett, and Eli Barnett) will help maintain quality data and ensure the test kits are properly located and functioning. Michael Fish will work to cross-train other MCNOES staff (Field Technicians) to ensure the successful completion of this project. Field Technicians will travel all eleven (11) MCN counties within the MCN Reservation, conducting various program deliverables such as outreach, testing, analyzing, and re-testing.

MCNOES IAQP staff will review and quality-assure the data collected before it is formally reported to the MCNOES director, tribal council, community, and other relevant parties.

Figure 3: Individuals Participating in the MCNOES Radon Risk Reduction in Tribal Buildings Project



1.4.3 Environmental Protection Agency (EPA) - Region 6

The EPA Technical Staff will be responsible for QAPP review, technical assistance, and approval of the QAPP for implementation.

1.4.4 NRSB Accredited Laboratories (Independent)

Independent laboratories will analyze radon test kits. Each laboratory has individuals identified and tasked as the QAO and QAM. These individuals ensure that appropriate and consistent methods are followed at each laboratory. EPA does not endorse any products or commercial services used in this QAPP.

Figure 4: Laboratories Used for the MCNOES Radon Risk Reduction in Tribal Buildings Project

AccuStar Labs – PA* http://www.accustarlabs.com NRSP Certification ID Number: ARL0017 NRSB Approved Device Numbers: 10317 NRPP Certification ID Number: 105011-AL	**Mail, UPS, or FedEx:** 6951 Allentown Blvd, Unit N Harrisburg, PA 17112 717-274-8310 or 800-523-4964 **US Postal Service (USPS):** P.O. Box 6994 Harrisburg, PA 17112
AccuStar Labs – MA* http://www.accustarlabs.com C-NRPP/PNCR-C ID Number: CAL-201657 NELAP Lab ID Number: 11769 NRSB Certification ID Number: ARL0017 NRSB Approved Device Numbers: 10317, 10320, 10302, 10313, 12193,12001 NRPP Certification ID Number: 101193-AL	**Mail, UPS, or FedEx**: 2 Saber Way Ward Hill, MA 01831 978-521-7498 or 888-480-8812 **US Postal Service (USPS):** P.O. Box 3008 Haverhill, MA 01831
AirChek/Spruce/AccuStar http://www.radon.com Certification Number: ARL1402 NELAP Lab ID Number: 11441 NRSB Certification ID Number: ARL1402 NRSB approved device numbers: 10333, 10334, 12003 NRPP Certification ID Number: 101138AL	**Mail, UPS, or FedEx:** 1936 Butler Bridge Rd. Mills River, NC 28759 828-684-0893 or 800-247-2435 **US Postal Service (USPS):** P.O. Box 2000 Naples, NC 28760
Kansas State University – Radon Chamber* IEMA Laboratory: RNL2018202 NRSB Certification ID Number: CHM004 NRPP Certification ID Number: SC-1006	**Mail, UPS, or FedEx:** 2323 Anderson Ave., Suite 300 Manhattan, KS 66502 785-532-6026 radonchamber@ksu.edu
Bowser-Morner, Inc. ANAB Certification ID Number: L2444 ANSI Certification ID Number: ISO/IEC 17025:2017 NRSB Certification ID Number: CHM0001 & CHM003 NRPP Certification ID Number: 101-SC	**Mail, UPS, or FedEx:** 4514 Taylorsville Road Dayton, OH 45424 937-236-8805 http://www.nrsb.org

AccuStar Labs has met the requirements for certification as an Analytical Laboratory with the National Radon Proficiency Program (NRPP). Certification has been granted for the specific measurement devices listed below.

- AC-1165 AccuStar PicoCan 400 DB
- AC-8201 Air Chek Pro Chek
- AC-2014 F&J R40VDB
- AT-8205 REM AT-100* (Alpha Track will be used for long-term testing)
- AC-6048 AccuStar PicoCan-275
- LS-8088 AccuStar CLS-2 * (Liquid Scintillation will be used for short-term testing)
- AC-1159 AccuStar PicoCan-400
- AC-8200 Air Chek Foil Bag

The MCNOES IAQP will use AccuStar Labs as the primary laboratory for short-term and long-term devices. Staff will use the Liquid Scintillation (LS-8088 AccuStar CLS-2) for short-term testing and Alpha Track (AT- 8205 REM AT-100) for long-term testing. AccuStar lab in Massachusetts and Air Chek laboratory in North Carolina have maintained National Environmental Laboratory Accreditation Program (NELAP) accreditations for over a decade. The AirChek/Spruce/AccuStar laboratory will be secondary if needed.

The MCNOES IAQP will use the Kansas State University Radon Chamber (primary) to provide calibration services for the EcoSense RadonEye Pro (continuous radon monitor or CRM). Performance tests require that radon measurement devices be exposed to a known amount of radon gas or decay products in an AARST-NRPP-approved radon chamber facility. For a passing test result, each device must measure within 25 percent of the chamber value. Bowser Morner (secondary) will be used for calibration services if needed.

1.5 Problem Definition/Background (EPA QA/R-5 A5) / Section 5

State the specific problem to be solved, the decision to be made, or the outcome to be achieved. Include sufficient background information to provide this project's historical, scientific, and regulatory perspective.

Radon is a colorless, odorless radioactive gas released from the natural breakdown of uranium in soil, rock, and, to some extent, water. It is considered to be the second leading cause of lung cancer in the United States and is responsible for approximately 21,000 lung cancer deaths per year. Only smoking causes more lung cancer deaths. In addition, if you smoke and your home has high radon levels, your risk of lung cancer is exceptionally high. The "State of Lung Cancer" report shows that only 5.8% of eligible Americans have been screened for lung cancer, and some states have screening rates as low as 1%.

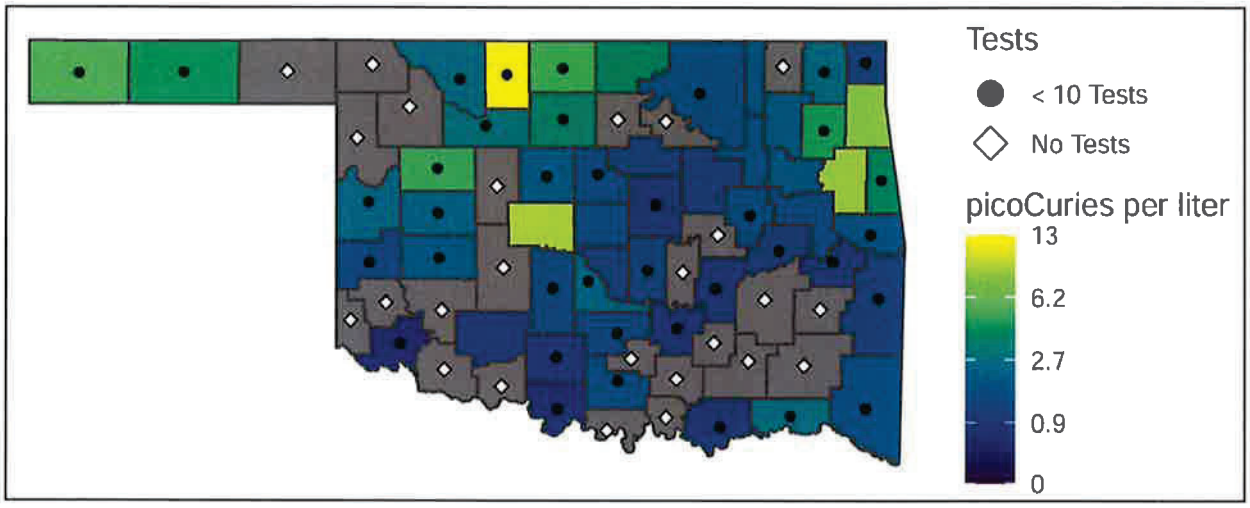
Native American communities face many disparities that have lasting impacts on their overall health and well-being. Below are a few of the forces working together to create increases in cancer disparities among native citizens:

- Compared to the rest of the United States population, Native American communities have much higher rates of poverty and lower levels of education, both of which have a significant impact on health.
- Tribal Trust lands are considered sovereign territories. This means they are not subject to state smoking restrictions or cigarette taxes. Because of this legal status, tobacco companies can sell cigarettes at much lower prices on tribal lands than in neighboring states. It also means that clean indoor air policies and other statutes that have helped to lower smoking rates among the United States general population don't help tribal communities.
- Reports have discovered Native Americans living in certain parts of the United States (Alaska, the Northern Plains, the Southern Plains, and the Pacific Coast) are more likely to develop lung cancer than white Americans. With Oklahoma being located in the Southern Plains, we must do everything we can to protect the health of our tribal members.

Radon levels vary geographically at large scales (state to state, county to county) and even finer scales. ***Figure 5: Smoothed Mean Radon Level by County Overall Reported Test*** illustrates this distribution for Oklahoma. Specifically, this figure shows the mean radon levels across all the tests reported during the period for which data are available. This map shows a general, overall level of risk in an area without explicitly considering the housing environment. The counties marked with a circle have less than ten total radon tests. Counties that are marked with a diamond have no recorded radon tests. Counties with no/low data were considered prevalent in Oklahoma for smoother values to be sufficiently reliable to display.

Figure 4 shows that Tulsa, Creek, Rogers, Wagoner, Muskogee, and Mayes Counties have conducted more tests than other counties within the MCN Reservation. These counties' radon level averages were between 0.9 - 2.7 pCi/L, except for Mayes County, which reported the highest radon level averages at around 6.2 pCi/L. Okmulgee, McIntosh, and Hughes Counties radon level averages were also between 0.9 - 2.7 pCi/L; however, fewer tests have been conducted in these areas (less than ten tests). Okfuskee and Seminole have had no tests conducted.

Figure 5: Smoothed Mean Radon Level by County Overall Reported Tests



Oklahoma is ranked 25th in state-level summary data and has an estimated mean radon level of 2.1 pCi/L, according to a 2022 report from the American Lung Association. However, as mentioned before, radon levels can vary geographically, both at large and finer scales. Elevated concentrations have been reported in many counties with low radon averages; therefore, additional radon testing/studies are needed to understand the following better:

(1.) the radon content of the soil;

(2.) the pressure differential between the interior of the home and the soil;

(3.) the air exchange rate for the building/home;

(4.) the moisture content surrounding the home;

(5.) the presence and size of entry pathways.

Climate change can affect these factors to varying degrees. In addition, more research is needed to understand how changes in ventilation patterns, increased air conditioning usage, increased ambient temperatures and humidity, weatherization, and energy efficiency impact radon concentrations in buildings and homes. Temperatures in Oklahoma have risen by about 0.6°F since the beginning of the 20th century. Soil has become drier, annual rainfall has increased, and more rain occurs in heavy downpours. These all affect the soil gas radon concentration.

1.5.1 Mission

The MCNOES IAQP's mission for the Radon Risk Reduction in Tribal Buildings Project is to promote radon awareness, testing, mitigation techniques, and radon-resistant new construction (RRNC). The MCNOES IAQP staff will provide outreach and radon testing to MCN Tribal buildings and homes (upon request).

1.5.2 Short-Term Goals

The MCNOES IAQP's short-term goal for the Radon Risk Reduction in Tribal Buildings Project is to conduct initial screening tests and follow-up screening for radon in tribal buildings and homes (upon

request) located in Okmulgee, Oklahoma. Staff will be consistent with recommendations in EPA's guidance documents on measurement and testing and will include the following:

- Selection and acquisition of an adequate supply of radon detectors for use in the winter months. Detectors selected will be approved by the NEHA (National Environmental Health Association), and the chosen supplier will have NEHA Radon Measurement Proficiency (NRPP) program certification.
- Develop an adequate database for tracking and reporting test results and other information collected from the homes tested.

1.5.3 Long-Term Goals

The MCNOES IAQP's mission/long-term goal is to help raise awareness and increase knowledge and understanding of radon issues in tribal buildings and homes. Below are some additional long-term goals outside the scope of this project:

- Additional MCN counties are conducting initial screening for radon in tribal buildings and homes.
- Conducting long-term home testing with short-term radon measurements of 4 pCi/L.
- Remediation of homes with radon levels above four pCi/L or remediation determination limits.

1.6 Project/Task Description and Schedule (EPA QA/R-5 A6) / Section 6

Provide a summary of all work, products to be produced, and the implementation schedule. Provide maps or tables that show or state the geographic locations of field tasks. This discussion need not be lengthy or overly detailed but should give an overall picture of how the project will resolve the problem or question described in A5.

The purpose of this project is to measure radon levels in MCN's tribal buildings and tribal homes (upon request) in Okmulgee County. MCNOES IAQP staff will design, develop, and implement radon testing procedures to assess initial radon levels in tribal buildings and identify potential risks to tribal employees and the community. Okmulgee, Oklahoma, is home to the Muscogee (Creek) Nation's Council House, Tribal Complex, Executive Branch (Principal Chief, Second Chief, Support Staff), Legislative Branch (National Council), and Judicial Branch (District and Supreme Courts). ***Figure 3: Okmulgee County – MCN Radon Risk Reduction in Tribal Buildings List*** guides' technical staff. Some of these buildings may no longer be occupied due to renovation; this list will be updated with relevant information regarding occupant/building status throughout the project. Residential buildings will be tested upon request. Additional buildings may be tested depending on resources and time restraints.

Table 3: Okmulgee County - MCN Radon Risk Reduction in Tribal Buildings List

Main Complex	15. Mvskoke Media Building
1. Solomon McCombs Building	16. Tribal Driveways Building
2. Mound Building	17. Indian Health Services Building
3. Commerce Building	19. BIA Firehouse
4. Finance Building	20. Lighthorse Building (New)
5. Veterans Affairs Building	**North of Main Complex**
6. Executive Building	21. Housing Authority Building
7. Transit Building	22. Elderly Nutrition Building
8. Headstart Building	23. Force Account Building
9. WIC Building	24. Food Distribution Building
10. Attorney General Building	25. Omniplex Multi-Purpose Building
11. Education and Training Building	26. Fleet/Transportation Building
12. Community Services Building	27. Recycling Center Building
13. Child Development Center Building	28. GSA Building
14. Lighthorse Building (Old)	29. Rehabilitation

The measurement will primarily be performed during the late fall and winter months when closed-building conditions generally exist as normal living conditions. The radon measurement will be performed following EPA-recommended testing steps with either short-term (ST), long-term (LT), or continuous radon monitor (CRM) testing device.

1.6.1 Project Objective

The objective is to develop and implement testing procedures to measure radon levels in tribal buildings and homes, following the EPA's recommended testing steps. The long-term goal is to reduce the health risks associated with radon exposure in tribal communities.

- The MCNOES IAQP staff will test MCN tribal buildings (homes upon request) for radon and analysis samples to determine the level of exposure.
- The MCNOES IAQP staff will make recommendations for remediation of high levels.

- The MCNOES IAQP staff will retest properties with radon levels over 4.0 pCi/L.
- The MCNOES IAQP staff will educate tribal employees and citizens about the dangers of radon and how radon can affect their health.
- The MCNOES IAQP staff will collaborate with the MCN's Department of Health and the Tobacco Prevention Program by providing outreach material about radon. In addition, the MCNOES IAQP will provide training to increase radon awareness for the MCN's Housing Division, Realty, and Tribal Construction on projects to raise awareness and reduce health risks associated with radon.
- The MCNOES IAQP staff will plan annual training with Radon Action Month (January). During these trainings, participants will learn about radon, how to test for it, radon risk reduction techniques, and how to incorporate mitigation and weatherization techniques in the building process.

1.6.2 EPA Recommended Testing Steps

Step 1: Take a short-term test. If your result is four pCi/L or higher, take a follow-up test (Step 2) to be sure.

Step 2: Follow up with can be with a short-term test and either a long-term test or a CRM:

- To better understand the year-round average radon level, take a long-term test.
- If you need results quickly, take a second short-term test or use a CRM.

The higher your initial short-term test result, the more confident you can be that you should take a short-term rather than a long-term follow-up test. If your first short-term test result is more than twice EPA's four pCi/L action level, you should take a second short-term test immediately.

Step 3: If you followed up with a long-term test:

- The building/home must be fixed if the long-term test result is four pCi/L or more.

If you follow up with a second short-term test or use a CRM:

- The higher the short-term results, the more confident the building/home must be fixed. Consider fixing the building/home if the average of the first and second tests is four pCi/L or higher. (Protocols for Radon and Radon Decay Product Measurements in Homes, USEPA, EPA 402-R-92-003).

1.6.3 Radon Testing Methods Used For This Project

This project is designed to assess initial radon levels and follow-up radon surveys of MCN-owned Tribal buildings and homes (upon request). MCNOES IAQP staff will use short-term devices for the initial screening; the follow-up screening will be with the short-term device and either a long-term or a CRM.

- **Short Term (ST) Measurements**
  - The quickest way to test is with a short-term test. Short-term tests remain in the building/home for at least two days, but some stay out for up to 90 days, depending on the device.

- Charcoal canisters, alpha track, electret ion chamber, continuous monitors, and charcoal liquid scintillation detectors are most commonly used for short-term testing.
- Because radon levels tend to vary from day to day and season to season, a short-term test is less likely than a long-term test to tell you your year-round average radon level.
- The MCNOES IAQP will use the charcoal liquid scintillation (LS-8088 AccuStar CLS-2) for the initial screening of the building/home. Under closed building conditions, the test devices must remain undisturbed for 48-96 hours.
    - AccuStar® test kits are listed by NRPP and NRSB and approved for use in all states.

- **Long Term (LT) Measurements**
    - Long-term tests remain in your home for more than 90 days. "alpha track" and "electret" detectors are commonly used for this type of testing.
    - A long-term test will give you a reading that is more likely to tell you your home's year-round average radon level than a short-term test.
    - The MCNOES IAQP will use the AccuStar alpha track (AT-8205 REM AT-100) when performing long-term radon in air measurements (90 days to one year).
        - Alpha track is a diffusion-based track detector that filters out dust and radon progeny through an integral filter in the housing. The track detector foil inside the housing is from dosimetry-grade CR-39 cast for AccuStar® Labs.
        - AccuStar® Labs is the only laboratory in the U.S. that uses electrochemical etching to process its alpha track foils, which are subsequently counted with computer-aided image analysis equipment. This system was superior to chemically etched alpha-track radon detectors.

- **Continuous Radon Monitor (CRM)**
    - This method category includes those devices that record real-time continuous measurements of radon gas. Air is either pumped or diffused into the counting chamber.
    - The counting chamber is typically a scintillation cell or ionization chamber. Scintillation counts are processed by electronics, and radon concentrations for predetermined intervals are stored in the instrument's memory or transmitted directly to a printer.
    - The MCNOES IAQP will use the EcoSense RadonEye Pro to record radon, temperature, and relative humidity. The RadonEye Pro uses pulsed ionization chamber detectors, a patented detection technology that provides ultra-sensitive 30 counts per hour (mph)/pCi/L.
        - Electrons and positive ions released as radon decays are collected using the electric field maintained by the high voltage between the central electrode and the chamber wall.

1.7 Quality Objectives & Criteria for Measurement Data (EPA QA/R-5 A7) / Section 7

Discuss the project's quality objectives and performance criteria for achieving those objectives. EPA requires a systematic planning process to define these quality objectives and performance criteria.

As noted in EPA's QAPP guidance, "When a study is to be based either entirely or in part on secondary data (data that was previously collected for a different intended use), this section of the QA Project Plan is used to explain the criteria for determining which sources of data are sufficient to support the goals of the current project." (EPA, 2002) Therefore, the following discussion presents the criteria that we will use to determine which data sources will be utilized to meet project objectives.

The EPA has developed and refined a framework for planning data collection known as the Data Quality Objective (DQO) process. Using the DQO process to prepare environmental data collection can help improve effectiveness and efficiency. The DQO process is a course of action for planning environmental data collection operations that allows the data user(s) to decide what data quality (and quantity) will be adequate for decision-making and directs the development of a statistical design to collect the data that will meet those needs. The DQO process emphasizes decision-making and quantifies the uncertainty acceptable in data used in decisions. The DQO process provides a logical structure that focuses data collection planning on the intended use of the data. There are seven steps to the DQO process (see ***Table 4: Data Quality Objective Process***). The output from each step is used in developing a statistical data collection design.

The DQO process should be used at the planning stage of a data collection operation before any samples are taken. The outputs of the DQO process provide the information needed by the planning team responsible for the project and form the inputs to the data collection planning process. Only with this type of effective communication of the data user's requirements can the data collection planning team hope to provide a design that will meet the user's needs. In general, EPA's policy is to use the DQO process to plan all data collection efforts that will require or result in a substantial commitment of resources.

Table 4: Data Quality Objective Process

	Data Quality Objective Process
1	State the problem to be resolved.
2	Identify the decision to be made.
3	Identify the inputs needed for the decision.
4	Define the boundaries of the study.
5	Develop a Decision Rule
6	Specify acceptable limits on uncertainty.
7	Optimize the design for obtaining the data.

1.7.1 Problem Statement

Radon is a known human carcinogen. Prolonged exposure to elevated radon concentrations causes an increased risk of lung cancer. Smokers face an increased risk of developing radon-related cancer, and smoking rates are nearly 10% higher among American Indians / Alaska Natives than among the general population (American Lung Association, June 2007). An individual's risk of getting lung cancer from radon depends mainly on three factors: the level of radon, the duration of exposure, and the individual's smoking habits. This project aims to implement programs and projects to reduce health risks associated with radon exposure.

1.7.2 Decision

The project is intended to assess radon levels in tribal buildings and homes on the MCN Reservation. The results will provide the MCNOES with the necessary information to make informed recommendations to participating building managers and homeowners regarding indoor air quality and potential mitigation procedures.

1.7.3 Inputs to Decision

Short-term (LS) and long-term (AT) test devices will used to measure the radon concentrations in tribal buildings and homes. The test devices will be obtained from and analyzed by AccuStar® Laboratory. CRM (RadonEye Pro) devices will be used alongside the short-term and long-term test devices

1.7.4 Study Boundaries

The project is limited to MCN tribal-owned public buildings and homes on the MCN Reservation. At each measurement location, the test devices will be placed two (2) to six (6) feet above the floor in the lowest living area of the home or building. The test packet's opening will face toward an open room area and be placed at least four (4) inches from other objects. The detector will be placed at least 12 inches from the outside walls of the building and no less than 36 inches from any opening in the outside walls, such as windows or doorways.

1.7.5 Decision Rule

If the results of the mitigation measurement exceed the EPA recommended action level of 4 pCi/L, appropriate mitigation strategies will be suggested to the building manager or resident.

1.7.6 Limits on Decision Errors

Radon measurements can fluctuate throughout the year depending on radon levels in the soil, how the radon is entering the home, and the pressure differences between the outside air and the inside air (air pressure). Buildings or homes whose initial measurement exceeds the EPA's recommended action level of 4 pCi/L will be offered a second follow-up test. If the average of the two results exceeds four pCi/L, the building manager or homeowner will be notified of the appropriate mitigation techniques recommended.

1.7.7 Design for Obtaining Data

The MCNOES IAQP staff will test MCN Tribal buildings and homes (upon request) to measure radon levels. For each test, the following information will be collected:

- Building type;
- Year built;
- Address including city, state, and zip;
- Technician's name and certification number;
- Device type and device number;
- Floor level;
- Room number;

- Name of area;
- Placement;
- Weather conditions;
- Temperature;
- Relative humidity;
- Date and time opened;
- Date and time closed;
- Date and time mailed and name of GSA staff who mailed the test;
- Date and time received by laboratory (if available);
- Results; and
- Comments/Recommendations.

1.7.8 Data Quality Indicators (DQI)

Data quality indicators (DQI) (accuracy, precision, completeness, representativeness, comparability, and method detection limits) refer to quality control criteria established for various aspects of data gathering, sampling, or analysis activity. Given the limited scope of the project, the relevant data quality indicators are:

- Detection limits of the analytical method;
- Standard quality control conducted by the laboratory;
- Field duplicates and field blanks collected by the monitoring technicians submitted blind to the analyst;
- Complete record keeping by field and data entry technicians;
- Review of data entered into a database.

Accuracy

A measure of the overall agreement of a measurement to a known value includes a combination of radon error (precision) and systematic error (bias) components of both sampling and analytical operations.

- LS-8088 AccuStar CLS-2 (short-term testing): 20 percent or better, representing calibration and accuracy and the error between the detectors' time-integrating properties and actual 2-day time averages.
- AT-8205 REM AT-100 (long-term testing): 15 percent or better for the mean of many measurements, representing the calibration accuracy achieved by the laboratory providing the LT detectors.
- Ecosense RadonEye Pro (continuous radon monitor): 10 percent or better, in continuous monitoring instrument detection limit error mode, measures from 0.1 pCi/L. Accuracy will be determined by the use of spikes

Precision

Precision is the quality, condition; or fact of being exact and actuate. Precision should be monitored and recorded periodically using the results of the duplicate device analyses described in Section 2.5.1.1 (B5) of this protocol. Measurements made with this method can produce duplicate results with a coefficient of variation of 10 percent or less at four pCi/L or greater. An alternate measure of precision is a relative percent difference defined as the difference between two duplicate measurements divided by their mean; note that these two precision measures are not identical qualities. It is essential that precision be monitored frequently over a range of radon concentrations and that a systematic and documented method for evaluating changes in precision is part of the operating procedure.

Due to the limited number of detectors, only two will be used to determine precision from field sampling. MCNOES IAQP will use a goal of 20 percent precision rather than the 10 to 15 percent experienced by the manufacturers.

- LS-8088 AccuStar CLS-2 (short-term testing): better than an average coefficient of variation of 15 percent among duplicate measurements at four pCi/L or greater, including uncontrolled non-statistical variation usually found in environmental sampling.
- AT-8205 REM AT-100 (long-term testing): Radon levels vary in daily and seasonal cycles and respond to weather conditions and ventilation patterns. For these reasons, making the test period as long as possible is preferable. A full-year test provides the most reliable prediction of future radon exposure and health risk. Precision will be determined by the better-than-average coefficient of variation of 10 percent among duplicate measurements at four pCi/L or greater. Duplicates will determine precision, less than 0.06 pCi/L per month, and humidity or temperature will not affect the measurement.
- Ecosense RadonEye Pro (continuous radon monitor): 10 percent or better. In the CRM mode, RadonEye Pro measures the EPA action level of 4 pCi/L in just 1 hour (60 minutes) using 30 cph/pCi/L, totaling 120 counts per hour with a standard deviation of 10%.

Completeness

Completeness is the amount of valid data obtained compared to the amount expected to be received under normal conditions. The number of valid results divided by the number of planned data points, expressed as a percentage, determines the completeness of the data set. Completeness for this project is not specified since the number of data points is contingent upon voluntary participation.

- The sampling protocol will recover over 90 percent of LS-8088 AccuStar CLS-2 (short-term testing and AT-8205 REM AT-100 (long-term testing) radon detectors. Some problems could arise due to inaccessibility, breakage, instrument failure, exceeded holding times, and laboratory errors. This pilot study determines factors necessary to achieve completeness and representativeness, including partial sampling of buildings.
- Ecosense RadonEye Pro (continuous radon monitor): This monitor continuously updates radon levels so you can see the trend at all times, not just at pre-set intervals. Therefore, the completeness of the samples is dependent on equipment reliability. A custom feature readily determines operational completeness, helping to complete standard (basic) radon reports and ANSI-AARST compliance templates.

Table 5: Precision, Accuracy, and Completeness Objectives for Radon

Precision*	Accuracy**	Completeness***	Measurement
20%	20%	90%	Liquid Scintillation (LS)
20%	15%	90%	Alpha-Track (AT)
20%	10%	90%	RadonEye Pro

* At 4 pCi/L or greater
** Percent of detectors returned or hourly measurements recorded
*** Background gamma radiation correction must be made to the radon concentration value

Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a population characteristic, parameter variation at a sampling point, a process condition, or an environmental condition. It depends on the sampling program's proper design and will be satisfied by ensuring that the field sampling plan is followed and proper sampling techniques are used. The MCNOES Environmental Specialist will ensure that all EPA radon testing protocols for deploying and retrieving radon detection devices, as listed in Section 2.2 (B2), are followed. Representativeness in the laboratory is ensured through proper analytical procedures, analyses of samples within holding times, and analyses and assessments of field duplicate samples when used.

- Sampling will include two-day screening tests with at least 48 contiguous hours, with LS-8088 AccuStar CLS-2 (short-term testing). Locations showing excess levels will be retested with an LS-8088 AccuStar CLS-2 (short-term testing) and either the AT-8205 REM AT-100 (long-term testing) or the Ecosense RadonEye Pro (continuous radon monitor). Also, AT-8205 REM AT-100 (long-term testing) may be deployed to evaluate sites that show levels above four pCi/L in the initial screening and retest. However, because radon can vary dramatically from site to site, these tests will not reflect or predict radon levels in other buildings or adjacent homes.

Comparability

Comparability is an expression of the confidence with which one data set can be compared. It depends on the proper design of the sample program and will be satisfied by ensuring that the field sampling plan is followed and proper sampling techniques are used. Planned data is comparable when similar sample collection and analytical methods are used and documented in the QAPP. This QAPP addresses comparability by specifying appropriate field methods and presenting the Air Chek, Inc. laboratory protocols in their QA documents.

- The LS-8088 AccuStar CLS-2 (short-term testing), AT-8205 REM AT-100 (long-term testing), and Ecosense RadonEye Pro (continuous radon monitor) results will be comparable to large numbers of screening measurements in buildings and homes within the MCN's Reservation and U.S. based on EPA protocol.

1.8 Special Training Requirements/Certifications (EPA QA/R-5 A8) / Section 8

Identify and describe any specialized training or certifications personnel need to complete the project or task. Discuss how such training will be provided and how the necessary skills will be assured and documented. See Section 4 of the QA Handbook for more air monitoring training programs information.

The State Indoor Radon Grant (SIRG) funds are to be used to support participation by state, tribal, or local radon employees in the following types of training activities:

1. EPA-sponsored training courses or workshops on radon.
2. Attendance at the Regional Radon Training Centers (RRTC) or their field sites for courses related to health effects and risk communication, radon dynamics, measurement and mitigation (including hands-on component), building investigation and diagnostic testing, worker health and safety, radon prevention in new construction, radon in water, or related subjects.
3. Radon-related courses (similar to those offered by RRTCs) at accredited colleges and universities or other private sector institutions.
4. Radon conferences and symposia, including the National Radon Meeting.

Eligible costs include travel expenses associated with attending courses, workshops, and seminars and any fees that may be incurred. EPA recommends that States and Tribes use the Regional Radon Training Centers; however, grantees may use other qualified training vendors. They should ensure that the other providers meet the following minimum requirements:

- The vendor has experience offering the specific type of training needs or experience in similar radon-related training.
- Vendors use experienced instructors to teach courses. SIRG recipients should establish an experience requirement based on a minimum number of hours of course presentations. Radon measurement and mitigation courses must be taught by instructors currently certified by one of the private sector organizations, the National Radon Safety Board (NRSB) or the National Environmental Health Association (NEHA), and are state-certified where applicable. At least one instructor should be a currently practicing contractor. NRSB or NEHA-certified training providers should be used to deliver residential radon mitigation courses.
- The vendor uses instructional materials that reflect current EPA policy and guidance, including currently available EPA publications. Sources and potential costs should be provided if the documents are not current.
- Vendor provides a plan for evaluating and continually improving the course. The evaluation plan should include a student survey form that evaluates course content by unit/module and instructor teaching skills.

States and Tribes should use existing training courses and materials to the greatest extent possible and not pay for additional course development that duplicates existing courses and materials. Cross-training should also be considered so that more than one individual can adequately perform some of this project's more essential functions. Due to high turnover rates in many environmental monitoring programs, developing detailed standard operating procedures (SOPs) is critical for ensuring a smooth transition from one person to the next. The importance of good SOPs cannot be overemphasized.

1.8.1 Training Courses

The purpose of this section is to describe any special or non-routine training or certifications necessary to complete the project. Discuss plans for providing required training, how training records will be documented, and where this information will be stored.

EPA acknowledges two certification bodies that have met the EPA's previously established criteria to perform radon inspections, use certified radon measurement equipment, and perform radon mitigation activities:

1.8.1.1 National Radon Proficiency Program (NRPP) Training

NRPP credentials indicate to building owners and service providers the mastery of the skills required to complete radon testing and remedial projects successfully. Achieving and maintaining NRPP certification requires biennial documentation of competence, expertise, and performance to demonstrate mastery, knowledge, and quality control. Multiple federal and state agencies require private accreditation.

NRPP is recognized by the EPA and accredited by the ANSI National Accreditation Board (ANAB) under ANSI/ISO/IEC 17024, General Requirements for Bodies Operating Certification Systems of Persons.

For further information, email: courses@nrpp.info

National Radon Proficiency Program
527 Justice Street
Hendersonville, NC 28739
828-348-0185
https://nrpp.info/education-training

1.8.1.2 National Radon Safety Board (NRSB) Courses

The NRSB recognized all ANSI/AARST radon standards as an alternative to the previously recognized radon standards established by the EPA and ASTM. An NRSB certificate holder must follow the standards recognized by the state where they are conducting business, and their QA plan must list the standards being followed.

The NRSB provides recognizable conformance to quality and confidence in the radon industry.

For further information, email: info@nrsb.org

National Radon Safety Board
14 Hayes Street
Elmsford, NY 10523
914-345-1168
http://info@nrsb.org/for-professionals/how-to-get-certified/

For further information, email: info@nrsb.org

1.8.2 Continuing Education Courses

The continuing education program aims to ensure that all professionals continue to enhance their knowledge and understanding of the radon profession and keep up-to-date with new developments within this field. The NRSB continuing education program documents this continuing professional education for state, federal, and professional agencies and the public.

Each year, before the anniversary of participants' initial certification, the administrative staff reminds applicants for renewal that they must submit proof of continuing education training during the year. Individuals may submit information regarding approved course completion throughout the year and evidence of courses that are pending approval.

Measurement & Mitigation Specialist – 8 credits/year

Measurement Technicians – 4 credits/year

If you have been certified by NRSB for ten years or more, your CE credit obligation will be cut in half.

NRSB courses approved for online training are listed below:

#1 Radon Tester, LLC Celia Rajkovich 724-774-4535	**122 West 5th Avenue Derry, PA 15627 www.numberoneradontesterllc.com**	**Credits**
Radon Measurement Course for Testing, Labs & Mitigators (On-Site and Correspondence)		16
ALARA Health & Safety – CE for Testers, Labs & Mitigators (On-Site and Correspondence)		16
CE for Radon Pro Plus comes with a Free Public Outreach Presentation (On-Site and Correspondence)		16
Radon Mitigation Standards for Multifamily Buildings		8
Multifamily Building Testing for Radon and Radon Decay Products		8
Eastern Regional Radon Training Center, Rutgers University 848-932-9271	**102 Ryders Lane New Brunswick, NJ 08901 http://cpe.rutger.edu/radon**	**Credits**
Radon Measurement Proficiency – Home Study Course		16
Radon Measurement Review Home Study Course		8
Radon Resistant New Construction		8
Advanced Radon Measurement and Health Risk		8
Waterborne Radon Home Study Course		8
Waterborne Radon On-Line Course		8
Quality Assurance/Quality Control in Radon Measurements Home Study Course		8
Radon Measurement Review Course		4
MURC – Kansas State University 785-532-4995	**2323 Anderson Ave., Suite 300 Manhattan, KS 66502**	**Credits**
User-Friendly QC Measurement Analysis		4
Radon System Diagnostics Fan Selection Case Studies		4
Introduction to Uncertainty of Measurement		2
Social Media for Radon Small Business		2
Radon Testing Corporation of America (RTCA) 800-457-2366	**2 Hayes Street Elmsford, NY 10523 http://www.rtcaeducation.com**	**Credits**
Radon Measurement Operator's Course for Specialists (On-Site and Correspondence)		16
Radon Occurrence, Radiation Fundamentals & Health Effects		3
Radon & RDP Measurements, Instruments & Methods		3

Measurement Protocols		3
Worker Safety & Health		2
Radon Mitigation Systems		1
Building Investigation		1
Radon in Water		1
Radon Resistant New Construction		1
Radon Entry & Behavior		1
Spruce Environmental Technologies, Inc 978-521-3703	**P.O. Box 8244 / 3 Saber Way Ward Hill, MA 01835 http://www.spruce.com**	**Credits**
QA/QC in Residential Radon Measurement Course		12
Detective Diagnosis		4
QA for Small Business		4
EPA's Energy Star & IAQ Home Labeling Programs: New Opportunities for the Radon Professionals		4
Getting Past Radon Schizophrenia: How Did We Get to Where We're Going?		4
Fighting the Radon Wars: New Marketing Tools to Add to Your Arsenal		4
Inspecting the Radon Mitigation System		4
Mechanics of How Radon Causes Lung Cancer		4
Marketing the Radon Message		4
Radon Ready New Construction: Guidance for New Buildings		4
Radon in Water: Residential Sampling & Aeration Mitigation		3
What Was That Middle Thing? Successfully Communicating Radon Risk		2
Writing Contracts & Guarantees		2
Recession-Proofing Your Radon Business		2
Where's the Radon Coming From?		1.5
Troubleshooting Tough Homes		1.5
Opportunities & Risks of RRNC		1.5
Dave's Corner Credits		1
University of Illinois at Chicago 312-413-7369	**2121 West Taylor Street, MC 922 Chicago, IL 60612 ...**	**Credits**
UIC Radon Course on Measurement (Online)		16
UIC Radon CE Course on Passive to Active Mitigation Systems		4
UIC Measurement & Mitigation: Working Together		2
UIC Best Practices: Radon Measurement		2
Epidemiology of Radon		2
Current Science on Radon & Human Health Effects of Radon		2
Defeating Murphy's Law		2
School and Commercial Buildings Radon Measurement Testing		2
VSI Environmental 815-344-1100	**27900 West Concrete Drive, Unit D Lakemoor, IL 60041**	**Credits**
Radon: The Discovery		3
WPB Enterprises 6010-346-8004	**2844 Slifer Valley Road Riegelsville, PA 18077 wmbroadhead@gmail.com**	**Credits**
School Radon Mitigation		4

1.8.3 Additional Training (CRM Devices)

Ecosense – RadonEye Pro

Ecosense Learning Center (ELC) provides Continuing Education classes led by Dallas Jones, Ecosense Vice President and nationally renowned radon expert. Dallas brings over 10,000 hours and 30 years of radon and IAQ teaching expertise to Ecosense and previously served as Executive Direction of the American Association of Radon Scientists and Technologists (AARST), where he spearheaded national radon data collection for the Center for Disease Control (CDC). He also successfully lobbied and secured the adoption of AARST voluntary consensus standards by the Environmental Protection Agency (EPA), the Department of Housing and Urban Development (HUD), and 20 state radon programs. ELC offers on-demand sessions to kick-start careers and renew NRPP/NRSB certifications or state licenses. Alongside paid courses, ELC serves as a platform to train customers with RadonEye Pro product-specific sessions free of charge.

Ecosense, Inc.
15481 Red Hill Avenue
Tustin, CA 92780-7316
408-634-2955
https://learningcenter@ecosense.io

1.9 Documents and Records (EPA QA/R-5 A9) / Section 9

Describe the process and responsibilities for ensuring the appropriate project personnel have the most current approved version of the QA Project Plan, including version control, updates, distribution, and disposition. Itemize the information and records that must be included in the data report package and specify the reporting format for hard copy and any electronic forms. Records can consist of raw data, data from other sources such as databases or literature, field logs, sample preparation and analysis logs, instrument printouts, model input and output files, and results of calibration and QC checks. Identify any other records and documents applicable to the project that will be produced, such as audit reports, interim progress reports, and final reports. Specify the level of detail of the field sampling, laboratory analysis, literature or database data collection, or modeling documents or records needed to provide a complete description of any difficulties encountered. Specify or reference all applicable requirements for the final disposition of records and documents, including location and length of retention period.

MCNOES IAQP staff will distribute copies of the QAPP, once approved, for use in this project to all project personnel, the EPA Region 6 Quality Assurance Coordinator, the EPA Region 6 Project Officer, and others identified in Section A3. The current version of the QAPP will be identified in the upper right-hand corner of each document page.

The MCNOES IAQP staff will record data appropriately on the test devices and field data collection sheets/chain of custody (Appendix F and H). The staff maintains all documents, records, and laboratory analytical results. The documentation will be kept in Department files for at least five years.

1.9.1 Device Deployment | Retrieval Records

The test device has a unique number that will be recorded onto a data sheet. An in-house field data collection form has been developed for use during the deployment and retrieval of the test devices, and another spreadsheet/form will have the same information and be a single sheet with the unique number of the sampling device. The form will include the name of the homeowner or building, address, location of the device, start date and time, stop date and time, the serial number of the device, temperature, and any additional information that is pertinent to the test site (such as evidence of tampering or whether "closed-building" conditions exist in the case of short-term deployment). This documentation will demonstrate that proper sampling protocol was performed in the field.

1.9.2 Sample Tracking Records

Chain-of-custody forms from the specific radon measurement device companies will be used for this project. Radon test devices mustn't be exposed to outdoor air without being closed, radon test devices are not tampered with during exposure, and devices must be adequately sealed at the end of the testing period. Devices will be shipped out by the following day to the analytical laboratory with next-day or two-day delivery. The delivery receipt of the device(s) received by the laboratory will be recorded using a delivery company's tracking records. A log will record device shipments and shipping labels in the MCNOES IAQP files (this may be an electronic spreadsheet file).

1.9.3 Analytical Data Records

AccuStar® will provide the analytical data to the MCNOES IAQP staff. These reports will be reviewed and evaluated, and recommendations for re-testing will be made if appropriate. All data will be kept confidential and shared only with the homeowner or building manager for privacy purposes. The information will be stored in spreadsheet format and accessible only to MCNOES IAQP staff members working from this QAPP.

1.9.4 Reporting Requirements

Progress / Quarterly Reports

40 CFR Part 31 requires all grantees to submit timely and comprehensive reports on the activities funded by the grant. These provide EPA with the information it needs to ensure that each grantee meets the schedule and commitments in the assistance agreement. More importantly, they provide a mechanism for evaluating the environmental progress brought about by the SIRG Program and reporting to Congress on this progress. Reporting schedules and submittal dates are to be specified in the individual assistance agreement, and each state/tribe will be expected to adhere to its agreed-upon schedule. Because this part of the process is so essential, the primary areas are listed below:

- **Summary of Radon Grant Activities.** This section should summarize the grant activities during the quarter and provide sufficient detail to allow for progress evaluation.
- **Accomplishments/Problems**. This section should discuss the progress to date, including the significant milestones that have been met. It should also discuss any problems that have occurred or are expected and what steps are planned to resolve them. Allowable revisions to budgets that have been made should be documented here if they have not already been sent in writing.
- **Schedules**. A comparison between completed milestones and the program schedule should be provided, along with an explanation of any discrepancies.
- **Funds**. A summary of funds spent during the quarter should be provided, and the original estimates should be compared. The Regional Project Office should be consulted about any problems in this area.
- **End-of-Year**. Regions will specify the level of detail needed in the End-Of-Year Report. Some Regions, however, will allow the fourth quarterly report to suffice, depending on the level of detail.

SIRG Data Reports

IRAA Section 306(h) requires that any state receiving grant funds provide to EPA all radon-related information generated in its activities, including the results of radon surveys, mitigation demonstration projects, and risk communication studies. Section 306(h) also authorizes the Agency to request any information, data, and reports developed by the state that EPA needs to ensure the state's continued eligibility for grant assistance. For example, EPA may request data on the number of homes tested or

mitigated within a state and recognize that states and tribes have had difficulties obtaining some of this data. Regional radon coordinators will continue to work with grantees to resolve data reporting issues.

Other Post Award Reporting

The other required reports are listed below. They are essentially forms to complete, come with instructions, and are self-explanatory.

- Financial Status Report (Standard Form 269) (due 90 days following the end of the budget period); and
- Disclosure of Lobbying Activities (SF-LLL) if applicable.

2.0 Data Generation and Acquisition (Group B)

*The elements in this group **(Table 6: (Group B) – Data Generation and Acquisition Elements**) address all aspects of data generation and acquisition to ensure that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and documented. The following QA Project Plan elements describe the requirements related to the actual methods or methodology to be used for the following:*

- *Collection, handling, and analysis of samples; Final EPA QA/R-5 15 March 2001*
- *Data obtained from other sources (e.g., contained in a computer database from previous sampling activities, compiled from surveys taken from the literature); and*
- *The management (i.e., compiling, handling) of the data.*

The methods described in these elements should have been summarized earlier in element A6. The purpose here is to provide detailed information on the methods. If the designated methods are well documented and readily available to all project participants, citations are adequate; otherwise, detailed copies of the methods and SOPs must accompany the QA Project Plan in the text or as attachments.

Table 6: (Group B) - Data Generation and Acquisition Elements

B1	Sampling Process Design (Experimental Design)
B2	Sampling Methods
B3	Sample Handling and Custody
B4	Analytical Methods
B5	Quality Control
B6	Instrument/Equipment Testing, Inspection, and Maintenance
B7	Instrument/Equipment Calibration and Frequency
B8	Inspection/Acceptance of Supplies and Consumables
B9	Non-direct Measurements
B10	Data Management

2.1 Sampling Design (Experimental Design) (EPA QA/R-5 B1) / Section 10

Describe the experimental data generation or data collection design for the project, including as appropriate:

- *The types and numbers of samples required,*
- *The design of the sampling network,*
- *The sampling locations and frequencies,*
- *Sample metrics,*
- *Measurement parameters of interest, and*
- *The rationale for the design*

2.1.1 Sampling Area

Radon is present at some level in almost every region of the United States. The amount of radon in a particular building depends on the geology specific to the location of the building, the amount of negative pressure that draws radon into the building from the soil, and the effectiveness of the building's ventilation. It is recommended that all tribal buildings and homes be tested for the presence of radon. The MCNOES IAQP will begin by testing all of the tribal buildings listed in Table 7 and residential buildings upon request/volunteer. Additional buildings may be tested depending on resources and time restraints.

Table 7: Okmulgee County - MCN Radon Risk Reduction in Tribal Buildings List

Main Complex	15. Myskoke Media Building
1. Solomon McCombs Building	16. Tribal Driveways Building
2. Mound Building	17. Indian Health Services Building
3. Commerce Building	19. BIA Firehouse
4. Finance Building	20. Lighthorse Building (New)
5. Veterans Affairs Building	**North of Main Complex**
6. Executive Building	21. Housing Authority Building
7. Transit Building	22. Elderly Nutrition Building
8. Headstart Building	23. Force Account Building
9. WIC Building	24. Food Distribution Building
10. Attorney General Building	25. Omniplex Multi-Purpose Building
11. Education and Training Building	26. Fleet/Transportation Building
12. Community Services Building	27. Recycling Center Building
13. Child Development Center Building	28. GSA Building
14. Lighthorse Building (Old)	29. Rehabilitation

2.1.2 Element of Concern

Radon (Rn) is a naturally occurring colorless, odorless, and tasteless radioactive gas known to cause cancer. The main goal of this project is to conduct a radon-screening study of Tribal buildings. The inhalation of radon at levels equal to or greater than 4 pCi/L over prolonged periods poses a significant concern to human health. Levels above ten pCi/L are more hazardous and are cause for immediate mitigation. Since it has not been determined what constitutes a safe level of exposure, homeowners with radon levels from 2 to 4 pCi/L may want to take mitigation measures. A long-term goal of the federal government is to reduce indoor radon levels to the average outdoor level of 0.4 pCi/L. Prolonged exposure to radon and its decay products can increase the potential of developing lung cancer.

Suppose the radon concentration meets certain action levels. In that case, the Muscogee (Creek) Nation will implement the following actions under the Protocols for Radon and Radon Decay Product Measurements in Homes (EPA 402-R-93-003, June 1993, Sec. 2.3.3).

Table 8: Action Levels and Action Protocols for Radon and Radon Decay Product Measurements

Action Levels Radon	Actions
Data in individual buildings less than 4.0pCi/L	No further monitoring is required. However, levels between 2.0 and 4.0 pCi/L may be considered for mitigation.
Data in individual buildings equal to or greater than 4.0pCi/	Interim mitigation by balancing the HVAC system and increasing ventilation. Follow up with the second test.
Average of the data of the initial test and the data of the second test equal to or greater than 4.0pCi/L	Recommend remediation of a building following EPA 402-R-93-078 Radon Mitigation Standards as funding becomes available.

2.1.3 Frequency

Sampling frequency under this plan is proposed to serve as a screening for the presence of radon in tribal buildings. EPA guidance A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family From Radon, 402-K-07-009 recommends that action be taken to reduce indoor radon levels in public and residential buildings if there is a radon test with results of 4 pCi/L or higher. The MCNOES IAQP will use short-term tests initially and then determine whether a second test is needed depending on the first test's results. Additional sampling events may take place in the future to evaluate any future construction on Tribal lands.

2.1.4 Field Sample Operations

Sufficient sampling information for measurement documentation must be recorded in a permanent log at pickup time. The information from each sample or group of samples at the same location is used for data interpretations and comparisons and quality assurance/quality control purposes. Information that will be recorded includes:

- The data and time of the start and stop of the measurement;
- Whether closed conditions, as previously specified, are satisfied;
- The exact location of the vial(s), detector(s), or continuous monitor(s), including a diagram of the room and house if possible;
- Serial number and manufacturer of the vial or detector along with a code number that uniquely identifies room and sampling position;
- Serial number of the CRM and the calibration uncertainty from the Certificate of Calibration;
- Other easily gathered information that may be useful: the type of house (i.e., categorized or open-room), type of heating system, the existence of a crawlspace or basements, occupants smoking habits, and operation of humidifiers, air filters, or electrostatic precipitators;
- General operating conditions of the heating, ventilation, and air-conditioning characteristics (HVAC).

2.2 Sampling Methods (EPA QA/R-5 B2) / Section 11

Describe the procedures for collecting samples and identify the sampling methods and equipment, including any implementation requirements, sample preservation requirements, decontamination procedures, and materials needed for projects involving physical sampling. Identify sampling methods by number, date, and regulatory citation where appropriate. If a technique allows the user to select from various options, then the method citations should state precisely which options are being selected.

Describe specific performance requirements for the method. For each sampling method, identify any support facilities needed. The discussion should also address what to do when a failure in the sampling or measurement system occurs, who is responsible for corrective action, and how the effectiveness of the corrective action shall be determined and documented. Describe the process for the preparation and decontamination of sampling equipment, including the disposal of decontamination by-products; the selection and preparation of sample containers, sample volumes, and preservation methods; and maximum holding times for sample extraction and analysis.

The MCNOES IAQP staff and building manager will decide whether to implement a short-term (ST), a long-term (LT), or a continuous radon monitor (CRM) measurement device - for the tribal building(s) for radon measurement. EPA recommends that radon re-testing occur every five years. Re-testing should also appear in buildings that have been renovated or remodeled, even if they have been in use for less than five years.

2.2.1 Methods

The choice of measurement strategy depends upon the purpose of the radon measurement and the type of building where the measurement is made, such as a home, school, or workplace. EPA's recommendation for measuring radon in various situations are outlined in documents such as the second edition of "A Citizen's Guide to Radon" (U.S. EPA 1992a), the EPA "Home Buyer's and Seller's Guide to Radon" (U.S. EPA 1992b), the "Protocols for Radon and Radon Decay Product Measurements in Homes" (U.S. EPA 1992c), and in "Radon Measurements in Schools" (EPA Document #402-R-92-014, revised July 1993). The following discussion on measurement conditions, device location selection, and documentation applies to measurements made in all types of buildings.

- **Short-Term (ST) Devices**
  The ST radon devices have a measurement duration of at least 48 hours but less than three months. For the ST testing method, closed-house conditions must be practiced – testing occurs with no house ventilation for 3 to 7 days, with an additional 12 hours before the device deployment. Radon fluctuates diurnally, seasonally, and with changes in weather patterns, and these details may be over-inflated or under-inflated with a short duration. Measurements under four days should not be made if high winds (greater than 30 mph) or rapidly charging barometric pressure are predicted. All participants will be reminded to ensure all external doors, windows, and vents are kept closed beginning 12 hours before the start of the test period (closed-house conditions). Written instructions will be left with the resident (Appendix D).
    - LS-8088 AccuStar CLS-2 detectors will provide passive, short-term radon in-air test results with a test duration of 2-4 days. These test devices are often used for quick, accurate initial residential testing and post-mitigation system evaluation. These test kits only provide a snapshot of a widely fluctuating value. The packets will be placed following the protocols supplied by AccuStar and the 1992 EPA document entitled Indoor Radon and Radon Decay Products Measurement Device Protocols.

- **Long-Term (LT) Devices**
  The LT radon devices have a measurement duration of 90 days or longer. The LT test results are more likely to tell you your home's year-round average radon level than an SL test. LT testing is advantageous because radon fluctuations are considered in the measurement. In warmer months, the residents do not have to have their windows and doors closed for the entire test duration. ST test usually indicates if the home should be considered for remediation, but an ST test considers the radon levels over time.

  - AT-8205 REM AT-100 detectors will be deployed for all long-term tests. These devices contain a detector element called a foil. When radon atoms decay inside the detector, they release alpha particles. If the alpha particles strike the foil, they make microscopic tracks on the surface of the foil. When the test is completed, it will be sent to the laboratory for analysis. The detectors need to be analyzed by the lab which provides them to you.

- **Continuous Radon Monitor (CRM) Devices**
  CRM records real-time continuous measurements of radon gas over a series of minutes and reports the results, generally in hourly increments. These devices will have methods for storing, displaying, and retrieving the data logged by the device. They may also be able to measure and track additional environmental parameters above and beyond the radon concentration, such as temperature, barometric pressure, and relative humidity. They often have onboard motion sensors.

  - Ecosense RadonEye Pro devices can automatically record a retrievable series of numeric measurements of radon concentration averaged over time intervals of one hour or less. They have a minimum detectable concentration (MDC) of no greater than four p/Ci/L for a one-hour measurement and a calibration factor (counting efficiency) of at least two counts per hour per picocuries. CRM devices will be used for return testing.

2.2.2 Measurement Conditions

To the extent possible, the MCNOES IAQP will ensure that the following conditions, which are compliant with EPA 402-R-92-004, 1992, Section 1.2.2), exist before and during a measurement period to standardize the measurement conditions:

- Winter is the preferred season for sampling as windows and doors are often closed to cold weather. If measurements must be made during a warmer season, meeting the criteria listed below will satisfy the closed-building conditions.
- Internal-external air exchange systems (other than a furnace), such as high-volume attic and window fans, will not operate during measurements and for at least 12 hours before measurements are initiated.
- Air conditioning systems that recycle interior air do not need to be turned off.
- Normal operation of permanently installed air-to-air heat exchangers may continue during closed-building conditions.
- Where permanent radon mitigation systems have been installed, the operational schedules of these systems should continue to be followed during the measurement period.

- Closed-building conditions will be verified and maintained when they are not the normal living conditions.
- Test should not be conducted if severe storms with high winds (e.g., > 30 mph) or rapidly changing barometric pressure are predicted during the measurement period.

2.2.3 Measurement Device Location

The following criteria, compliant with EPA 402-R-93-003, 1993, Section 2.2 and EPA 402-R-92-004, 1992, Section 1.2.3), will be applied when selecting the detector's location within a room. The following criteria will be used to choose the location of measurement devices and their deployment within a building or home.

- Select a position where the measurement device will not be disturbed during the measurement period but also exposed to open air that people breathe.
- The detector will be at least 50 centimeters (20 inches) from the floor and 10 centimeters (4 inches) from other objects. For those detectors that may be suspended, an optimal height for placement is in the general breath zone, such as 2 to 2.5 meters (about 6 to 8 feet) from the floor.
- Measurements will be made in the lowest lived-in level of the house. The following criteria will be applied to select the detector's location within a room on this level: a position where the detector will not be disturbed during the measurement period and where there is adequate room for the device.
- The measurement will be made away from drafts caused by heating, ventilation, air conditioning vents, doors, fans, and windows. Placing detectors near excessive heat, such as a fireplace or in direct sunlight, and areas of high humidity will be avoided.
- The measurement location will not be within 90 centimeters (3 feet) of windows or other openings in the exterior wall. If there are no potential openings (e.g., windows) in the exterior wall, then the measurement location will not be within 30 centimeters (1 foot) of the exterior walls of the building.
- In general, measurements will not be made in kitchens, laundry rooms, closets, or bathrooms.
- The device will be placed during closed building conditions, as specified in short-term and continuous radon monitoring.
- The device will be placed away from the reach of pets and children.
- For CRM, ensure the placement is at least 12 inches from a Wi-Fi router; interference waves from proximity to a router may result in anomalous readings.
- For CRM, ensure the placement is at least 20 inches above a concrete slab. Placing it too close to the soil or materials containing radium could result in thoron detection.

2.2.4 Pre-Deployment Preparation

The instruction manual and materials from each manufacturer should be read or reviewed before deployment of any device to ensure that the device selected is appropriate for the intended use, is from the latest order, and that the user thoroughly understands and accounts for the limitations of each measurement device in interpreting results.

- The devices will be inspected before deployment to ensure that the airtight cover is in place before it is removed at the beginning and resealed at the end of a measurement.
- The EIC will be inspected before deployment to ensure it has not been damaged during shipping and handling.
- Both long and short-term devices will be deployed as soon as possible after their initial voltage is measured.
- The CRM should be carefully inspected before and after each measurement.
- When feasible, the CRM unit will be checked every 168 hours of operation to measure the background count rate using the procedures that may be identified in the instrument's operating manual.
- In addition, participation in a CRM laboratory inter-comparison program at least semiannually will verify that the conversion factor used in the microprocessor is accurate. This is done by comparing the unit's response to a known radon decay product concentration. At this time, the pump's correct operation should also be verified by measuring the flow rate.

2.2.4 Retrieval of Detectors

At the end of the monitoring period, the detector will be inspected for any deviation from the conditions described in the logbook during deployment time. Any changes will be noted. The (short-term and long-term) detectors will be resealed using the original protective cover and then returned to the laboratory as soon as possible for analysis. This process is compliant with EPA 402-R-92-004, 1992, Section 2.4.8.

2.2.5 Documentation

The operator of the measurement device must record enough information about the measurement in a permanent log so that data interpretation and comparison can be made.

The results of the radon decay product measurements should be reported in Working Levels (WL). If the WL value is converted to a radon concentration reported to a homeowner, it should be stated that this approximate conversion is based on a 50 percent equilibrium ratio. In addition, the report should indicate that this ratio is typical of the home environment. Still, any indoor environment (especially in schools and workplaces) may have a different and varying relationship between radon and decay products.

The following list may be applied to each measurement method discussed in Appendix B and C. However, there may be method-specific documentation requirements that will be mentioned in the applicable protocol.

- The start and stop times and dates of the measurement;
- Whether the standardized measurement conditions, as discussed in Section 2.2.2 (B2), are satisfied;
- The exact location of the device on a diagram of the room and building, if possible;
- Other easily obtained information that may be useful, such as the type of building and heating system, the existence of a crawl space or basement, the occupants' smoking habits, and the operation of humidifiers, air filters, electrostatic precipitators, and clothes dryers;

- The serial number and manufacturer of the detector, along with the code number or description which uniquely identifies the customer, building, room, and sampling position;
- The condition (open or closed) of any crawl space vents.

2.3 Sample Handing and Custody (EPA QA/R-5 B3) / Section 12

Describe the requirements for sample handling and custody in the field, laboratory, and transport, taking into account the nature of the samples, the maximum allowable sample holding times before extraction or analysis, and available shipping options and schedules for projects involving physical sampling. Sample handling includes packaging, shipment from the site, and storage at the laboratory. Examples of sample labels, custody forms, and sample custody logs should be included.

When MCNOES IAQP staff retrieve the test vial(s), detector(s), and continuous monitor(s), they document the unique, pre-printed serial number for proper identification. MCNOES IAQP staff are committed to providing accurate, valid, reproducible, and defensible radon measurements that may be used to make critical decisions about radiation-related environmental health. The due diligence of MCNOES IAQP staff, building/home occupants, and the laboratories involved with radon measurement is crucial for achieving this goal.

Conducting quality control (QC) measurements routinely and consistently ensures radon measurements meet nationally accepted quality standards. QC measurements and the following information will be recorded electronically in a logbook.

2.3.1 Field Notes and Log Forms

At a minimum, the following information will be recorded during the collection of each sample. (EPA 402-R-92-004, 1992, Sec. 1.2.4) In addition, custody of the devices should be tracked from the time of ordering, receiving the detectors, labeling, logging in, storing, collecting, shipping, analysis, and final results.

Sufficient sampling information for measurement documentation must be recorded in a permanent log at pickup time. The information from each sample or group of samples at the same location is used for data interpretations and comparisons and quality assurance/quality control purposes. Information that will be recorded includes:

- The date and time of start and stop of measurement;
- Whether closed conditions, as previously specified, are satisfied;
- The exact location of the LS vial(s), detection(s), or continuous monitor, including a diagram of the room and sampling position;
- Serial number and manufacturer of the vial or detector along with a code number that uniquely identifies room and sampling position;
- Serial number of the CRM and the calibration uncertainty from the Certificate of Calibration;
- Field observations and details related to analysis and integrity of samples (e.g., weather conditions, noticeable drafts in the testing room, unusual temperatures, noticeable humidity, or any other unusual condition present during testing).
- Other easily gathered information that may be useful: the type of house (i.e., categorized or open room), type of heating system, the existence of a crawlspace or basements, occupants' smoking habits, operation of humidifiers, air filters, or electrostatic precipitators.

Appendix H includes a copy of the instruction sheet or SOPs for entering data into the project template.

2.3.2 Labeling

All samples collected will be clearly labeled for proper identification in the field and for tracking in the laboratory. All labels are pre-applied to the individual test kits. Each short-term and long-term has a unique 6-digit identifier/information card corresponding to the detector's foil. These numbers are used to reduce the potential for sample mishandling. The following information will be included on the label:

- Resident identification number (or applicable duplicate or blank identification number)
- Detector number
- Test location
- Start date and end date of sample

2.3.3 Chain of Custody Forms and Custody Seals

A chain of custody record will accompany all sample shipments for analysis. The chain of custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in that person's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel only. When samples are shipped, the MCNOES IAQP will be responsible for the custody of the samples. The designee will sign the chain of custody form in the "relinquished by" box and note the date, time, and unique monitor number.

Sample numbers for all samples, field duplicates, and blanks will be documented on this form. A request for the laboratory to use one of the samples for laboratory QC sample will also be noted on this form. A copy shall be made for the MCNOES IAQP project files. A copy of the chain of custody form is included in Appendix F.

2.3.4 Packaging and Shipment

All samples will be packaged according to the following procedures. If necessary, the sample containers will be placed inside a shipping container.

- Seals will be checked on the individual test kits for tightness.
- space in the shipping container will be filled with bubble wrap or Styrofoam peanuts to prevent movement and possible loosening of seals on test kits during transport or shipment.
- Each shipping container will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to its front, right, and back.

2.4 Analytical Methods (EPA QA/R-5 B 4) / Section 13

Identify the analytical methods and equipment required, including sub-sampling or extraction methods, laboratory decontamination procedures and materials (such as hazardous or radioactive samples), waste disposal requirements (if any), and any specific performance requirements for the method. Number, date, and regulatory citation may identify appropriate analytical techniques. Address what to do when a failure in the analytical system occurs, who is responsible for corrective action, and how the effectiveness of the corrective action shall be determined and documented. Specify the laboratory turnaround time needed if it is essential to the project schedule.

List any method performance standards. If a method allows the user to select from various options, then the method citations should state precisely which options are being selected. For non-standard method applications, such as for unusual sample matrices and situations, appropriate method performance study information is needed to confirm the method's performance for the particular matrix. If previous performance studies are unavailable, they must be developed during the project and included in the project results.

2.4.1 Sampling Procedures

Sampling will be conducted following EPA protocols for the short-term, long-term, and CRM detector radon measurement methods as described in "Indoor Radon and Radon Decay Product Measurement Device Protocols" (EPA 402-R-92-004, July 1992); Protocols for Radon and Radon Decay Product Measurements in Homes (EPA 402-R-92-003, May 1993); "Radon Measurements in Schools An Interim Guide (EPA 520/1-89-010).

Liquid Scintillation (LS)

The Charcoal Liquid Scintillation (LS) method employs a small vial containing activated charcoal for sampling the radon. After an exposure period of 2 to 7 days (depending on design), the vial is sealed and returned to a laboratory for analysis. While the adsorption of radon onto the charcoal is the same as for the AC method, analysis is accomplished by treating the charcoal with a scintillation fluid and then analyzing the fluid using a scintillation counter. The radon concentration of the sample site is determined by converting from counts per minute.

Alpha Track (AT) Detection (Filtered)

The detector is a small piece of special plastic or film inside a small container. Air being tested diffuses through a filter covering a hole in the container. When alpha particles from radon and its decay products strike the detector, they cause damage tracks. At the end of the test, the container is sealed and returned to a laboratory for reading.

The plastic or film detector is treated to enhance the damaged tracks, and then the tracks over a predetermined area are counted using a microscope or optical reader. The number of tracks per area counted is used to calculate the radon concentration of the site tested. Alpha track detectors are usually exposed for 3 to 12 months. Still, because they are true integrating devices, they may be exposed for shorter lengths when measuring higher radon concentrations.

CRM Measuring Procedures (Ecosense RadonEye Pro)

The MCNOES IAQP uses the NRPP and NRSB-approved CRM (FTLab/Ecosense RadonEye Pro RD200P), a real-time radon detector. Follow the steps below:

- Plug it in. It will flash green and red and then start to initialize. The OLED display will show the serial number and track the progress as it is set up.
    - When the unit is ready to start a test, it will read: READY

- Follow the directions for downloading the RadonEye Pro app in Section 2.9 of this document.
- Create your account.
  1. Create an account from the app or web dashboard.
  2. Select either the admin or employee account.
  3. Once your email address is entered, you cannot change it to another email.
- Verify account.
  1. Activate your account with the link in this email.
     - If you do not receive the confirmation message within a few minutes of signing up, check your spam folder.
- Connect to either Bluetooth or Wi-Fi for data communication.
  - After Bluetooth or Wi-Fi connection, the radon concentration value will be displayed.
  - After measurement starts, do not touch the CRM if possible.
    - First data is out 10 minutes after it starts
    - Data updates every 10 minutes
    - Run for at least 48 hours continuous measurement and check the peak value of your house.

2.4.2 Analytical Laboratory

See Appendices B and C for laboratory protocol approved by EPA.

2.4.3 Background Method Requirements

Field blanks are devices not exposed but sent to be analyzed with field-exposed devices to ensure no false positive. Field control detectors (field blanks) should be at least five percent (1 in 20 deployed). These devices should be set aside and sealed in a low radon environment, then labeled like the field detectors to ensure equal processing during the manufacturer's analysis. These control devices measure the background exposure that may accumulate during shipment or storage, and results should be recorded. If the field control detectors have concentrations significantly greater than the LLD established by the supplier, it may indicate defective devices or poor procedures. For controls substantially greater than the LLD, the average value of the field controls should be subtracted from the reported field detector concentrations, and the supplied will be notified of a possible problem. The packets should have background radon levels or at least less than 1.0 pCi/L.

2.5 Quality Control Requirements (EPA QA/R-5 B5) / Section 14

Identify QC activities needed for each sampling, analysis, or measurement technique. List the associated method or procedure, acceptance criteria, and corrective action for each required QC activity. Because standard methods are often vague or incomplete in specifying QC requirements, simply relying on the cited method to provide this information is usually insufficient. QC activities for the field and the laboratory include but are not limited to, blanks, duplicates, matrix spikes, laboratory control samples, surrogates, or second-column confirmation.

State the analysis frequency for each type of QC activity and the spike compounds' sources and levels. State or reference the required control limits for each QC activity and corrective action needed when control limits are exceeded and how the effectiveness of the corrective action shall be determined and documented.

Describe or reference the procedures to calculate applicable statistics (e.g., precision and bias). Copies of the formulas are acceptable if the accompanying narrative or explanation specifies how the calculations will address potentially difficult situations such as missing data values, "less than" or "greater than" values, and other standard data qualifiers.

This section identifies the QC checks in place for the sample collection, analyses, and field measurement activities that will help determine the reliability of the data generated. Specific procedures regarding these items are presented in other sections of the QAPP. See Appendices B and C for laboratory protocols approved by the EPA.

2.5.1 Field Quality Control Samples

Duplicates (Collocated)

Duplicates are side-by-side measurements that analyze the precision of the measurements taken in a building or home. They involve putting a second measurement device next to the original detector. Duplicate measurements will be made with either 10% of the total number of detectors placed or 50, whichever is smaller. The duplicate and original detectors will be treated identically in every respect.

They will be shipped, stored, opened, installed, removed, and processed together and not identified as duplicates to the processing laboratory. Data from duplicate detectors will agree to within 20%, on average, at radon concentrations of 4 pCi/L or greater. Consistent failure in the duplicate agreement would indicate an error in the measurement process that should be investigated.

- **Short-Term and Long-Term Passive Devices**

  Like all measurements, radon measurements usually do not produce the same results, even for simultaneous, co-located measurements. Duplicates are two side-by-side measurement devices placed 4 to 8 inches apart, or as specified by the manufacturer, that simultaneously measure radon.

  Duplicates are made at a rate of 10% per configuration. Duplicate tests must be conducted for at least 48 hours. Tests should be randomly distributed and deployed in the ordinary course of business across various projects, operators, and environments.

  A duplicate will be collected for 10% of the deployed devices. The duplicate and original detectors will be treated identically in every respect. However, the duplicates will be labeled with a unique location identification number known only to the staff of the MCNOES and will be submitted blindly to the analytical laboratory.

When duplicate measurements are made, the results are reported as such to the person who receives the test. The individual results and the average of the two will be reported. In addition, duplicate results are recorded on duplicate control charts. Duplicate control charts shall include:

- Start and stop dates of each test;
- Individual results of each test;
- Device identification number of each test;
- Average of test results,
- Relative percent difference;
- Document any investigation, inquiry findings, and corrective actions taken.

Precision involving duplicates is calculated by using Relative Percent Difference (RPD). RPD equals the difference between the higher and lower test results divided by the average of the two duplicate test results multiplied by 100. The RPD result is then compared to warning levels and control limits. Any result at or above the Warning Limit or Control Limit must be investigated.

The control and warning limits for duplicates are:

- At concentrations averaging less than 2 pCi./L, the warning limit is a difference 1 pCi/L between the results (there is no control limit);
- Between 2 and 3.9 pCi/L;
  - The warning limit is 50% RPD;
  - The control limit is 67% RPD.
- Four or more pCi/L;
  - The warning limit is 28% RPD;
  - The control limit is 36% RPD.

Precision will be monitored using the results of the duplicate detector analyses. Duplicate measurements should achieve a relative percent difference of 20% or less at four pCi/L or greater. (EPA 402-R-92-004, 1992, Sec. 2.4.11.3)

- **Continuous Radon Monitors (CRM)**

The objective of the duplicate tests is to verify and document that the measurement system imprecision has not increased since the last QC check or calibration. Passing duplicate tests before and after a set of measurements assures that the device functions correctly during all tests between those two QC measurements.

Duplicates shall be made at a rate of every 10^{th} measurement per device (10%). Duplicates must be conducted for at least 48 hours. Tests should be randomly distributed and deployed in the ordinary course of business across various projects, operators, and environments.

Methods that can be used include:

- CRM software that tracks the number of tests each machine performs and notifies you when a duplicate is needed.

- Scheduling system that tracks which machine(s) are used for each test conducted.
- Test result tracking system that documents which CRM did each test.
- Hashmarks on each device that are updated when that device does a test.
- If each device has its case, place ten notification forms in the case, remove the 10th form, and make a duplicate.

Certain events may create the need to do a duplicate test to ensure the device is functioning accurately before the device is placed into service again. Duplicates should be conducted when a CRM is:

- Received, either new or from recalibration,
- Mishandled or dropped,
- Exposed to harsh environments.

This practice can identify inaccurate recalibrations, malfunctions, or damage during shipping, handling, or misuse.

When duplicate measurements are made, the results are reported as such to the customer who receives the test. The individual results and the average of the two are reported. In addition, duplicate results are recorded on duplicate control charts. Duplicate control charts include:

- Start and stop dates of each test;
- Individual results of each test;
- Device identification number of each test;
- Average of test results;
- Relative percent difference, and
- Document any investigation, inquiry findings, and corrective actions taken.

Precision involving duplicates is calculated by using Relative Percent Difference (RPD). RPD equals the difference between the higher test results minus the lower test result divided by the average of the two duplicate test results, which is then multiplied by 100. The RPD result is then compared to warning and control limits. The Warning Limit is set at the deviation from ideal performance that would be expected to occur by chance only 5% of the time, and the Control Limit is set at the deviation from ideal performance that would be expected to occur by chance only 1% of the time. Any result at or above the Warning Limit or Control Limit must be investigated.

The control and warning limits for duplicates are:

- At concentrations averaging less than 2 pCi./L, the warning limit is a difference 1 pCi/L between the results (there is no control limit);
- Between 2 and 3.9 pCi/L;
  - The warning limit is 50% RPD,
  - The control limit is 67% RPD.
- four or more pCi/L;

- The warning limit is 28% RPD;
- The control limit is 36% RPD.

Blanks (Field Control)

Field control detectors (field blanks) are measurements performed to determine if the measurement device may have unintended exposure (background) during storage, handling, and shipping. A blank is an unexposed measurement device that is opened, immediately closed, and sealed. Like an exposed measurement device, it is labeled with plausible start and stop dates and times and then returned to the analytical laboratory.

- **Short-Term and Long-Term Passive Devices**

  Blanks must be the same type and configuration and from the same analytical laboratory as the other devices used by the measurement professional. To facilitate problem investigations, tracking the environments in which the measurement devices are stored, transported, and used is essential. Blanks should not be labeled as such when submitted to the laboratory; they should be treated and labeled as other kits returned to the laboratory.

  Blanks are made per configuration at a rate of 5% of measurements or 25 per month, whichever is less. Different configurations mean differences in the detector's design, manufacturers, and the type and source of the sensitive material. Blanks will be distributed among all the environments where the devices are handled, stored, and transported. The locations and times for all detectors used as blanks are carefully logged.

  A portion of the blanks shall be field blanks. Field blanks verify that there have been no unexpected influences during all conditions within the chain of custody. Therefore, field blanks are to be handled and placed exactly as the routine devices used for testing, except that the blanks are not used to measure radon concentrations. Office/storage blanks verify that no influencing factors occurred during storage or in-office handling. Suppose charcoal adsorption devices (CAD) or alpha track detector (ATD) inventories are stored in a low-radon environment. In that case, relative humidity (RH) extremes are recorded, and this information is documented and available upon request to auditors; then, office blanks need not be used as long as this is consistent with the manufacturer's directions. CAD and ATD users who cannot meet these requirements must conduct office/storage blanks.

  Transit (or "trip") blanks verify and document the absence of influences during shipping. They are submitted to the lab after the devices are received.

  The results of blank measurements are recorded on a blank control chart. The blank control chart must include the following:

  - Start and stop dates;
  - Device identification;
  - Test results;
  - Document any investigation, inquiry findings, and corrective actions taken.

Blank test results should be less than the minimum detectable concentration of the passive measurement device. If the background is detected with any blank, the cause shall be investigated, including contracting the analytical laboratory.

2.5.2 Laboratory Quality Control Samples

The laboratory will conduct QC checks following its Standard Operating Procedures and Quality Assurance Plan.

Spiked Samples

- **Short-Term and Long-Term Passive Devices**

  Spikes compares the reported radon concentration from a recognized reference authority for radon concentration (spiking chamber) to the result provided by the laboratory. Spike measurements are obtained from a spiking chamber certified by NRPP or NRSB. The process involves (1) sending an unopened passive measurement device(s) to the approved chamber and (2) then, after it is returned, sending the device to the device's analytical laboratory. The start and stop dates and times, plus temperature and humidity, if applicable, must match the information provided by the approved chamber. These factors can affect the test result, so they must be accurate.

  Spikes are made at a rate of 3% of devices deployed per configuration. There is a minimum of 3 per year per configuration and a maximum of 6 per month per configuration. Any project involving more than 100 measurements shall include at least three spikes.

  If practicable, the conditions of the spiking chamber should be similar to the humidity and temperature of the test conditions. This takes planning, as most spiking chamber conditions cannot be changed for an individual project.

  The results of spiked measurements are recorded on a spike control chart. The spike control chart shall include the following:

  - Start and stop dates;
  - Device identification;
  - Test result from the lab;
  - Stated radon level from the spiking chamber;
  - Relative percent error (RPE);
  - Document any investigation, inquiry findings, and corrective actions taken.

  Relative Percent Error (RPE) is calculated by subtracting the spiking chamber's value from the value obtained from the analytical laboratory, and that difference is divided by the spiking chamber's value. 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 of +/-30% is the warning level, outside of +/-30% is the control limit. Any RPE outside of 20% will be investigated and documented.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance (EPA QA/R-5 B6) / Section 15

Describe how inspections and acceptance testing of instruments, equipment, and components affecting quality will be performed and documented to ensure their intended use as specified. Identify and discuss the procedure by which independent personnel will perform final acceptance (e.g., personnel other than those performing the work). Describe how deficiencies are to be resolved, when re-inspection will be performed, and how the effectiveness of the corrective action shall be determined and documented.

Describe or reference how periodic preventive and corrective maintenance of measurement or test equipment or other systems and their components affecting quality shall be performed to ensure availability and satisfactory performance of the systems. Identify the equipment or systems requiring periodic maintenance. Discuss how the availability of critical spare parts, identified in the operating guidance and design specifications of the systems, will be assured and maintained.

2.6.1 Quality Assurance Officer (QAO)

The Quality Assurance Officer's responsibilities are to:

- Ensure proper storage of radon measurement devices;
- Design and present training to new employees and, on an annual basis, to all employees;
- Oversee measurement device use, including placement and retrieval;
- Create and maintain QA records;
- Prepare or over client test reports and specify how they are distributed to clients;
- Manage and oversee quality control (QC) measures;
- Initiate QA audits;
- Make recommendations on corrective action and to ensure corrective action is carried out;
- Initiate QA audit reporting to management and
- Participate in all meetings regarding staffing, training, equipment, record keeping, and changes in practices and procedures.

2.6.2 Routine Instrument Checks / Preventative Maintenance

Routine instrument checks involve following the manufacturer's instructions and examining the packaging upon receipt and disbursement of the devices. For CRM devices, instrument checks involve following the manufacturer's instructions to ensure proper working conditions. This includes checking battery voltage levels, cleaning screen inlet ports, and verifying up-to-date calibration. Performance checks will be made before every measurement. Any concerns are logged and reported to the QAO.

2.7 Instrument/Equipment Calibration and Frequency (EPA QA/R-5 B7) / Section 16

Identify all tools, gauges, instruments, and other sampling, measuring, and test equipment used for data generation or collection activities affecting quality that must be controlled and, at specified periods, calibrated to maintain performance within specified limits. Describe or reference how calibration will be conducted using certified equipment and standards with known valid relationships to nationally recognized performance standards. If no such nationally recognized standards exist, document the basis for the calibration. Identify the certified equipment and standards used for calibration. Indicate how calibration records shall be maintained and traceable to the instrument.

Calibration refers to determining a measurement device's response to a series of known radon concentrations and making necessary adjustments to the device. The monitor manufacturer or a national radon proficiency program-approved calibration laboratory approved by the device manufacturer calibrates each CRM every 12 months or after repair.

Any monitor without a calibration certification dated within 12 months must be removed from service. View Section 1.4.4 for laboratory certifications, mailing, and contact information.

In addition to calibration, an annual background check is performed by purging with clean aged air or nitrogen. The manufacturer or calibration laboratory completes this process at the time of calibration.

Calibration Laboratories

KSU (Kansas State University)
Contact Number: (785)532-6026
https://www.ksuradonchamber.org/Calibrations

Bowser-Morner
Contact Number: (416)650-9090
https://www.bowser-morner.com/radon-reference-lab

* Exclusively for the Ecosense RadonEye Pro:

- State-mandated initial calibration certification ($130)
- Annual renewal calibration ($150)

2.8 Inspection/Acceptance Requirements for Supplies & Consumables (EPA QA/R-5 B8)/Section 17

Describe how and by whom supplies and consumables (e.g., standard materials and solutions, sample bottles, calibration gases, reagents, hoses, deionized water, potable water, electronic data storage media, etc.) shall be inspected and accepted for use in the project—state acceptance criteria for such supplies and consumables.

Each device will be evaluated for suitable use before deployment as specified in Section 2.6.2 by MCNOES IAQP staff. The QAO is responsible for reviewing and developing the training plans for all staff and the plans for retaining when procedures change. New staff shall receive QA training before conducting radon measurements. Adequate training is prioritized since implementing this QA plan depends on the staff's understanding of its requirements. The training includes an emphasis on each employee's ethical and legal requirements. The training emphasizes each employee's moral and legal responsibilities for reliable and valid measurement test results and reporting those results.

MCNOES IAQP staff are responsible for knowing everything in this QA Plan that falls within their particular area of responsibility. This QA Plan is the principal source document for the QA procedures and protocols, which responsible staff must know and practice.

The QAO provides each employee with a copy of this QA Plan, which marks and indexes the specific QA activities and responsibilities of that particular employee.

Before conducting radon measurements and at least annually after, the QAO checks each involved employee's knowledge and understanding of their QA duties and responsibilities as defined in this plan. If, in the QAO's judgment, an employee does not adequately understand their responsibilities, follow-up instructions, and checks are carried out until an acceptable understanding is demonstrated. The QAO notifies the employee's supervisor of each check result, including compensation and job advancement reviews.

2.9 Data Acquisition Requirements (Non-Direct Measurements) (EPA QA/R-5 B9) / Section 18

Identify any data types needed for project implementation or decision-making obtained from non-measurement sources such as computer databases, programs, literature files, and historical databases. Describe the intended use of the data. Define the acceptance criteria for using such data in the project and specify any limitations on using the data.

All records and documents are maintained to be legible, retrievable, and protected from fire, water, theft, and deterioration for at least three years. Computer software and records for our radon measurements are routinely backed up to the cloud or a remote server. The MCNOES IAQP will utilize the smartphone app "Radon Eye." The following provides a step-by-step guide to downloading the app, running a test, exploring graph mode, and saving data.

2.9.1 "RadonEye Pro" App Download and Run

- Search "RadonEye Pro" in the play store or app store.
- Download the app and install it on your smartphone.
- Please allow Bluetooth consent.
- After the logo display, you can see the current search for RadonEye Pro.
- Click on the connect button. It is connected to RadonEye Pro by Bluetooth communication and makes a loud "beep."
- One smartphone to connect with one RadonEye Pro.
- If the connection is not smooth, please try again.
- If it is still trouble, turn off the Bluetooth function and turn it on again.

2.9.2 Continuous Monitoring with Wi-Fi

- If Wi-Fi is on, data is automatically uploaded to the server. If Wi-Fi is off, data can be manually uploaded to the server after the continuous monitoring operation is complete.
- Data will be stored on the device for 300 days.
- If the measurement time is below 10 minutes, you must wait up to 10 minutes.
- Various information is displayed: 1 day & 1-month average, measurement time, serial number, peak value, pulse count during 10 min (new/old).

2.9.3 Graph Mode and Data Save

- If you tap LOGO at the bottom of the display, you can see the graph mode.
- Tap on the data load; the measured data saved every 1 hour will be displayed as a graph.

- If you want to save this data on your smartphone, tap the save as button.
- You can change the saving file name if you want.
- The position of saved data files is the RadonFTLab folder for Android users.
- For iPhone users, please use iTunes.
- The saved file format is txt, a simple text file for Excel.

2.10 Data Management (EPA QA/R-5 B10) / Section 19

Describe the project data management process, tracing the path of the data from their generation to their final use or storage (e.g., the field, the office, the laboratory). Describe or reference the standard record-keeping procedures, document control system, and electronic media data storage and retrieval approach. Discuss the control mechanism for detecting and correcting errors and preventing data loss during data reduction, data reporting, and data entry to forms, reports, and databases. Provide examples of any forms or checklists to be used.

Identify and describe all data handling equipment and procedures to process, compile, and analyze the data. This includes methods for addressing data generated as part of the project and data from other sources. Include any required computer hardware and software and address specific hardware/software configuration performance requirements. Describe the procedures that will be followed to demonstrate the acceptability of the hardware/software configuration required.

An in-house field data form that includes the name of the homeowner or renter, address, location or the device, state data and time, stop data and time, device ID number, temperature (short-term only), and any additional information that is pertinent to the test site will be the initial documentation for all test devices deployed. The data will be transferred to an Excel spreadsheet by the MCNOES IAQP staff as the tests are completed. The forms will be bound and kept on file at the MCNOES office, either physically or electronically (CAA share drive), for at least three (3) years. Backup files will be managed on an external drive, staff computers, or USB. This drive is accessible only to MCNOES personnel.

Analytical data for the short-term and long-term devices will be submitted to the MCNOES IAQP staff by laboratories for evaluation and recommendation for re-testing. The information will be added to the Excel spreadsheet database, and the accuracy of previously transferred data will be verified then. For privacy, all residential data will be kept confidential and shared only with the homeowner or building manager. Data will be handled and controlled by the MCNOES IAQP staff. Any mapping or correlation with, i.e., geological data, will be strictly internal. Tribal office/home data will be released to the building manager/homeowner.

Personal-identifiable information (PII) will not be shared. The PII collected will be protected and securely stored. (This information includes name, phone number, and address.) Any radon levels for public display will be aggregated to the zip code level before public release.

2.10.1 Continuous Radon Monitor (CRM) – RadonEye Pro

This section discusses saving inspection data in the device, app, and web dashboard. Appendix G contains more information and SOPs for the RadonEye Pro device, app, and web dashboard.

Inspection Date and Generated Report

Inspection data can be saved in several locations when you finish the inspection.

1. **Inspection data saved in the device**
   a) View Result: The device storage can store up to 10 files. When you reach ten files, delete them and start a new inspection.
2. **Inspection data saved in the app**
   a) File Load: Raw data as a text file
   b) File Load: Report as a pdf file

c) Inspection Data: Saved inspection data

3. **Inspection data saved in the web dashboard**

a) Inspection Data: A report can be generated with data

b) Radon Report: Generated reports uploaded to the server

Note: Radon inspection data will not be uploaded to the server if an internet connection is unavailable.

2.10.2 Entering Data Into Project Template

The following is the step-by-step process for entering data into the project template. For more information, view Appendix H.

Step 1 – Location Data Tab

- Open the spreadsheet and go to the "Location Data" tab at the bottom.
- Fill in all the required fields highlighted in **RED**. These fields must be submitted as they are necessary for accurate calculations and cannot be left blank.
- In Column B, enter the report name, address, city, state, and zip code.
- In Column d, enter the test name, test address, test city, test state, and test zip code.
- In Column F, enter the Technician's Name and Certification information for simple placement and retrieval.
- The report email field can contain up to 2 emails separated by a semi-colon(;). For example, abc@def.com; 123@456.com.

Step 2: Test Device Tab

- Click on the tab next to "Location Data Tab" labeled "Test Device".
- Before entering data, ensure that you start typing in cell A2.
- Fill in all the required fields highlighted in **RED** and the other fields.
- Pay attention to the exact format required for specific fields:
    - Date Format: Enter dates in mm/dd/yyyy (e.g., 06/14/2023).
    - Time Format: Enter times in the format hh: mm using the 24-hour notation (e.g., 14:36 or 07:23).
    - Building Format: Enter only the building name or number in each row.
    - Unit Format: Enter only the unit's name or number in each row.
    - Floor Level: Enter the floor name or number in each row. For example, entering "First" will show as "First Floor" on the report, while entering "1" will show as "Floor 1" on the report.

Step 3: Quality Control (Duplicates and Blacks) Fields

- Duplicate Field: Enter "Yes" or "Y" if the sample is a QC Duplicate. The sample dates, times, and placement information must match for duplicate samples.
- Blank Field: Enter "Yes" or "Y" if the sample is a QC Black. The sample dates and times are also required for blanks.

Step 4: Indoor Temperature and Indoor Humidity

- We recommend calibrating temperature and humidity measurement devices, as this information will be used to calculate the radon result.
- Indoor Temperature: Required for charcoal canisters and LS devices.
- Indoor Humidity: Required for LS devices only.

Step 5: Submitting the Spreadsheet to the Laboratory

- Double-check that all fields, especially the ones highlighted in RED, are filled.

Save the spreadsheet on your computer with a new file name. It is recommended that you use the project name or test address. Appendix H also includes information about sharing the template with AccuStar Labs.

3.0 Assessment and Oversight (Group C)

*The elements in this group **(Table 9: (Group C) – Assessment and Oversight Elements)** address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The assessment ensures that the QA Project Plan is implemented as prescribed. The assessment consists of external activities, including a planned review system and audit procedures by personnel not actively involved in the inventory development process. The fundamental concept of this component is the independent objective review by a third party to assess the effectiveness of the internal Quality Control program and the quality of the inventory and to reduce or eliminate any inherent bias in the inventory process.*

Table 9: (Group C): Assessment and Oversight Elements

C1	Assessments and Response Actions
C2	Reports to Management

3.1 Assessments/Oversight & Response Actions (EPA QA/R-5 C1) / Section 20

Describe each assessment used in the project, including the frequency and type. Assessments include but are not limited to, surveillance, management systems reviews, readiness reviews, technical systems audits, performance evaluations, audits of data quality, and data quality assessments. Discuss the information expected and the success criteria (i.e., goals, performance objectives, acceptance criteria specifications, etc.) for each evaluation proposed. List the approximate schedule of assessment activities. Identify potential participants and their exact relationship within the project organization for any planned self-assessments (utilizing personnel from within the project groups). For independent assessments, identify the organization and person(s) that shall perform the assessments if this information is available. Describe how and to whom the results of each assessment shall be reported.

Define the assessors' scope of authority, including stop work orders and when they are authorized to act.

Discuss how response actions to assessment findings, including corrective actions for deficiencies and other non-conforming conditions, will be addressed and by whom. Include details on how the corrective actions will be verified and documented.

3.1.1 Assessments/Oversight

No external audits are planned for this program. The MCNOES IAQP staff will ensure that the elements of the QAPP are implemented as prescribed. Testing device deployment, retrieval, scheduling, and data management will be periodically assessed via discussion between the MCNOES Coordinator and the Environmental Specialist/Field Technician. Any need for corrective action will be identified during these reviews and implemented immediately.

The Project Manager will review the project to determine that:

- Field quality control measures have been conducted (e.g., duplicate and blank sample collection);
- Laboratory quality control measures have been conducted following the Standard Operating Procedures (SOPs);
- Data transferred from laboratory reports have been entered correctly into tables, charts, or graphs for evaluation;
- Data quality objectives have been met;
- Procedural changes made in the field or laboratory are incorporated in the QAPP.

3.1.2 Corrective Action and Reports

The MCNOES IAQP staff will investigate and establish a corrective action if any of the following occurs:

- Duplicates fail to meet the coefficient of variations criteria;
- It is reported that EPA protocols were not followed;
- Results for spikes are not evaluated within the accuracy and precision limits;
- Blanks are below instrument detection limits;
- Detectors are lost;
- Information reported for the exposures is incomplete;
- If someone in the group finds other issues.

A corrective action form will document the tracking and progress of the corrective action. The form will include:

- Description and date of the problem;
- Person who identified the problem;
- Person doing corrective action;
- Target date of solution;
- Reporting of status;
- Nature and date of solution.

3.2 Reports to Management (EPA QA/R-5 C2) / Section 21

Identify the frequency and distribution of reports issued to inform management (EPA or otherwise) of the project status; for example, reports on performance evaluations and system audits, results of periodic data quality assessments, and significant quality assurance problems and recommended solutions. Identify the preparer and the recipients of the reports, as well as any specific actions recipients are expected to take as a result of the reports.

Under the terms and conditions of the grant, the MCNOES IAQP will submit quarterly programmatic and financial status reports to EPA Project Office Aunjanee Gautreaux. The MCNOES IAQP will also report quarterly to the laboratory coordinator, evaluating test accuracy, precision, and completeness and any QA problems with recommended solutions for use by the designated QAO.

4.0 Data Review and Usability (Group D)

*The elements in this group **(Table 10: (Group D) – Data Validation & Usability)** address the QA activities after the project's data collection phase. Implementation of these elements determines whether the data conforms to the specified criteria, thus satisfying the project objectives. These sections describe how you will review and interpret the data. Data review encompasses the processes of verification and evaluation/validation, as well as reconciling for usability in supporting project objectives and decisions.*

Table 10: (Group D) - Data Validation & Usability

D1	Data Review, Verification, and Validation
D2	Verification and Validation Methods
D3	Reconciliation with User Requirements

4.1 Data Review, Verification, & Validation Requirements (EPA QA/R-5 D1) / Section 22

This section aims to identify the criteria used to review and validate data objectively and consistently: to accept, reject, or qualify it.

Describe the criteria you will use to decide whether to accept, reject, or qualify any data. These are the final checks on the data to determine if they satisfy the quality objectives and measurement criteria listed in Section 2.5.

MCNOES IAQP staff will use the protocol outlined in Section 2.0 (Group B) of this document. This protocol outlines the details for consistent deployment, retrieval, and sample shipment methods. Adherence to the protocols will ensure the data's usability from a field collection standpoint.

The Project Manager will review the laboratory report for compliance with the Data Quality Indicators (DQIs), which are accuracy, precision, completeness, representativeness, comparability, and method detection limits, and refer to quality control criteria established for various aspects of data gathering, sampling, or analysis activity. Due to the limited scope of the project, the pertinent data quality indicators are:

- Detection limits of the analytical method;
- Standard quality control conducted by the laboratory;
- Field duplicates and field blanks collected by the monitoring technicians will be submitted blindly to the analyst (View Section 2.5.1);
- Through record keeping by filed and data entry technicians;
- Review of data entered into the database.

If the sample results do not comply with quality standards, the Project Manager will:

- Flag the data that is not in compliance;
- Review the field notes for irregularities or inconsistencies;
- Contact the analytical laboratory to discuss actions taken by the laboratory to correct problems.

Valid data is produced when a measurement system, including storage, field deployment, transport, analysis, and reporting, operates "in control" and within QC limits. In-control QC checks have been made

before and after a validated data set. The qualified measurement professional is responsible for conducting, recording, and making available the QC check results relevant to each reported result.

The quality assurance officer (QAO) will review radon reports to ensure the QA plan is followed. Validation factors include proofreading files to ensure correct information is entered into the computer from the test placement/retrieval checklist. Any errors found during validation checks are documented, including who made the errors, the dates, and how these errors were resolved.

4.2 Verification and Validation Methods (EPA QA/R-5 D2) / Section 23

Describe the process used for verifying and validating data, including the chain of custody for data throughout the life of the project or task. Discuss how issues shall be resolved and the authorities responsible for resolving such issues. Describe how the results are conveyed to data users. Precisely define and interpret how validation issues differ from verification issues for this project. Provide examples of any forms or checklists to be used. Identify any project-specific calculations required.

The Project Manager will conduct or supervise staff completion of the following tasks to compile and evaluate the data collected, based on recommendations outlined in EPA's guidance Indoor Radon and Radon Decay Product Measurement Protocols (EPA 402-R-92-004, July 1992); a copy of the document is included as a reference in Appendix A.

- Data will be transferred to a spreadsheet or database approved by the MCNOES IAQP. Summary data tables will be created, and statistics will be performed to determine whether the sampled residential and public buildings meet the long-term exposure action level of 4.0 pCi/L or greater.
- A summary report will be prepared showing the monitoring results, including Task 1 above, the laboratory reports, field data sheets, chain of custody forms, and the assessment conducted by the Field Technician. The results will be reviewed regarding the data quality objectives and indicators (Section 1.7), and changes will be recommended to the QAPP if appropriate.
- After the data has been entered into electronic spreadsheets and databases, hard and electronic documentation copies will be stored on-site in a locked, fire-proof file cabinet.

As the results are reported from the laboratory, the data is entered on MCNOES computers. The format outlines/categorizes sampling data by location, county, zip code, structural type, and radon levels (< 4 pCi/L, four pCi/L, < 20 pCi/L, > 20 pCi/L, etc.). Radon levels are also grouped according to U.S. EPA guidelines (i.e., by zip code in ascending levels).

The laboratory will provide notice with, or in place of, the analytical results concerning the data's accuracy or validity. These notices are related to the following conditions noted by the laboratory on receipt of the testing devices:

- Time elapsed since the close of the test and receipt at the laboratory;
- Exposure to excessive moisture;
- Exposure to extreme temperatures;
- Insufficient information supplied with the device;
- Improperly sealed test packets;

- Device expiration data.

The MCNOES IAQP staff will review these notices to assess the usability of an individual analytical result. The program staff will then review, interpret, and discuss the data before disseminating it to the homeowner. The data will be reported to homes using a summary sheet of results and a cover letter.

4.3 Reconciliation with User Requirements (EPA QA/R-5 D3) / Section 24

The purpose of this section is to describe how you will evaluate the study results to see if they meet the requirements defined (in Sections 1.7 and 2.5) by the data user.

Describe how the results obtained from the project or task will be reconciled with the requirements defined by the data user or decision maker. Outline the proposed methods to analyze the data and determine possible anomalies or departures from assumptions established in the planning phase of data collection. Describe how reconciliation with user requirements will be documented, how issues will be resolved, and how limitations on the use of the data will be reported to decision-makers.

Data quality assessment (DQA) follows the data validation and verification steps. As such, DQA determines how well the validated data can support their intended use. The Program Manager will evaluate the data to determine if it will meet the data quality objectives outlined in Section 2.0 (Group B).

The Project Manager will review the project to determine that:

- Field quality control measures have been conducted (e.g., duplicate and blank sample collection);
- Laboratory quality control measures have been conducted following the Standard Operating Procedures (SOPs);
- Data transferred from laboratory reports have been entered correctly into tables, charts, or graphs for evaluation;
- Data quality objectives have been met;
- Procedural changes made in the field or laboratory are incorporated in the QAPP.

Appendix A: References

A Citizen's Guide to Radon: The guide to protecting yourself and your family from Radon, EPA 402-K-07-009, Revised May 2007.

Device Protocols 2 - 2.2 Protocol for Using Alpha Trach Detectors (AT or ATD) to Measure Indoor Radon Concentrations and 2.5 Protocol for Using Charcoal Liquid Scintillation (LS) Devices to Measure Indoor Radon Concentration, AccuStar, https://accustarlabs.com/radon-testing-support/radon-testing-protocols/dprotocols2#2.2

Guidance for the Indian Radon Pilot Projects, U.S. EPA Office of Radon Programs, March 25, 1991.

Indoor Radon and Radon Decay Product Measurement Protocols, U.S. EPA Office of Radiation Programs, July 1992, EPA 402-R-92-004.

Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, EPA-600/4-83-004, February 1983

Protocols for Radon and Radon Decay Measurements in Homes, EPA 402-R-93-003, June 1993.

Quality Assurance Guidance for State Indoor Radon Grant Program, U.S. EPA Office of Radon Programs, March 12, 1991.

Quality Assurance Plan for Conducting Radon Measurements, Minnesota Department of Health, Indoor Air Unit, MDH Standard QA Plan V3.3, Org. Date: October 31, 2019, Rev. Date: July 01, 2024.

Quality Assurance Project Plan - Radon Program, Cherokee Nation Office of Environmental Protection, January 3, 2015

Quality Assurance Project Plan, State Radon Monitoring Program, U.S. EPA, EPA 402/B-17/003.

Quality Assurance Project Plan Standard, U.S. EPA Chief Information Officer, CIO 2105-S-02.0, May 7, 2023.

Radon Measurement Proficiency (RMP) Program Handbook, U.S. EPA Office of Radiation Programs, March 1991, EPA 520/1-91-006.

Region 4 QAPP Review Checklist, U.S. EPA Office of Radiation Programs, EPA 402//B-07/002, March 29, 2007.

State and Tribal Indoor Radon Grants – Program Guidance and Handbook, EPA 402/B-05/002, January 2005.

Appendix B: Protocol for Using Charcoal Liquid Scintillation (LS) Devices to Measure Indoor Radon Concentration (Provided by AccuStar)

2.5.1 Purpose

This protocol guides using charcoal liquid scintillation (LS) devices to obtain accurate and reproducible measurements of indoor radon concentrations. Adherence to this protocol will help ensure uniformity among measurement programs and allow valid intercomparison of results. Measurements made following this protocol will produce results representative of closed-building conditions. Measurements made under closed-building conditions have a minor variability and are more reproducible than those made when the building conditions are uncontrolled. The investigator should also follow the guidance provided by the EPA in "Protocols for Radon and Radon Decay Product Measurements in Homes" (U.S. EPA, 1992c) or other appropriate EPA measurement guidance documents.

2.5.2 Scope

This protocol covers, in general terms, the equipment, procedures, and quality control objectives to be used in performing the measurements. It is not meant to replace an instrument manual but provides guidelines for anyone providing measurement services to incorporate into standard operating procedures. Questions about these guidelines should be directed to the U.S. Environmental Protection Agency.

2.5.3 Method

LS devices are passive detectors that require no power to function. The activated charcoal's passive nature allows continual adsorption and desorption of radon, and the adsorbed radon undergoes radioactive decay during the measurement period. Therefore, the technique does not uniformly integrate radon concentrations during exposure. As with all devices that store radon, the calculated average concentration is subject to error if the ambient radon concentration adsorbed during the first half of the sampling period is substantially higher or lower than the average.

The LS technique is described elsewhere (Prichard & Marien, 1985). Several companies now provide a type of LS device that is a capped, 20-ml liquid scintillation vial approximately 25 mm in diameter by 60 mm and contains one to three grams of charcoal (other designs are also feasible). In some cases, the vial includes a diffusion barrier over the charcoal, which improves the uniformity of the device's response to variations of radon concentration over time, particularly for longer exposures. Some LS devices include a few grams of desiccant, which reduces interference from the charcoal's moisture adsorption (Perlman, 1989). All LS devices are sealed with a radon-proof closure after preparation.

A measurement with the LS device is initiated by removing the radon-proof closure, which allows radon-laden air to diffuse into the charcoal, where the radon is adsorbed. At the end of the exposure (typically two to seven days), the device is resealed securely and returned to the laboratory for analysis.

The devices are prepared for analysis at the laboratory using radon desorption techniques. This technique transfers reproducibly a significant fraction of the radon adsorbed on the charcoal into a vial of liquid scintillation fluid. The vials of liquid scintillation fluid containing the dissolved radon are placed in a liquid scintillation counter and counted for a specified number of minutes (e.g., 10 minutes) or until the standard deviation of the count is acceptable (e.g., less than 10 percent).

2.5.4 Equipment

Several laboratories supply and analyze LS devices explicitly made for ambient radon monitoring.

The following equipment is required to measure radon with an LS device:

The supplier properly seals LS devices, an instruction sheet for the occupant, a shipping container (along with a prepaid mailing label, if appropriate, and a data collection log.

2.5.5 Pre-Deployment Considerations

Before deployment, the occupant's plans during the proposed measurement period should be considered. If the occupant moves during the measurement period, the LS measurement should not be made. Deployment should be delayed until the new occupant is settled in the house.

The LS device should not be deployed if the occupant's schedule prohibits terminating the measurement at the time selected for closing the device and returning it to the laboratory.

2.5.6 Measurement Criteria

The reader should refer to Section 1.2.2 for the list of general conditions that must be met to ensure standardization of measurement conditions.

2.5.7 Deployment

2.5.7.1 Location Selection. When choosing a measurement device location, the reader should refer to Section 1.2.3 for standard criteria.

2.5.7.2 Timely Deployment. LS devices should be deployed into buildings within the shelf life specified by the supplier. Until they are deployed, they should remain tightly sealed to maintain a low background.

The protective cap should be removed from the device to begin the sampling period. The cap must be saved to reseal the device at the end of the measurement. The device should be inspected to ensure it is not damaged during handling and shipping. It should be intact, with no charcoal leakage. The device should also be placed with the open vial mouth up. Nothing should impede airflow around the device.

2.5.8 Retrieval of Devices

The device should be deployed for the measurement period (usually between two days and one week) specified in the instructions supplied by the analytical laboratory. If the occupant is terminating the sampling, the instructions should inform the occupant of when to terminate the sampling period. They should indicate that the actual time of termination must be documented on the device. In addition, the occupant also should be instructed to send the device to the laboratory as soon as possible, preferably on the day of sample termination. The analysis laboratory should be calibrated to permit accurate analysis of devices deployed for some reasonable time beyond the recommended sampling period. For example, a detector deployed 24 hours beyond the recommended sampling time may not present an analysis problem to the measurement laboratory.

At the end of the monitoring period, the device should be inspected for any deviation from the conditions described in the log book during deployment time. Any changes should be noted. The device should be resealed using the original protective cap.

2.5.9 Documentation

The reader should refer to Section 1.2.4 for the list of standard information that must be documented for data interpretation and comparison.

2.5.10 Analysis Requirements

LS devices should be returned to the supplier's analysis laboratory as soon as possible following removal from the houses. The maximum allowable delay time between the end of sampling and analysis should not exceed the time specified by the supplier's instructions, especially if the radon concentration measured were expected to be low. Corrections for radon-222 decay during sampling, during the interval between sampling and counting, and counting will be made by the analysis laboratory. The procedures followed by an individual supplier's analysis laboratory may include correcting moisture measured by weight gain if this is significant for their device configuration. Other correction or calibration factors applied by the analysis laboratory must consist of factors accounting for the transfer of radon from the charcoal to the scintillation fluid under rigorously controlled conditions and for the counting efficiency achieved with the specified scintillation mixture and liquid scintillation counting system.

2.5.10.1 Sensitivity. Individual suppliers should specify the lower limit of detection (LLD [calculated using methods described by Altshuler and Pasternack 1963]) for LS devices exposed and shipped according to their directions. LLDs of a few tenths of a picocurie per liter (pCi/L) are estimated to be achievable for some LS devices (Cohen, 1988; Grodzins, 1988; Perlman, 1988; Prichard, 1988). The LLD should be calculated using the results of the laboratory control devices discussed in Section 2.5.11.4.1 of this protocol.

2.5.10.2 Precision. Precision should be monitored and recorded periodically using the results of the duplicate device analyses described in Section 2.5.11.3 of this protocol. Measurements made with this method can produce duplicate results with a coefficient of variation of 10 percent or less at four pCi/L or greater. An alternate measure of precision is a relative percent difference, defined as the difference between two duplicate measurements divided by their mean; note that these two precision measures are not identical quantities. It is essential that precision be monitored frequently over a range of radon concentrations and that a systematic and documented method for evaluating changes in precision be part of the operating procedures.

2.5.11 Quality Assurance

The quality assurance program for an LS system includes five parts: (1) calibration, (2) known exposure devices, (3) duplicate (collocated) devices, (4) control devices, and (5) routine instrument checks. A quality assurance program aims to identify the measurements' accuracy and precision and ensure that the measurements are not influenced by exposure from sources outside the environment to be measured. The quality assurance program should include the maintenance of control charts (Goldin, 1984); general information is also available (Taylor, 1987; U.S. EPA, 1984).

2.5.11.1 Calibration. Every LS laboratory system should be calibrated in a radon calibration chamber at least once every 12 months. Determining calibration factors for LS devices requires exposure to known concentrations of radon-222 in a radon exposure chamber at carefully measured radon concentrations. The calibration factors depend on the exposure time and may also depend on the amount of water adsorbed by the device during exposure. Calibration factors should be determined for various exposure times and, if appropriate, humidity.

2.5.11.2 Known Exposure Devices. Anyone providing measurement services with LS devices should submit devices with known radon exposures (spiked samples) for analysis at a rate of three per 100 measurements, with a minimum of three per year and a maximum required of six per month. Known exposure (spiked) devices should be labeled like field devices to ensure identical processing. The results of

the spiked device analysis should be monitored and recorded, and any significant deviation from the known concentration to which they were exposed should be investigated.

2.5.11.3 Duplicate (Collocated) Devices. Anyone providing measurement services with LS devices should place duplicate detectors in enough houses to test the precision of the measurement. The number of duplicate detectors deployed should be approximately 10 percent of the number deployed each month or 50, whichever is smaller. Each pair of duplicate devices should be shipped, stored, exposed, and analyzed under the same conditions. The samples for duplication should be distributed systematically throughout the entire population of samples. Groups selling measurement services to homeowners can do this by providing two detectors instead of one to a random selection of purchasers with instructions to place them side-by-side. Consideration should be given to providing some means to ensure that duplicate devices are not separated during the measurement period. Data from duplicate devices should be evaluated using procedures described by Goldin (section 5.3 of Goldin 1984), by Taylor (Taylor, 1987), or by the EPA (U.S. EPA, 1984). Whatever procedures are used must be documented before beginning measurements. Consistent failure in duplicate agreement may indicate a problem in the measurement process and should be investigated.

2.5.11.4 Control Devices

2.5.11.4.1 Laboratory Control Devices. Each laboratory or supplier should establish the laboratory background level for each batch of LS devices. Suppliers should measure the background of a statistically significant number of unexposed LS devices processed according to their standard operating procedures (laboratory blanks). Typically, the analysis laboratory or supplier calculates the net readings (used to calculate the reported sample radon concentrations) by subtracting the laboratory blank values from the results obtained from the field detectors.

2.5.11.4.2 Field Control Devices. Field control devices (field blanks) should consist of at least five percent of the devices deployed every month or 25, whichever is smaller. Large users of LS detectors should set these aside from each shipment, keep them sealed and in a low radon (less than 0.2 pCi/L) environment, label them in the same manner as the field devices, and send them back to the supplier with one shipment each month for analysis. These control devices measure the background exposure that may accumulate during shipment or storage, and the results should be monitored and recorded. If one or a few of the field control detectors have concentrations significantly greater than the LLD established by the supplier, it may indicate defective devices or procedures. Suppose most controls have concentrations substantially greater than the LLD. In that case, the average value at the field controls should be subtracted from the reported field device concentration, and the supplier should be notified of a possible problem.

2.5.11.5 Routine Instrument Checks. Proper operation of all radiation counting instruments requires a constant response to a reference source within established limits. Therefore, counting equipment should be subject to routine checks to ensure proper operation. This is achieved by counting an instrument check source at least once daily. If possible, the characteristics of the check source (i.e., type of radiation emitted) should be similar to the samples to be analyzed. The count rate of the check source should be high enough to yield good counting statistics in a short time (for example, 1,000 to 10,000 counts per minute).

Appendix C: Protocol for Using Alpha Track Detectors (AT or ATD) to Measure Indoor Radon Concentrations (Provided by AccuStar)

2.2.1 Purpose

This protocol guides using alpha track detectors (AT or ATD) to obtain accurate and reproducible measurements of indoor radon concentrations. Adherence to this protocol will help ensure uniformity among measurement programs and allow valid intercomparison of results. The investigator should also follow the EPA's guidance in "Protocols for Radon and Radon Decay Product Measurements in Homes" (U.S. EPA, 1992c) or other appropriate EPA measurement guidance documents.

2.2.2 Scope

This protocol covers, in general terms, the equipment, procedures, and quality control objectives to be used in performing the measurements. It is not meant to replace an instrument manual but provides guidelines for anyone providing measurement services to incorporate into standard operating procedures. Questions about these guidelines should be directed to the U.S. Environmental Protection Agency.

2.2.3 Method

An AT consists of a small plastic or film enclosed in a container with a filter-covered opening or similar design to exclude radon decay products. Radon diffuses into the container, emitting alpha particles, and its decay products strike the detector and produce submicroscopic damage tracks. At the end of the measurement period, the detectors are returned to a laboratory. Plastic detectors are placed in a caustic solution that accentuates the damaged tracks so they can be counted using a microscope or an automated counting system. The number of tracks per unit area correlates to the air's radon concentration using a conversion factor derived from data generated at a calibration facility. The number of tracks per unit of analyzed detector area produced per unit of time (minus the background) is proportional to the radon concentration. AT detectors function as true integrators and measure the average concentration of overexposure.

Many factors contribute to the variability of AT results, including differences in the detector response within and between batches of plastic, non-uniform plate-out of decay products inside the detector holder, differences in the number of background tracks, and variations in etching conditions. Since the variability in AT results decreases with the number of net tracks counted, counting more tracks over a larger area of the detector, particularly at low exposures, will reduce the uncertainty of the result.

2.2.4 Equipment

ATs are available from commercial suppliers. These suppliers offer contract services that provide the detector and subsequent analysis and reporting for a fixed price. Establishing an in-house capability to provide packaged detectors, a calibration program, and an analysis program would probably not be practical or economically advantageous for most users. Therefore, details for establishing the analytical aspects of an AT program are omitted from this protocol. Additional AT program information has been reviewed elsewhere (Fleischer et al., 1965; Lovett, 1969).

Assuming ATs are obtained from a commercial supplier, the following equipment is needed to initiate a measurement:

An AT in an individual, sealed container (such as an aluminized plastic bag) to prevent extraneous exposure before deployment; a means to attach the AT to its measurement location, if it is to be hung from the wall or ceiling; an instruction sheet for the occupant, a sample log sheet, and a shipping container (along with a prepaid mailing label, if appropriate); manufacturer instructions for resealing the detector at the time of retrieval and before returning it to the supplier for analysis; and a data collection log, if appropriate.

2.2.5 Pre-Deployment Considerations

Before deployment, the occupant's plans during the proposed measurement period should be considered. The AT measurement should not be made if the occupant moves during the measurement period. Deployment should be delayed until the new occupant is settled in the house.

The AT should not be deployed if the user's schedule prohibits terminating the measurement at the appropriate time.

2.2.6 Measurement Criteria

The reader should refer to Section 1.2.2 for the list of general conditions that must be met to ensure standardization of measurement conditions.

A 12-month AT measurement provides information about radon concentrations in a building during an entire year, so the closed-building conditions do not have to be satisfied to perform a valid year-long measurement.

2.2.7 Deployment

2.2.7.1 Location Selection. The reader should refer to Section 1.2.3 for standard criteria when choosing a measurement device location.

Suppose the detector is installed during a site visit. In that case, the final site selected should be shown to the building occupant to ensure its acceptance for the measurement period.

2.2.7.2 Timely Deployment. A group of ATs should be deployed into houses as soon as possible after delivery from the supplier. To minimize the chances of high background exposures, users should not order more ATs than they can reasonably expect to install within the following few months. If the storage time exceeds a few months, the background exposures from a sample of the stored detectors should be assessed to determine if they differ from the background of detectors that are not stored for long periods. The supplier's instructions regarding storage and background determination should be followed. This background assessment of detectors stored for long periods is unnecessary if the analysis laboratory routinely measures the background of stored detectors and if the stored detectors remain tightly sealed.

The sampling period begins when the protective cover or bag is removed. The edge of the bag must be cut carefully, or the cover must be removed to be reused to reseal the detector at the end of the exposure period. The detector and the radon-proof container should be inspected to ensure they are intact and have not been physically damaged in shipment or handling.

2.2.8 Retrieval of Detectors

At the end of the measurement period (usually 90 days for short-term tests and one year for long-term measurements), the detector should be inspected for damage or deviation from the conditions entered in the log book at the time of deployment. Any changes should be noted in the logbook. The time and date of

removal should be entered on the data form for the detector and in the logbook if used. The detector should then be resealed following the instructions provided by the supplier. After retrieval, the detectors should be stored in a low radon environment and returned to the analytical laboratory for processing as soon as possible. In many cases, attempts at resealing ATs have not been successful, resulting in some continued exposure of the detectors beyond the deployment period. This extra exposure could bias the results if the detectors are held for a significant length of time before analysis.

2.2.9 Documentation

The reader should refer to Section 1.2.4 for the list of standard information that should be documented.

2.2.10 Analysis Requirements

2.2.10.1 Sensitivity The lower limit of detection (LLD [calculated using methods described by Altshuler and Pasternack 1963]) depends on the stability of the number of background tracks. Depending upon the system used, the background may be less variable if a greater area is analyzed. With present ATs, routine counting can achieve an LLD of 1 pCi/L-month, and an LLD of 0.2 pCi/L-month may be accomplished by counting additional areas.

2.2.10.2 Precision. The precision should be monitored using the results of the duplicate detectors described in Section 2.2.11.3 of this protocol rather than a precision quoted by the manufacturer. The precision of an AT system depends upon the total number of tracks counted on the flank and test detector and, therefore, the area of the detector that is analyzed. If few net tracks are counted, poor precision is obtained. Thus, the organization measuring with an AT must arrange for counting an adequate area or number of net tracks.

2.2.11 Quality Assurance

The quality assurance program for AT measurements involves five separate parts: (1) calibration, (2) known exposure measurements, (3) duplicate (collocated) detectors, (4) control detectors, and (5) routine instrument checks. A quality assurance program aims to identify the measurements' accuracy and precision and ensure that the measurements are not influenced by exposure from sources outside the environment to be measured. The quality assurance program should include the maintenance of control charts (Goldin, 1984); general information is also available (Taylor, 1987; U.S. EPA, 1984).

2.2.11.1 Calibration. Every AT laboratory system should be calibrated in a radon calibration chamber at least once every 12 months. Determination of a calibration factor requires exposure of ATs to a known radon concentration in a radon exposure chamber. These calibration exposures will obtain or verify the conversion factor between net tracks per unit area and radon concentration. Participation in EPA's former National Radon Proficiency Program (NRPP) did not satisfy the need for annual calibration, as this Program was a proficiency test rather than an internal calibration. The following guidance is provided to manufacturers and suppliers of AT services as minimum requirements in determining the calibration factor.

ATs should be exposed in a radon chamber at several different radon concentrations or exposure levels similar to those found in the tested buildings (a minimum of three different concentrations).

A minimum of 10 detectors should be exposed at each level.

A calibration factor should be determined for each batch or sheet of detector material from the supplier. Alternatively, calibration factors may be established from several sheets, extending to detectors from sheets exhibiting similar sensitivities (within pre-established tolerance limits).

2.2.11.2 Known Exposure Measurements. Anyone providing measurement services with AT devices should submit ATs with known radon exposures (spiked samples) for analysis at a rate of three per 100 measurements, with a minimum of three per year and a maximum required of six per month. Known exposure (spiked) detectors should be labeled like field detectors to ensure identical processing. The results of the spiked detector analyses should be monitored and recorded. Any significant deviation from the known concentration to which they were exposed should be investigated.

2.2.11.3 Duplicate (Collocated) Detectors. Anyone providing measurement services with AT devices should place duplicate detectors in enough houses to test the precision of the measurement. The number of duplicate detectors deployed should be approximately 10 percent of the number deployed each month or 50, whichever is smaller. The pair of detectors should be treated identically in every respect. They should be shipped, stored, opened, installed, removed, and processed together, not identified as duplicates to the processing laboratory. The samples selected for duplication should be distributed systematically throughout the entire population of measurements. Groups selling measurements to homeowners can accomplish this by providing two detectors instead of one to a random selection of purchasers, with instructions to place the detectors side-by-side. Consideration should be given to providing some means to ensure that duplicate devices are not separated during the measurement period. Data from duplicate detectors should be evaluated using the procedures described by Goldin (section 5.3 of Goldin 1984), by Taylor (Taylor, 1987), or by the EPA (U.S. EPA 1984). Whatever procedures are used must be documented before beginning measurements. Consistent failure in duplicate agreement may indicate a problem in the measurement process and should be investigated.

2.2.11.4 Control Detectors

2.2.11.4.1 Laboratory Control Detectors. Each laboratory or supplier should establish the laboratory background level for each batch of ATs. Suppliers should measure the background of a statistically significant number of unexposed ATs processed according to their standard operating procedures. Typically, the analysis laboratory or supplier calculates the net readings (used to calculate the reported sample radon concentrations) by subtracting the laboratory blank values from the results obtained from the field detectors.

2.2.11.4.2 Field Control Detectors. Field control detectors must be a component of any AT measurement program. Field control ATs (field blanks) should consist of at least five percent of the devices deployed every month or 25, whichever is smaller. Users should set these aside from each shipment, keep them sealed and in a low radon (less than 0.2 pCi/L) environment, label them in the same manner as the field ATs to ensure identical processing, and send them back to the supplier with the field ATs for analysis. These control devices are necessary to measure the background exposure accumulating during shipment and storage. The results should be monitored and recorded. If one or a few field blanks have concentrations significantly greater than the LLD established by the supplier, it may indicate defective packaging or handling. Suppose the average value from the field control devices (field blanks) is significantly greater than the LLD established by the supplier. This average value should be subtracted from the individual values reported for the other devices in the exposure group.

It may be advisable to use three sets of detectors (pre-exposure, field, and post-exposure background) for the most thorough and complete evaluation of radon levels. For example, one group of detectors (pre-exposure detectors) may be earmarked for background measurement and returned for processing immediately after the other detectors are deployed. The results from these detectors determine if the number of tracks acquired before deployment is significant and should be subtracted from the gross result. The second set of background detectors (post-exposure background detectors) are obtained just before the field monitors are collected, opened, and kept in the exact location as the returning field monitors for the same duration and returned with them. Finally, if found to be significant, this "post-exposure background" is subtracted from the field results. A value of 1 pCi/L or greater for any blank AT indicates a significant level that should be investigated and potentially subtracted from the field AT results.

2.2.11.5 Routine Instrument Checks. The proper functioning of the analysis instruments and the adequate response of their operators require that the equipment be subject to routine checks. Daily or more frequent monitoring of equipment and operators is vital to ensuring consistently accurate results.

Appendix D: Protocol for Using Continuous Radon Monitors (CRM) to Measure Indoor Radon Concentrations (Provided by AccuStar)

2.1.1 Purpose

This protocol uses continuous radon monitors (CR) to measure indoor radon concentrations and obtain reproducible results accurately. Adherence to this protocol will help ensure uniformity among measurement programs and allow valid comparisons of results. Measurements made following this protocol will produce results representative of closed-building conditions. Measurements made under closed-building conditions have a smaller variability and are more reproducible than those made when the building conditions are uncontrolled. The investigator should also follow the guidance provided by the EPA in Protocols for Radon and Radon Decay Product Measurements in Homes (U.S. EPA 1992c) or other appropriate EPA measurement guidance documents.

2.1.2 Scope

This protocol covers, in general terms, the sample collection and analysis method, the equipment needed, and the quality control objectives of measurements made with CRs. It is not meant to replace an instrument manual but provides guidelines for anyone providing measurement services to incorporate into standard operating procedures. Questions about these guidelines should be directed to the U.S. Environmental Protection Agency.

2.1.3 Method

This protocol covers three general types of CR monitors. In the first type, ambient air is sampled for radon in a scintillation cell after passing through a filter that removes radon decay products and dust. As the radon in the cell decays, the radon decay products plate out on the interior surface of the scintillation cell. Alpha particles produced by subsequent or initial radon decay strike the zinc sulfide coating on the scintillation cell's inside, producing scintillations. The scintillations are detected by a photomultiplier tube in the detector, generating electrical pulses. The detector electronics process these pulses, and the data are usually stored in the monitor's memory, where results are available for recall or transmission to a data logger or printer.

This type of CR monitor uses either a flow-through or periodic-fill cell. In the flow-through cell, a small pump draws air continuously through the cell. In the periodic-fill cell, the air is drawn into the cell once during each pre-selected time interval; then, the scintillations are counted, and the cycle is repeated. A third variation operates by radon diffusion through a filter area, with the radon concentration in the cell varying with the radon concentration in the ambient air after a small diffusion time lag. The concentrations measured by all three variations of cells lag the ambient radon concentrations because of the inherent delay in the radon decay product disintegration process.

A second type of CR monitor operates as an ionization chamber. Radon in the ambient air diffuses into the chamber through a filtered area so that the radon concentration in the chamber follows the radon concentration in the ambient air with some small time lag. Within the chamber, alpha particles emitted during the decay of radon atoms produce bursts of ions, recorded as individual electrical pulses for each disintegration. The monitor electronics process these pulses; the number of pulses counted is usually displayed on the monitor, and the data are usually available for processing by an optional data logger/printer.

A third type of CR monitor allows ambient air to diffuse through a filter into a detection chamber. As the radon decays, the alpha particles are counted using a solid-state silicon detector. The measured radon concentration in the chamber follows the radon concentration in the ambient air by a small time lag.

2.1.4 Equipment

The equipment required depends on the type and model of CR monitor used. Aged air or nitrogen must be introduced into the CR monitor to measure the background count rate during calibration. For scintillation cell-type CRs, sealed scintillation cells with a measured low background should be available as spare cells.

2.1.5 Pre-deployment Considerations

Before deployment, the occupant's plans during the proposed measurement period should be considered. If the occupant moves during the measurement period, the CR measurement should not be made. Deployment should be delayed until the new occupant is settled in the house.

2.1.5.1 Pre-Sampling Testing. Before and after each measurement, the CR monitor should be tested carefully according to the manufacturer's directions to Verify that the correct input parameters and the unit's clock or timer are set properly and to Verify the pump's operation. Flow rates within the range of the manufacturer's specifications are satisfactory.

After every 1,000 hours of scintillation cell-type CRs, the background count rate should be checked by purging the unit with clean, aged air or nitrogen following the procedures identified in the instrument's operating manual. In addition, the background count rate of all CR types should be monitored more frequently by operating the instrument in a low-radon environment.

Participation in a laboratory intercomparison program should be conducted initially and at least once every 12 months after equipment repair to verify that the conversion factor used by the CR monitor is accurate. This is done by comparing the unit's response to a known radon concentration. At this time, the correct operation of the pump should be verified. Participation in EPA's National Radon Proficiency Program (RPP) did not satisfy the need for annual calibration, as this Program was a performance test rather than an internal calibration.

2.1.6 Measurement Criteria

The reader should refer to Section 1.2.2 for the list of general conditions that must be met to ensure standardization of measurement conditions.

2.1.7 Deployment and Operation

2.1.7.1 Location Selection. When choosing a measurement device location, the reader should refer to Section 1.2.3 for standard criteria.

2.1.7.2 Operation. The CR monitor should be programmed to run continuously, recording periodically the radon concentration for at least 48 hours. Longer measurements may be required, depending on the measured CR type and radon level. An increased operating time decreases the uncertainty associated with using the measurement result to represent a longer-term average concentration.

Care should be taken to account for data produced before equilibrium conditions have been established in a flow-through cell. Generally, conditions stabilize after the first four hours. Measurements made before this time are low and should either be discarded or used to estimate radon concentrations using pre-established system constants (Busigin et al., 1979; Thomas, 1972). If the first four hours of data from a 48-

hour measurement are discarded, the remaining hours of data can be averaged and are sufficient to represent a two-day measurement.

2.1.8 Retrieval of Monitors

When the measurement is terminated, the operator should document the stop date and time and whether the closed-building conditions are still in effect.

2.1.9 Documentation

The reader should refer to Section 1.2.4 for the list of standard information that must be documented. The serial numbers of the CR monitor, scintillation cells, and other equipment must also be recorded.

2.1.10 Results

2.1.10.1 Sensitivity. Most CR monitors are capable of a lower limit of detection (LLD [calculated using methods described by Altshuler and Pasternack 1963]) of 1.0 picoCurie per liter (pCi/L) or less.

2.1.10.2 Precision. Most CR monitors can achieve a coefficient of variation of less than 10 percent at four pCi/L or greater. An alternate measure of precision is a relative percent difference, defined as the difference between two duplicate measurements divided by their mean; note that these two precision measures are not identical quantities. It is important that precision be monitored continuously over a range of radon concentrations and that a systematic and documented method for evaluating changes in precision be part of the operating procedures.

2.1.11 Quality Assurance

The quality assurance program for CR measurements includes four parts: (1) calibration, (2) background measurements, (3) duplicate measurements, and (4) routine instrument checks. The purpose of a quality assurance program is to identify the measurements' accuracy and precision and ensure that the measurements are not influenced by exposure from sources outside the environment to be measured. The quality assurance program should include the maintenance of control charts (Goldin, 1984); general information is also available (Taylor, 1987; U.S. EPA, 1984).

2.1.11.1 Calibration. Every CR monitor should be calibrated in a radon calibration chamber before being put into service and after any repairs or modifications. (Note that an inherent element in the calibration process is thoroughly determining the background count rate using clean, aged air or nitrogen.) Subsequent recalibrations and background checks should be done at least once every 12 months, with cross-checks to a recently calibrated instrument at least semiannually. All cells need individual calibration factors.

2.1.11.2 Background Measurements. After every 1,000 hours of operation of scintillation cell-type CRs (about every 20th 48-hour measurement), and whenever any type of CR is calibrated, the background should be checked by purging the monitor with clean, aged air or nitrogen. In addition, the background count rate should be monitored more frequently by operating the instrument in a low-radon environment. Cells that develop a high background after prolonged use should be reconditioned by the manufacturer.

2.1.11.3 Duplicate Measurements. When two or more CR monitors of the same type (e.g., scintillation cell, ionization chamber, or silicon detector types) are available, the precision of the measurements can be estimated by operating the monitors side-by-side. The analysis of duplicate results should follow the methodology described by Goldin (section 5.3 of Goldin 1984), by Taylor (Taylor, 1987), or by the EPA (U.S. EPA, 1984). Whatever procedures are used must be documented prior to beginning measurements.

Consistent failure in duplicate agreement may indicate a problem in the measurement process and should be investigated.

2.1.11.4 Routine Instrument Checks. The proper operation of all radiation counting instruments requires their response to a reference source to be constant and within established limits. Therefore, counting equipment should be subject to routine checks to ensure proper operation. This is achieved by counting an instrument check cell (for scintillation cell-type CRs) before beginning each measurement. The count rate of the check source should be high enough to yield good counting statistics in a short time (for example, 1,000 to 10,000 counts per minute).

If a check source is unavailable or incompatible with the type of CR monitor used, an informal intercomparison with another measurement method that has proven reliability (for example, in the EPA National RMP Program) should be conducted at least every tenth measurement. In addition, it is important to regularly check all equipment components that affect the result, including battery and electronics, and to document these checks.

Pumps and flow meters should be checked routinely to ensure the accuracy of volume measurements. This may be performed using a dry-gas meter or other flow measurement device of traceable accuracy.

Appendix E: Test Kit Instructions / SOP (AccuStar Laboratory)

To ensure the most accurate results, please see the instructions below.

Step 1 – Prepare the House for Testing

The test must be performed under closed-house conditions to provide a valid test result. Maintain these conditions in the home for 12 hours before the test and during the exposure period:

- Keep all exterior doors closed except for normal entry and exit.
- Keep all windows closed.
- Leave radon mitigation systems operating.
- Set HVAC systems on "Auto" and set window units to recirculate. Dehumidifiers may be operated.
- Do not operate whole house exhaust fans.
- Do not operate wood or coal stoves (unless they are the primary heat source).

Unusual weather conditions affect test results. Do not perform the test during sustained high winds or heavy rain. Do not test when indoor air temperature is less than 50°F or greater than 90°F. Do not test when indoor humidity is less than 20% RH or greater than 90% RH. The results will be invalid.

Step 2 – Select the Test Area

- Perform the test in the lowest area of the home that could be used regularly, whether finished or unfinished.
- Choose an area that could be used as a bedroom, play area, family room, den, exercise room, or workshop, but not a kitchen or bathroom and any area with high humidity.
- Do not test in closets or crawl spaces.
- Find a location at least 3 feet from any door, wall, or window, 2 feet from the floor or ceiling, and 4 inches from other objects.
- Do not place test devices directly under blowing air.
- If this test is associated with purchasing or selling a home, the AARST-ANSI Time-Sensitive Testing Protocol recommends placing two devices, 4 inches apart, in the select test area.

Step 3 – Perform the Test

Do not open the devices until you are ready to test.

- Check devices for expiration dates. End your test before the device expires, or the results will be invalid.

- Remove the test devices from the box. Remove the lids for each test device. Save the box for returning the devices to the Lab.
- Short-Term Testing: Liquid Scintillation (LS-8088 AccuStar CLS-2)
    - Leave each device open for at least 48 hours. Do not touch or move devices during the test.
    - If you leave the device open for less than 48 hours or more than 96 hours, the results will be invalid. You will need to buy another test kit and repeat the test.
    - After 48 hours, securely replace the lid of each device. If using the metal charcoal canister, replace the original lid and wrap the tap provided around the closed canister where the base meets the lid. Do not cover device numbers with tape.
- Long-Term Testing: Alpha Track (AT-8205 REM AT-100)
    - Recommended for real estate transactions.
    - Leave each device open for at least 91 days but not more than a year (365 days). Closed-house conditions are not needed.
    - After 91 days, securely replace the lid of each device. If using the metal charcoal canister, replace the original lid and wrap the tap provided around the closed canister where the base meets the lid. Do not cover device numbers with tape.

Step 4 – Complete the Data Sheet

It is essential to complete the Radon Test Data Sheet fully.

To access a copy of your radon test report on the AccuStar website, you must record the zip code of the property tested on the radon test data sheet.

Note: If information is missing from the Data Sheet, if you do not send back the data sheet, or if you do not send back the data sheet with devices, you will receive a report stating that we cannot provide your test results. You may send any mission information to us in writing later (mail, email, or fax required), and we will issue an Amended Test Report.

Amended Test Reports take five business days.

A Same-Day Amended Test Report is an additional fee, payable by credit card.

Step 5 – Return Devices Immediately

- Return closed test devices and the completed Date Sheet to the box and send it to AccuStar immediately.
- AccuStar must receive the test devices within eight days after you complete the test.
- Your test results will be invalid if we receive test devices more than eight days after you complete the test.

Checklist for a Successful Test

- Did you follow all instructions and fill out the data sheet completely?
- Did you keep a record of your device number(s) and the property's zip code tested?
- Did you send your test kit with the completed data sheet to AccuStar Labs immediately after you finished the test?

Test Results 24 Hours a Day

Call the AccuStar Radon Test Results Line at 888-404-3144 to check whether we received your kit and for verbal test results.

You must have your device numbers to receive test results.

On the next business day after AccuStar receives the test kit, we will email or mail your radon test report to the person indicated on the datasheet.

Contact 888-480-8812 for questions; business hours are 8:30 a.m. to 5:00 p.m. Eastern Time, Monday – Friday.

Appendix F: Chain of Custody / Radon Test Data Sheet

AccuStar
Radon Test Data Sheet – Short-Term Test

AccuStar Labs
Tel: 888-480-8812
Fax: 508-533-8831
24 Hour Test Results: 888-404-3144
www.accustarlabs.com

Test Device Analysis:
UPS & FedEx:
2 Saber Way, Ward Hill, MA 01835
U.S. Postal Service
P.O. Box 3008, Haverhill, MA 01831-3018

For an electronic version of this form, go to www.accustarlabs.com, complete it, and submit it to our lab.

Send Written Report To:
(print clearly)

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

E-mail: _____

Property Tested (Required):
(print clearly)

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

County: _____

Technician Name: _____ Technician Certification #: _____

Required Device Information

□ Check here if there is an operating radon system in this house.

1st Device Serial #: _____
Location:
□ Basement □ First Floor □ Other Floor
□ Room _____ Location in Room: _____

2nd Device Serial #: _____
Location:
□ Basement □ First Floor □ Other Floor
□ Room _____ Location in Room: _____

□ Check if devices were placed side by side, 4 inches apart.

Exposure Period NOTE: Must be 48-96 hours

Beginning Date: _____/_____/_____

Time: _____ AM/PM (please circle)

Ending Date: _____/_____/_____

Time: _____ AM/PM (please circle)

Notes:

_____

_____

_____

_____

_____

Required Device Information

Were foundation vests or any other permanent vents open? □ Yes □ No

Were test devices placed and retrieved by the same person? □ Yes □ No

Test Purpose? □ Initial Test □ Follow Up □ Post Mitigation □ Real Estate

Structure Type: □ Basement □ Crawl Space □ Slab on Grade

□ Other: _____ (please specify)

Indoor Conditions (NOTE: Extreme conditions will invalidate the test)

Were closed-house conditions maintained? □ Yes □ No

Temperature: □ Normal Actual _____

Humidity: □ Normal □ Actual _____

Outdoor Conditions

Precipitation Present: □ Yes □ No If Yes, Severe? □ Yes □ No

Wind Present: □ Yes □ No If Yes, Severe? □ Yes □ No

Return this section with the test device(s) to the laboratory.

Appendix G: SOP RadonEye Pro (Device, App, and Web Dashboard)

This SOP's objective is to explain the RadonEye Pro device menu options, the mobile app menu options, and the web dashboard menu options and functions. It will also explain how to create an account, use the navigation menu, connect to the device, start and stop tests, view the device status, generate a report PDF, and use the Wi-Fi option for remote monitoring.

Device Information (NRPP & NRSB Approved CRM)

NRPP:

- FTLab/Ecosense RadonEye Pro RD200P
- Device Code: CR-8306
- https://nrpp.info/devices/approved-devices/

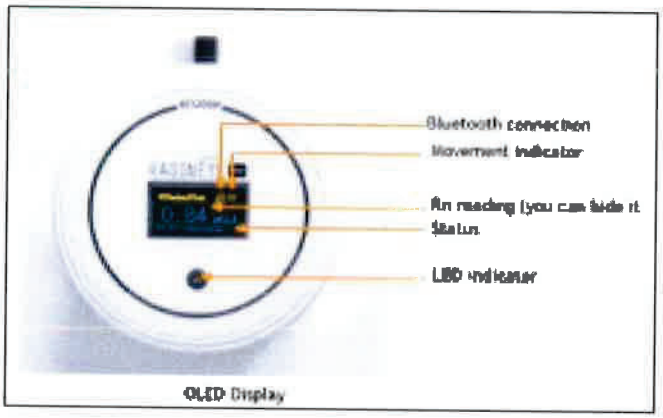
NRSB:

- Ecosense RadonEye Pro
- Device Code: 31827
- https://nrsb.og/wp-content/uploads/2019/04/NRSB-Approved-Devices.pdf

Getting Started

Plug it in. It will flash green and red and then start to initialize. The OLED display will show the serial number and track the progress as it is set up.

- When the unit is ready to start a test, it will read: READY



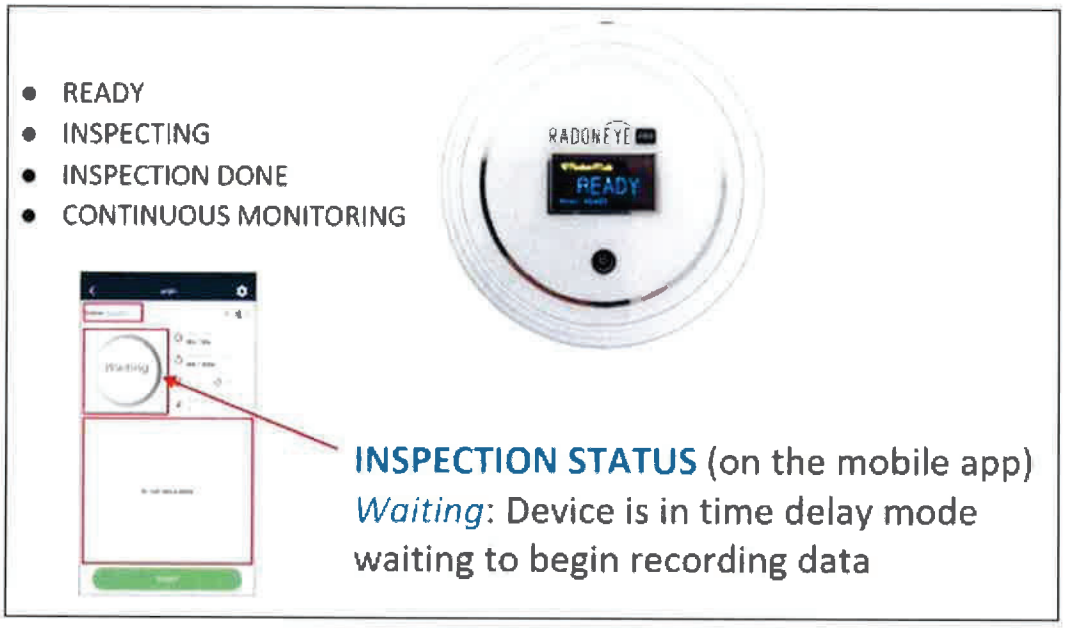
Download the RadonEye Pro app:

- iOS (Apple App Store)
- Android (Google Play Store)
- CAUTION: Do not download the app for:
    - ~~RadonEye~~
    - ~~RadonEye Plus or RadonEye2~~

Device Status

- Ready
- Inspecting

- Inspection Done
- Continuous Monitoring



Continuous Monitoring with Wi-Fi

- If Wi-Fi is on, data is automatically uploaded to the server. If Wi-Fi is off, data can be manually uploaded to the server after the continuous monitoring operation is complete.
- Data will be stored on the device for 300 days.

RadonEye Pro Specifications

Detector Type : Pulsed Ion Chamber

Data logging interval : 1h (with 10-min updates)

Sensitivity : 0.5cpm/pCi/L (30cph/pCi/L)

Minimum Detectable Concentration (MDC): 0.2 pCi/L

Operating Range : 34~104°F (1~40°C), RH < 80% (No condensation)

Range : 0.2 ~ 255pCi/L (7~9,435Bq/m³)

Reproducibility : < ±10% at 10pCi/L (after 1 hour)

Accuracy : < ±10% at 10pCi/L (min. error < ±0.5pCi/L)

Temperature Sensor: 0-122 degrees F

Relative Humidity Sensor:10-90% non-condensing

Movement sensor

Weight : 8.82(oz) / 250g

Data communication: Wi-Fi (internet), Bluetooth LE (Android/iOS)

Data storage capacity:

Inspection mode: Max 240h

Continuous mode: 300 days (7,200 data points)

Display : 0.96-inch OLED

Mobile App Overview

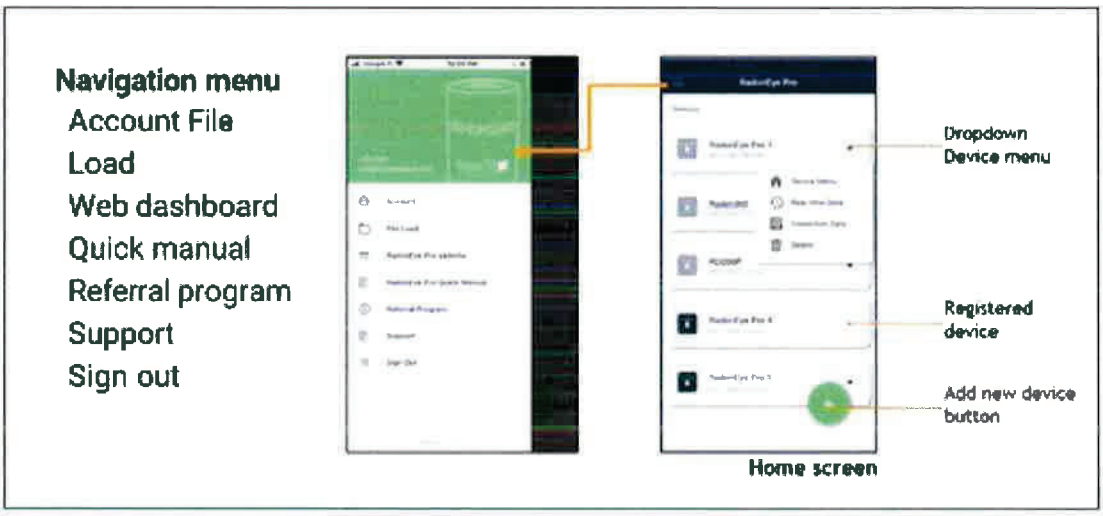
Create Your Account

1. Create an account from the app or web dashboard.
2. Select the admin or employee account.
3. Once your email address is entered, you cannot change it to another email.
4. Verify your account (activate your account using the link in this email).
    - If you do not receive the confirmation message within a few minutes of signing up, check your spam folder.

Forgot Password

Enter your email and receive a link to reset your password.

RadonEye Pro Mobile App – Home and Navigation Menu



Home – Device List

Grayed icon: The device is in either the "READY" or "WAITING" status.

Active icon: The device is in "Inspecting" (testing) status. It is either performing a test or continuously monitoring via Wi-Fi.

- Add a new device by clicking the + button.

Home – Account Information

Account information is automatically populated into the report.

- First and Last Name
- Certification or State-License Number
- Phone Number
- Address

Radon Inspection (Test) Data in Device, App, and Web

The device must be within Bluetooth range to view the test data stored on the device.

1. View Results (up to 10 radon inspection data stored)

   Device Menu > View Result.

2. Continuously Monitoring – the same data is uploaded to the Cloud if Wi-Fi mode is on

   Device Menu > Continuous Monitoring

If the user deletes the app, saved data will be deleted.

1. Navigation > File Load > Report

   (PDF format stored in App)

2. Navigation > File Load > Data

   (Text format test raw data stored in the App)

3. Device List > Test Data

   Test data is stored in the cloud when the inspection is finished.

The network must be stable to upload inspection data to the server. If the upload fails, try again when the network is stable.

1. Web > Data > Inspection Data

   (When finishing the inspection, data is uploaded to the cloud)

2. Web > Data > Continuous Monitoring

   (During continuous monitoring, data is uploaded to the cloud)

3. Web > Radon Report

   (PDF format report uploaded to the cloud)

Home – File Load

File Load shows data stored only in the app. If the app is removed, the data will not be accessible.

Report

- PDF format radon report generated from "View Results"
- PDF can be exported

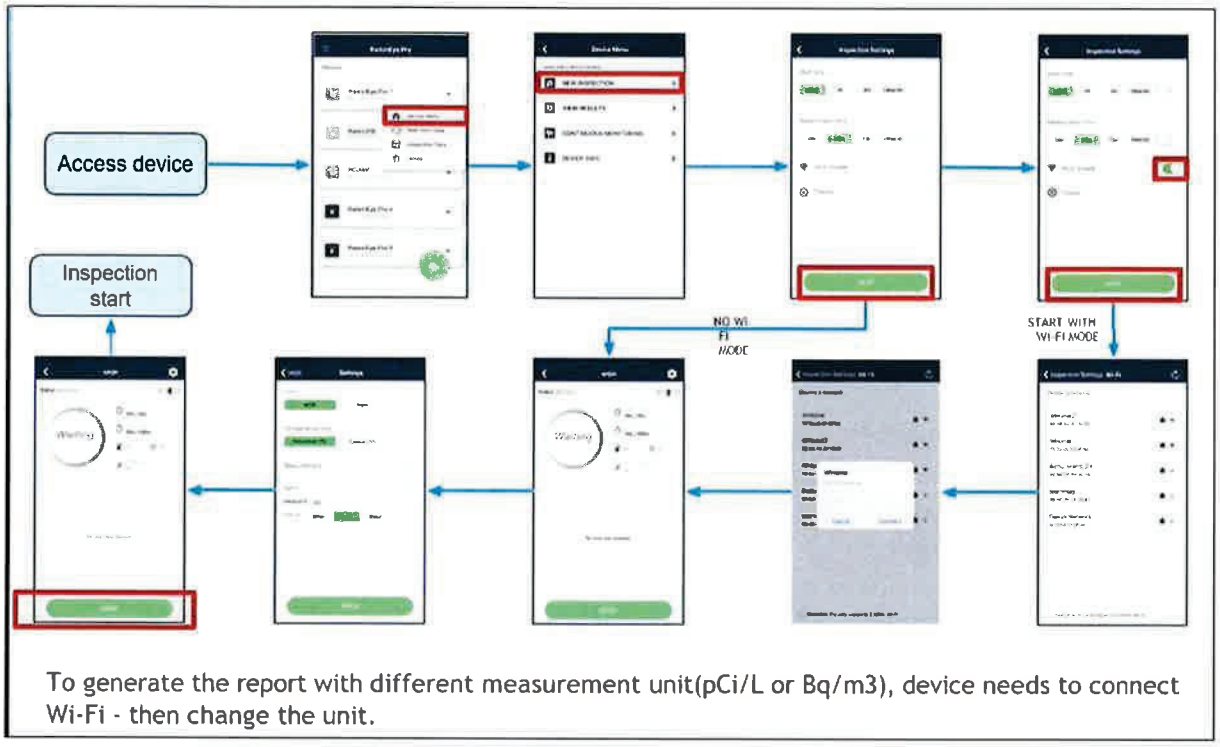
Data

- Stored test data can be accessed from "View Results" only.
- A text file is a comma-separated values (CSV) format that can be opened with MC Excel, Apple Numbers, Google Spreadsheets, or any text editor.
- Text files can be exported.

Home – Radon Inspection Data

- When you click the down arrow for a particular device, you can select "Inspection Data."
    - "Inspection Data" displays the test data in the app and is stored there after the test is terminated.
    - No limit to the number of test data stored in the app.
- No Need to connect to the device for data on the app.
- This data is also uploaded to the Cloud, accessible via Dashboard.
- "View Result" shows the test data stored in the device's memory.
    - A maximum of 10 test data sets can be stored on the device.

Radon Inspections (Test) with App



Radon Inspection Settings

Measurement Time

Set measurement time 24hrs, 48 hrs, 72 hrs, or other (max 240 hours).

Wi-Fi Enable

Connect the device to a Wi-Fi network, which can be monitored remotely.

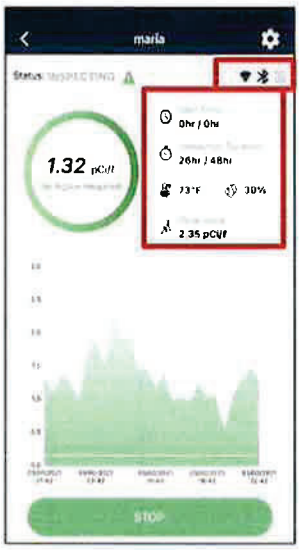
Display

If the switch is disabled, the measured radon value will not be displayed on the device when the inspection is in progress.

Select "Inspecting" from the Device Menu to view the monitor's inspection status.

Inspection icons

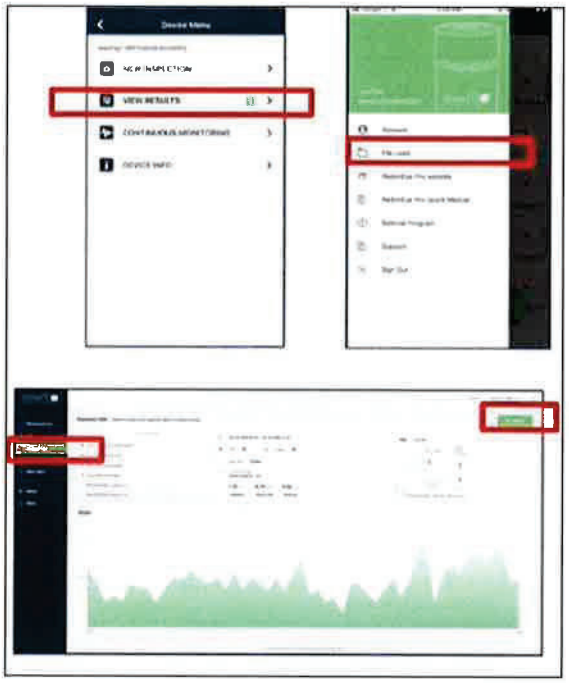
- Wi-Fi connection
- Bluetooth connection
- TILT: Detect movement of the device
- Temperature
- Humidity
- Wait Time: Delay time before starting the test (max 24 hours)
- Inspection Duration: Test Deployment period max 240 hours)
- Peak Value: Highest Radon level



Finish the Radon Inspection

- Once the inspection run is completed, the inspection results are available by clicking the "CONFIRM" button, and you must have a Bluetooth connection to the monitor at that time. This operation cannot be accomplished by only using Wi-Fi.
- Inspection data can be stored in up to 10 files; when you reach 10, delete the files and start a new inspection. (Inspection data will be saved in the File Load and web dashboard)

Inspection Date and Generated Report



Inspection data can be saved in several locations when you finish the inspection.

1. **Inspection data saved in the device**
   a) View Result: The device storage can store up to 10 files. When you reach ten files, delete them and start a new inspection.
2. **Inspection data saved in the app**
   a) File Load: Raw data as a text file
   b) File Load: Report as a pdf file
   c) Inspection Data: Saved inspection data
3. **Inspection data saved in the Web dashboard**
   a) Inspection Data: A report can be generated with data
   b) Radon Report: Generated reports uploaded to the server

Note: Radon inspection data will not be uploaded to the server if an internet connection is unavailable.

Save Inspection Data

RadonEye Pro Radon Report

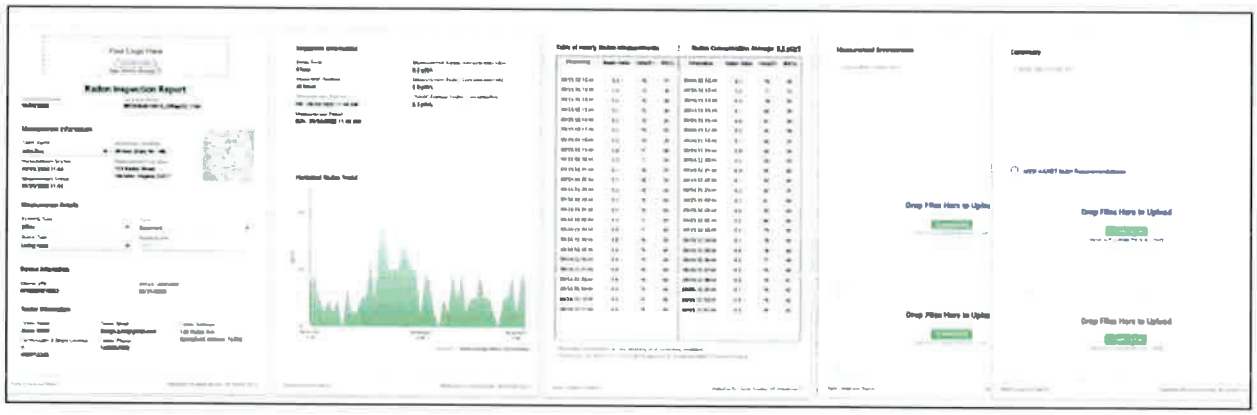
RadonEye Pro Reporting Compliance Update

- In 2022, Ecosense updated the RadonEye Pro mobile app and web dashboard, enabling users to generate test reports that comply with the ANSI/AARST standards and State requirements.
- The updated data collection and report software are available to all RadonEye Pro users.

Select the Type of Radon Report

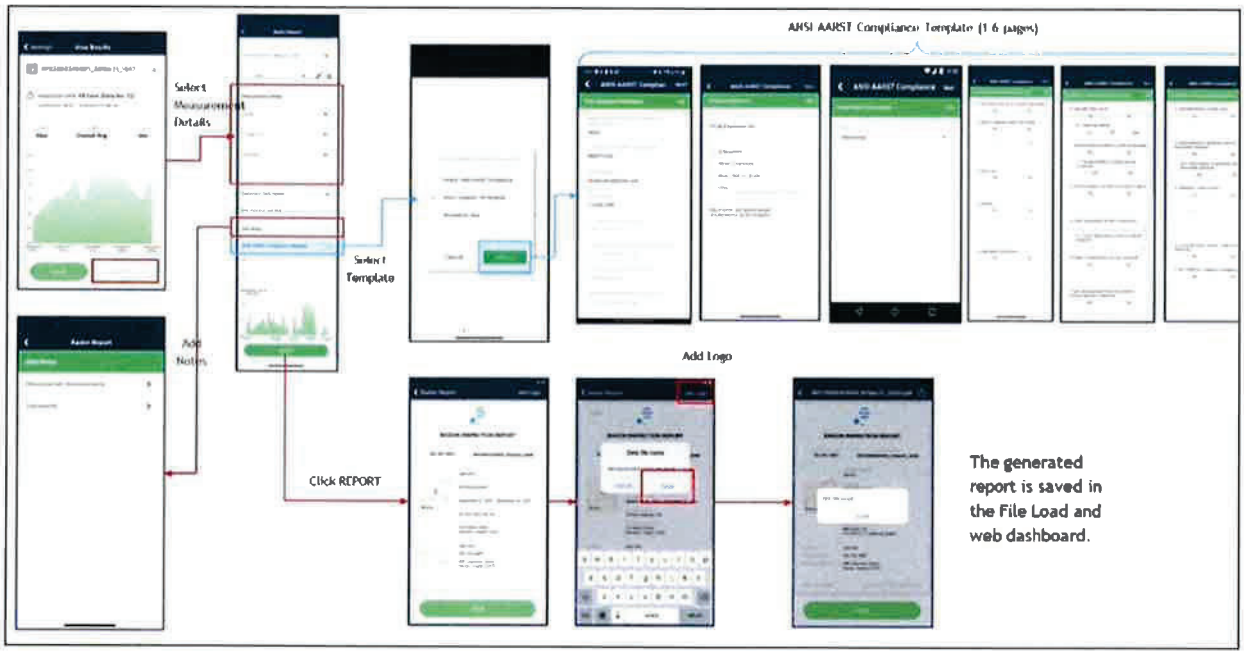
- Standard (basic) radon report – general radon report
- ANSI-AARST Compliance Template
    - Default template
    - Pre-configure a customized template in the admin dashboard

Standard Radon Report



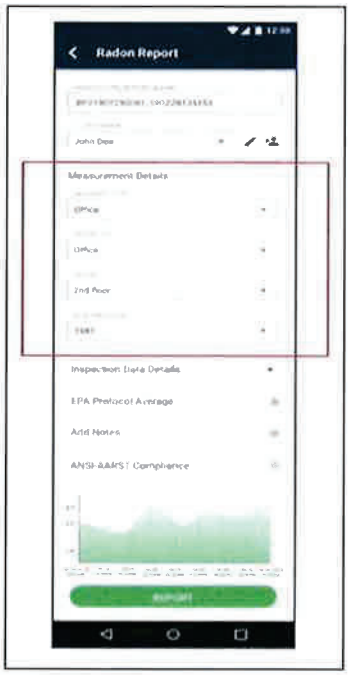
- Measurement Information
- Measurement Details
- Device Information
- Tester Information (Pre-auto fill from account info)
- Inspection Information
- Historical Radon Trend
- Table of Hourly Radon Measurements
- Measurement Environments (Text and two images)
- Comments (Text and two images)
- ANSI-AARST MAH Recommendations

Generate the Report (ANSI-AARST Compliance)



Add Measurement Details

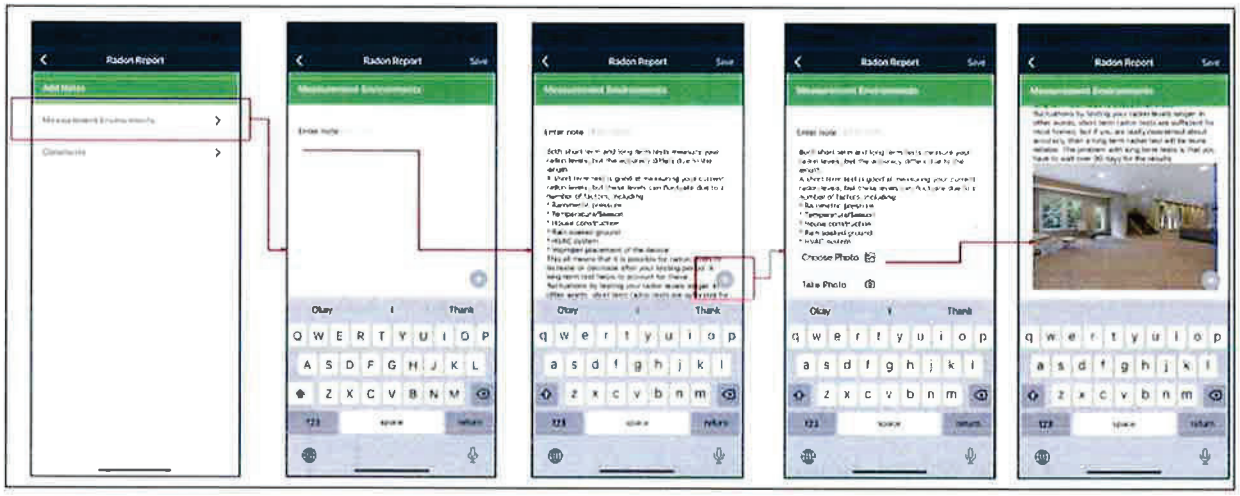
- **Building type (dropdown)**
  - Office, School, House, or Other (type)
- **Room Type (dropdown)**
  - Office, Bedroom, Kitchen, Basement, or Other (type)
- **Floor (dropdown)**
  - Basement 1st floor, 2nd floor, 3rd floor or above
- **Building year (type – years)**



Add Notes

- Two pages are available: Comments and Measurement Environment
- Add text up to 1,000 characters
- Can be added up to two images in Comments and two images in the Measurement Environment section
- Photos can be added from the camera library or take a photo
- Content added by admins is shared with users
- Can select pre-configured ANSI-AARST MAH Recommendations

Add Notes > Measurement Environments.



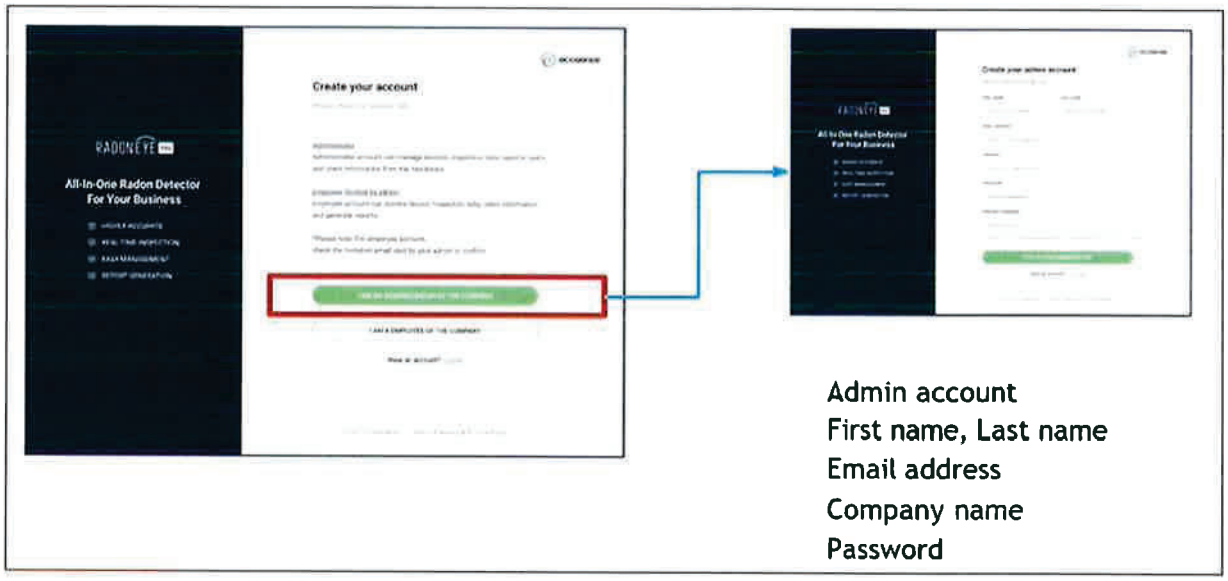
Web Dashboard Overview

http://radoneyepro.com

Role-Based Control – Admin vs. Employee

- **Admin**
  - Register and manage devices (register, edit, delete)
  - Invite and manage employees (invite, delete)
  - Manage device access for employees
  - Manage company information (i.e., company name and logo will be available to all employees when generating radon report)
  - Create ANSI-AARST Compliance Pre-Configured template
- **Employee**
  - Cannot register and manage devices
  - Cannot invite access to other employees
  - Can start and finish radon inspections with the devices allowed by admin
  - Can access test data
  - Can manage client information from the mobile app
  - Can manage radon reports from the mobile app
  - Can access exported raw data files from the app
  - Can add or overwrite company logo image when generating radon report
- **Sharing**
  - Devices are shared with all employees (by default); can update the employee access per device
  - Inspection data is shared with employees when they have access to the device

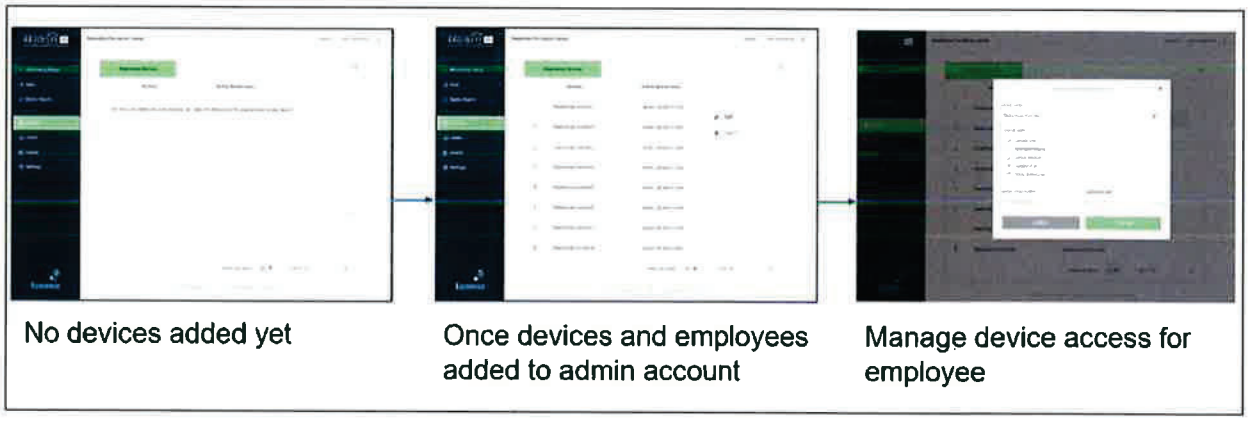
Admin / Create an Account



Admin / Add Employees

- Admin can send up to 10 invitation emails at once.
- Admin can check the status of the invitation:
  - Pending/Active
- Admin can delete users

Admin / Register Devices



Admin & Employee / Inspection Data

- Radon inspection data will be saved to the app and the web dashboard

- Employee finishes the radon inspection & data will be shared with admin and other employees
- All inspection data will be shared with the employee who added to the device
- Employees can only see the list of devices they are given access to
- Both the admin and employees can generate the report PDF from the radon inspection data

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Admin / Create Template for Pre-Configured ANSI-AARST Compliant Report

- Only the admin can create a template
- Registered users can use pre-configured template
- Admin can delete or edit template

Pre-Configure a Customized ANSI-AARST Compliant Report Template (Admin Only)

- Test-Company Information
- Test-Placement Field Technician (Optional)
- Test-Retrieval Field Technician (Optional)
- Comments (Optional) – Add text up to 1,000 characters and upload up to 2 files

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Monitoring Status

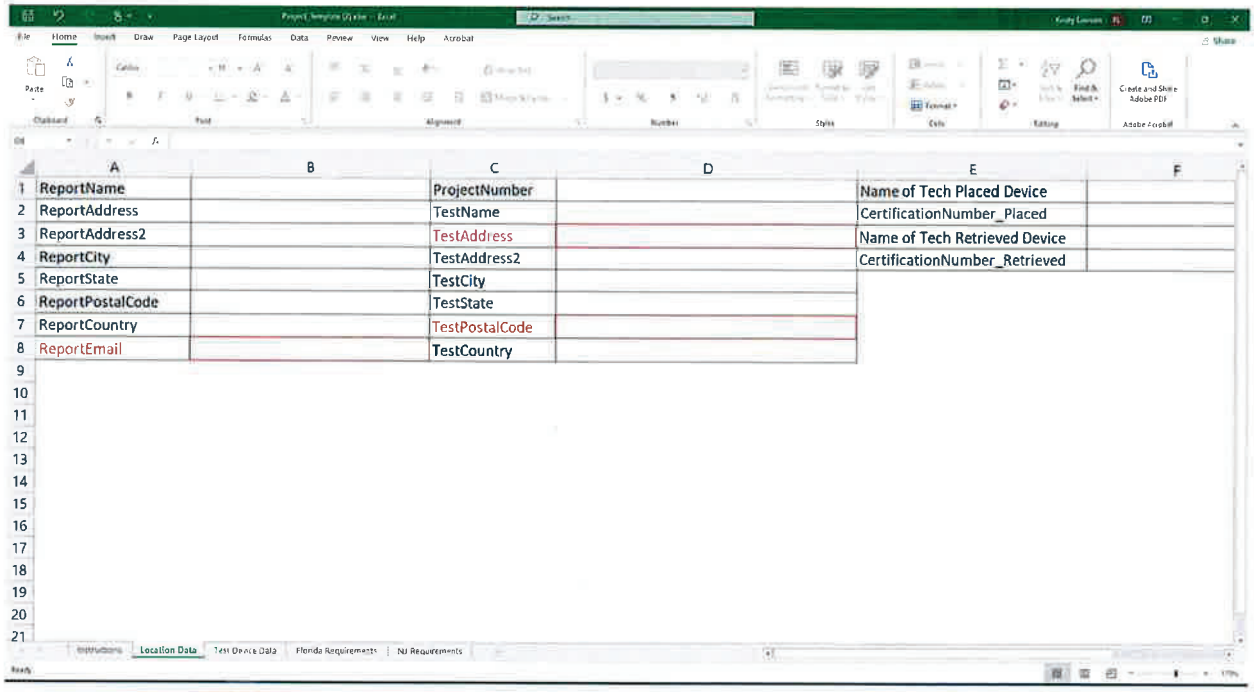
- **Device name:** (serial number of the device)
- **Radon readings:** It shows radon readings when connected to Wi-Fi.
- **Last updated:** If the device is not connected to Wi-Fi, its status is not real-time. It shows its status when the inspection starts.
- **Status:** Ready, Run, Continuous Monitoring

- **Location:** GPS is not in the device; location is not accurate.
    - Status: status of the device
    - User: Who started the inspection of the device

Appendix H: SOP For Entering Data Into Project Template

Step 1 – Location Data Tab

- Open the spreadsheet and go to the "Location Data" tab at the bottom.
- Fill in all the required fields highlighted in **RED**. These fields must be submitted as they are necessary for accurate calculations and cannot be left blank.
- In Column B, enter the report name, address, city, state, and zip code.
- In Column d, enter the test name, test address, test city, test state, and test zip code.
- In Column F, enter the Technician's Name and Certification information for simple placement and retrieval.
- The report email field can contain up to 2 emails separated by a semi-colon(;). For example, abc@def.com; 123@456.com.

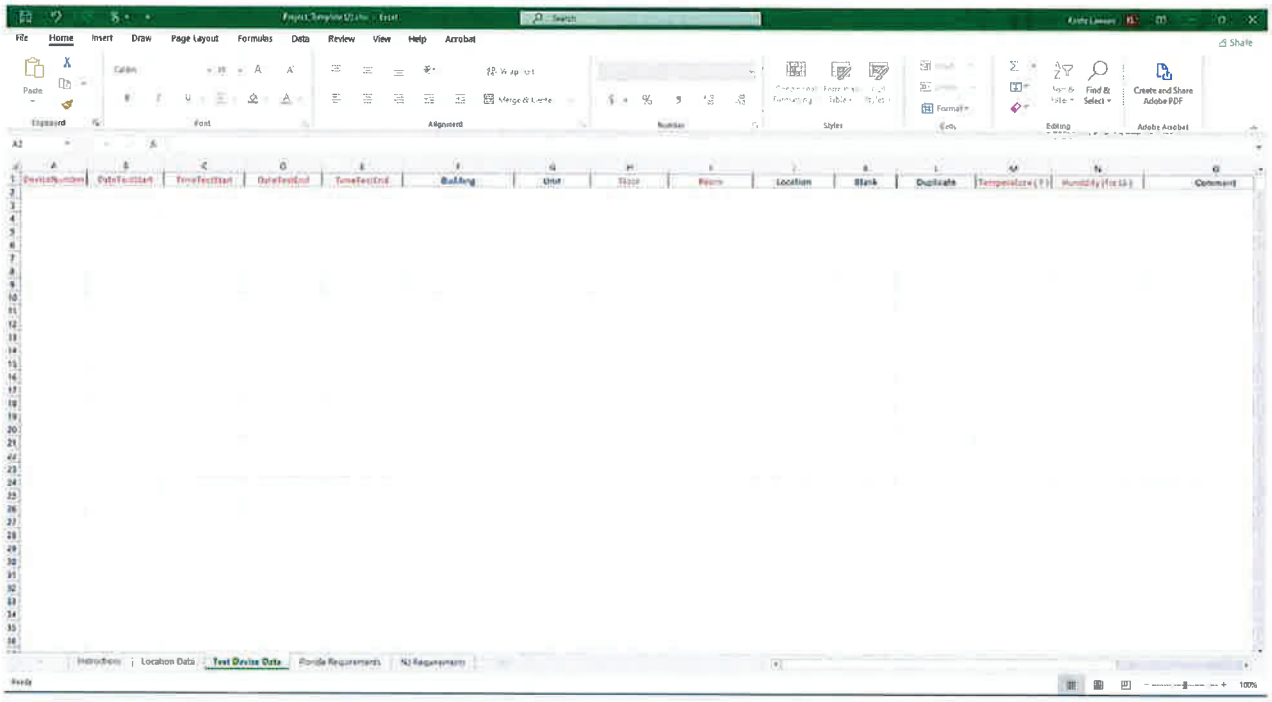


	A	B	C	D	E	F
1	ReportName		ProjectNumber		Name of Tech Placed Device	
2	ReportAddress		TestName		CertificationNumber_Placed	
3	ReportAddress2		TestAddress		Name of Tech Retrieved Device	
4	ReportCity		TestAddress2		CertificationNumber_Retrieved	
5	ReportState		TestCity			
6	ReportPostalCode		TestState			
7	ReportCountry		TestPostalCode			
8	ReportEmail		TestCountry			
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

Step 2: Test Device Tab

- Click on the tab next to "Location Data Tab" labeled "Test Device".
- Before entering data, ensure that you start typing in cell A2.
- Fill in all the required fields highlighted in **RED** and the other fields.
- Pay attention to the exact format required for specific fields:
    - Date Format: Enter dates in mm/dd/yyyy (e.g., 06/14/2023).

- Time Format: Enter times in the format hh: mm using the 24-hour notation (e.g., 14:36 or 07:23).
- Building Format: Enter only the building name or number in each row.
- Unit Format: Enter only the unit's name or number in each row.
- Floor Level: Enter the floor name or number in each row. For example, entering "First" will show as "First Floor" on the report, while entering "1" will show as "Floor 1" on the report.



Step 3: Quality Control (Duplicates and Blacks) Fields

- Duplicate Field: Enter "Yes" or "Y" if the sample is a QC Duplicate. The sample dates, times, and placement information must match for duplicate samples.
- Blank Field: Enter "Yes" or "Y" if the sample is a QC Black. The sample dates and times are also required for blanks.

Step 4: Indoor Temperature and Indoor Humidity

- We recommend calibrating temperature and humidity measurement devices, as this information will be used to calculate the radon result.
- Indoor Temperature: Required for charcoal canisters and LS devices.
- Indoor Humidity: Required for LS devices only.

Step 5: Submitting the Spreadsheet to the Laboratory

- Double-check that all fields, especially the ones highlighted in RED, are filled.
- Save the spreadsheet on your computer with a new file name. It is recommended that you use the project name or test address.

If you have an online account with AccuStar Labs:

- Log in to your account on the AccuStar Labs website and navigate to the professional login section.
- Enter your username and password.
- Drag and drop your file into the "Upload Project" section at the bottom of the page.
- Do not close the browser or navigate away from the page until the file is fully uploaded.
- Mail in your devices after completing the upload.

If you have an established online account with AccuStar Labs:

- Email your spreadsheet to datadelivery@accustarlabs.com
- Mail your devices to the lab.

For any questions or further instructions, contact AccuStar Labs at 888-480-8812 or visit www.accustarlabs.com

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