

**Residential Radon Sampling Plan  
For Residential Properties in the  
Vicinity of the North Alcoa Site  
East St. Louis, IL**

**Prepared by:**



**November 22, 2016**

**4621 S. Cooper St. # 131-332  
Arlington, TX 76017  
+1 877-433-2029**

## **Introduction**

Subsurface bauxite residue has been identified on or in the vicinity of several properties along the south side of Louisiana Boulevard adjoining the North Alcoa Site in East St. Louis, IL. The outer limit of bauxite residue extends beyond the OU-1 boundary, but as determined from previous off-site borings, it does not extend as far north as Louisiana Boulevard (Figure 1).

This residential radon sampling plan is designed to measure the radon concentrations in homes along Louisiana Boulevard and determine whether there are radon concentrations attributable to the bauxite residue present on or near the properties.

## **Background**

Radon is naturally present in widely varying concentrations throughout the State of Illinois. Therefore, detection of radon in any particular residence in the Illinois is not unusual. The bauxite residue at the North Alcoa Site contains concentrations of radium-226 and radium-228 that are above background concentrations. These radium isotopes decay to form radon-222 and radon-220 (after intermediate decays) which can diffuse out of the ground. Due to its short half-life (55 seconds) radon-220 is not a significant contributor to indoor radon concentrations. This work plan is designed to:

1. Determine the residential radon concentrations in the homes along Louisiana Blvd adjacent to the North Alcoa Site.
2. Determine whether the measured residential radon concentrations are impacted by the North Alcoa Site, i.e. are greater than background.

The US EPA has a recommended maximum indoor air concentration for radon of 4 picocuries (pCi)/L.

The North Alcoa Site is within zip code 62205. Based on publically available information, no radon measurements have been collected and reported to the State of Illinois within this zip code or within 62203 or 62204. Zip code 62207 to the south has only a single measurement of 1.0 pCi/L. Zip code 62223 to the west has had 139 measurements collected with an average of 3.7 pCi/L and 35% of the measurements were in excess of 4 pCi/L. Zip code 62208 is similar with 228 measurements also with an average of 3.7 pCi/L and 34% of the measurements above 4 pCi/L.<sup>1</sup>

## **Field Sampling Plan**

Radon sampling of the selected houses (where access agreements are in place and the owners have agreed to allow the testing to occur) will be performed in accordance with the requirements

---

<sup>1</sup> <http://tornado.iema.state.il.us/RADON31a/PGS/county.cfm?fips=17163>

of Illinois Title 32 Part 22 Regulations for Radon Service Providers. A State of Illinois licensed radon measurement professional will perform the measurements using a continuous radon monitor. This instrument provides hourly measurements of the radon concentration. Measurements will be taken for a minimum of 48 hours.

Illinois regulations require that the radon sampling be conducted in each of the lowest structural areas suitable for occupancy. In addition to this requirement, radon sampling shall be conducted on the most-commonly occupied level of the house, i.e. the floor containing the living room, den, and/or master bedroom even if this level is not on the lowest structural level. Houses with a single level and a single foundation type may be sampled in only one location while houses with a basement or multiple foundation types will be sampled in two locations.

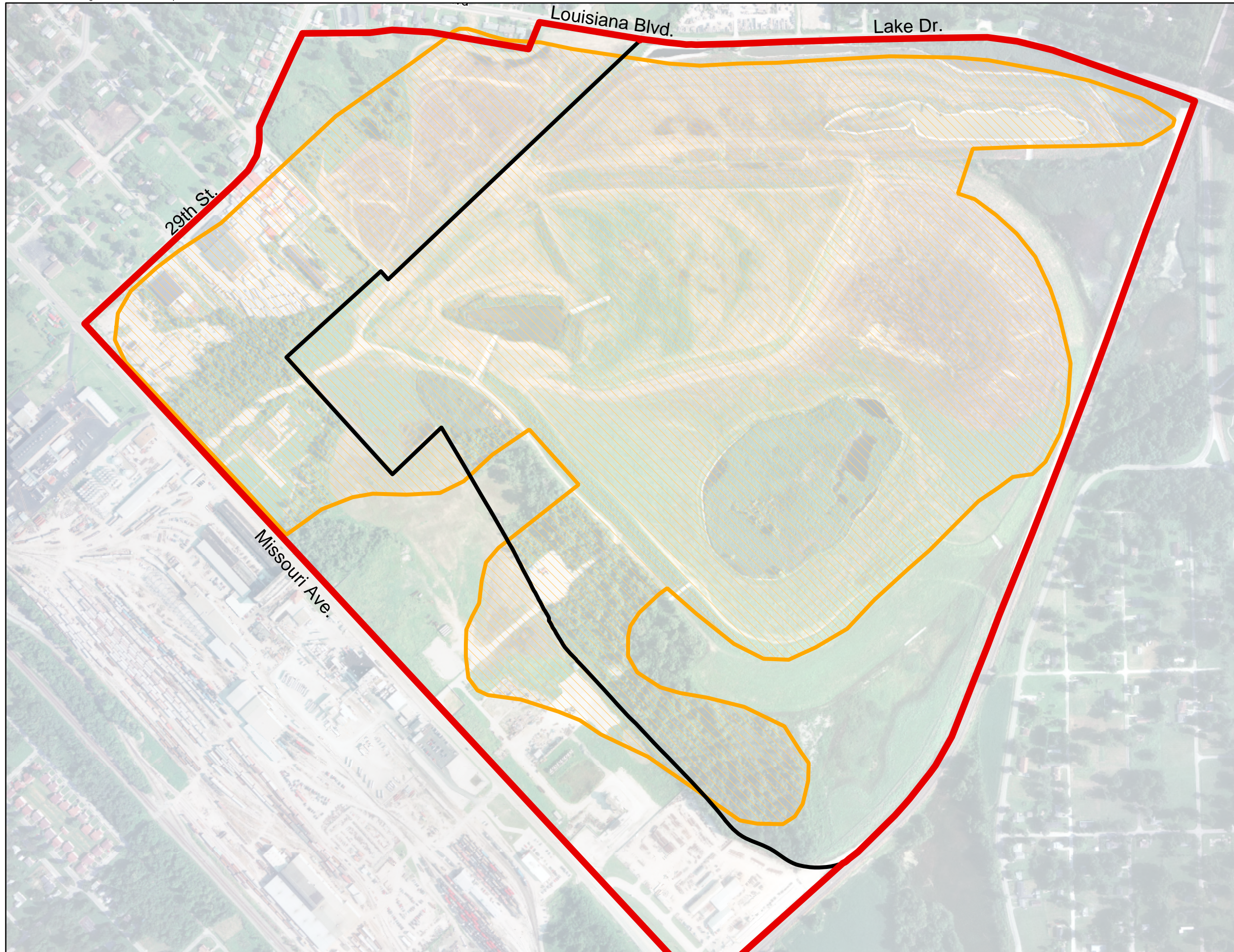
### **Quality Assurance**

A Quality Assurance Project Plan, attached as Appendix A, will be used to ensure the integrity of the data.




### **Data Analysis**

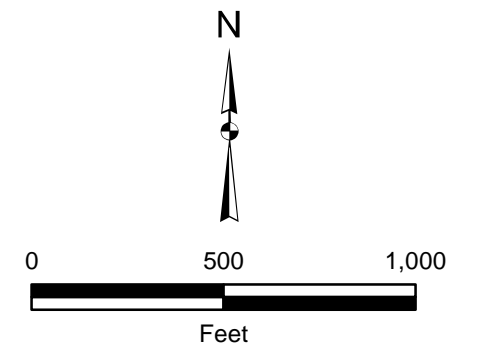
The collected residential data will be compared to the available background data from zip codes 62208 and 62223. If available, detailed background data will be used to do a statistical comparison.

A summary report will be prepared for each property.



**Explanation**

-  Operable Unit Boundary
-  Site Boundary
-  Approximate Limit of Subsurface Bauxite Residue



**NORTH ALCOA SITE**  
EAST ST. LOUIS, IL

FIGURE 1  
**APPROXIMATE EXTENT  
OF SUBSURFACE  
BAUXITE RESIDUE MAP**

PROJECT: 114-021803	DATE: 11/22/2016
REV: 00	BY: AAM   CHECKED: CML

**TETRA TECH**  
*complex world, clear solutions*

## **Appendix A**

### **Quality Assurance Project Plan**



## QUALITY ASSURANCE PROJECT PLAN

Residential Radon Monitoring  
Vicinity of North Alcoa Site  
East St. Louis, IL

Prepared by:  
AmeriChoice Radon Testing, Inc.  
2105 Eastland Drive, Suite 10  
Bloomington, IL 61704

### **Scope of Work:**

School Screenings

All relevant aspects of radon activities conducted AmeriChoice Radon Testing, Inc. are described in written standardized procedures. Standard Operating Procedures (SOP) are developed in accordance with Illinois Statutes Title 32 Illinois Administrative Code subpart b, Section 422 and USEPA 402-R-92-014, 1993, Revised Edition, with reference to updated best practices in ANSI-AARST MAH 2014. These SOPs stipulate necessary procedures, the development process, procedure format, procedure initiation, and how staff is trained in approved procedures use.

**TABLE OF CONTENTS**

*Signature Page* ..... *i*  
*Acronyms* ..... *ii*  
*Distribution List* ..... *iii*  
*Glossary of Terms*..... *iv-xiii*

1. PROJECT MANAGEMENT

    A) Organizational Chart ..... 1  
    B) Problem definition/background ..... 2  
    C) Project Description ..... 2  
    D) Quality Objectives and Criteria for Radon Screenings ..... 4  
    E) Data Quality Indicators ..... 5  
    F) Training and Certification ..... 5  
    G) Documentation, Record Keeping, and Reporting ..... 6

2. DATA GENERATION/ACQUISITION ..... 6

    A) Measurement Process Design ..... 7  
    B) Measurement Methods ..... 7  
    C) Sample Handling and Custody ..... 9  
    D) Analytical Methods ..... 9  
    E) Quality Control Methods ..... 9  
    F) Instrument/Equipment Testing, Inspection, Maintenance, and Calibration ..... 9  
    G) Data Management, Documents, and Record Keeping ..... 10

3. ASSESSMENT AND OVERSIGHT ..... 11

4. DATA VALIDATION AND USABILITY ..... 12

5. PROCEDURES FOR RESPONDING TO COMPLAINTS ..... 13

6. PROCEDURES FOR CORRECTIVE ACTIONS ..... 13

**Signature Page**

**QUALITY ASSURANCE PROJECT PLAN**

Residential Radon Monitoring  
Vicinity of North Alcoa Site  
East St. Louis, IL

Prepared by:  
AmeriChoice Radon Testing, Inc.  
2105 Eastland Drive, Suite 10  
Bloomington, IL 61704

**Document approved by:**

\_\_\_\_\_ Date: \_\_\_\_\_  
Christian Lull  
Tetra Tech

\_\_\_\_\_ Date: \_\_\_\_\_  
Riley J. Carey, Project Manager  
AmeriChoice Radon Testing, Inc.

\_\_\_\_\_ Date: \_\_\_\_\_  
Lin Marie Carey, Quality Assurance Officer  
AmeriChoice Radon Testing, Inc.

\_\_\_\_\_ Date: \_\_\_\_\_

EPA



	<b>ACRONYM</b>	Health
a or $\alpha$ - alpha radiation		NIST-National Institute for Standards and Technology
AC - Activated Carbon		NRC - Nuclear Regulatory Commission
ACH - Air changes per hour		NRPP – National Radon Proficiency Program
ACM - Asbestos containing material		NRSB – National Radon Safety Board
ALARA-As Low as Reasonably Achievable		OSHA - Occupational Safety and Health Administration
AQA-Air Quality Administrator		Pa - Pascal
ASD - Active soil depressurization		pCi - picoCurie
ATD - Alpha Track Detector		pCi/L - picoCuries per liter
b or $\beta$ - beta radiation		PFE - Pressure field extension
BEIR - Biological Effects of Ionizing Radiation		PVC - Polyvinyl chloride
BTU - British thermal unit		QA - Quality Assurance
cfm - Cubic feet per minute		QAP - Quality Assurance Program
Ci - Curie		QAPP-Quality Assurance Project Plan
COC-Chain of Custody		QC - Quality Control
COV - Coefficient of Variation		Ra - Radium
CRM - Continuous Radon Monitor		RDP - Radon Decay Product
CWLM - Continuous working level monitor		RH-Relative Humidity
DEQ – Montana Dept. of Environmental Quality		Rn - Radon
dpm - Decays per minute		SMD - Sub membrane depressurization
DQO-Data Quality Objectives		SOP-Standard Operating Procedure
DTD - Drain tile depressurization		SSD - Sub slab depressurization
EIC - Electret Ion Chamber		U 238 - Uranium 238
ELA - Effective Leakage Area		UMTRA - Uranium Mill Tailings Recovery Act
EPA - Environmental Protection Agency		USGS-United States Geological Survey
EPA-Environmental Protection Agency		VOC - Volatile Organic Compound
ER - Equilibrium ratio		WC - Water column
ES-Environmental Specialist		WL - Working level
FAU - Forced Air Unit, such as a forced air furnace		WLM - Working Level Month
g or $\gamma$ - gamma radiation		
GAC - Granular Activated Carbon		
GFI - Ground Fault Interrupter		
GPS-Global Positioning System		
HRV - Heat Recovery Ventilator		
in - inches		
L - Liter		
LLD - Lower Limit of Detection		
MAC-Montana Administrative Code		
MCL - Maximum Contaminant Level		
MQO-Measurement Quality Objective		
MSDS - Material safety data sheets		
NIOSH - National Institute of Occupational Safety and		

## DISTRIBUTION LIST

Paper copies of this QAPP are distributed to the administrators in this Distribution List. Revised sections or the entire QAPP are sent to these people. Additionally, this QAPP will be distributed to contractors analyzing data for this program. Upon approval by EPA, this QAPP will also be distributed to the following entities:

**Riley J. Carey**

Project Manager  
AmeriChoice Radon Testing, Inc.  
309.533.3079  
riley@americhoiceradon.com

**Lin Marie Carey**

Quality Assurance Officer  
Certified Environmental Safety Compliance Officer  
AmeriChoice Radon Testing, Inc.  
309.530.6185  
lin@americhoiceradon.com

**Christian Llull**

Project Geologist  
Tetra Tech  
512.338.2861  
christian.llull@tetrattech.com

## GLOSSARY OF TERMS

**Absorbed Dose** - The energy deposited by ionizing radiation per unit mass of material. Units of absorbed dose are the gray [GY] and the rad.

**Accuracy** – The correlation between the measured value and the original target or “true” value.

**Activated Carbon** - A material manufactured from the combustion of fibrous materials such as coconut shells or wood under low oxygen conditions. This process makes "sites" within the material upon which radon can be adsorbed. This material is used in activated carbon measurement devices and in activated carbon adsorption units for removing radon from water.

**Active radon/radon decay product measurement device** - A radon test or radon decay product measurement system which uses a sampling device, detector, and measurement system integrated as a complete unit or as separate, but portable, components. Active devices include continuous radon monitors, continuous working level monitors, and grab radon gas and grab working level measurement systems, but does not include devices such as electret ion chamber devices, activated carbon or other adsorbent systems, or alpha track devices.

**Active Soil Depressurization [ASD]** — A family of radon mitigation systems involving mechanically-driven soil depressurization, including sub-slab depressurization [SSD], sump pit depressurization [SPD], drain tile depressurization [DTD], hollow block wall depressurization [BWD], and sub-membrane depressurization [SMD] (see Appendix X2).

**Activity** - Synonymous with RADIOACTIVITY

**Acute Effect** - An effect that becomes apparent after a discrete brief exposure, rather than being manifested only long after exposure.

**Addition** - An extension or increase in floor area or height of a building or structure.

**Adsorption** - The adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface, i.e., where radon molecules are retained on the surface of the charcoal in a charcoal canister.

**Air Changes per Hour [ACH]** - The number of times within 1 hour that the volume of air inside a house would nominally be replaced, given the rate at which outdoor air is infiltrating the house. If a house has 1 ACH, it means that all of the air in the house will be nominally replaced in a 1-hour period.

**Air Exchange Rate** - The rate at which the house air is replaced with outdoor air. Commonly expressed in terms of air changes per hour.

**Air Pressure Differentials** - Differences in air pressure that exist over short distances, e.g. ,Between the interior of a home and below slab or between inside and outside the building shell. Air moves from areas of higher pressure to lower pressure. Air flow caused by pressure differentials is a major force for radon entry into buildings.

**Alpha Decay** - The radioactive decay of an atom in which the nucleus loses two protons and two neutrons.

**Alpha Particle** - Two neutrons and two protons bound as a single particle that is emitted from the nucleus of certain radioactive isotopes in the process of decay.

**Alpha Track Detector** – A long-term detector for radon. It consists of a plastic material or celluloid film, in which alpha radiation leaves damage tracks that can be counted under a microscope after the plastic material is etched in naoh (sodium hydroxide) solution.

**Back-Drafting** - A condition where the normal movement of combustion products up a flue, resulting from the buoyant forces on the hot gases, is reversed, so that the combustion products can enter the house. Back-drafting of combustion appliances (such as fireplaces and furnaces) can occur when depressurization in the house overwhelms the buoyant force on the hot gases. Back-drafting can also be caused by high air pressures at the chimney or flue termination.

**Background Measurements** - Background measurements are made with instruments exposed to very low radon concentration environments (such as outdoor air), or can be "blanks", unexposed passive detectors. Background levels are subtracted from samples before calculating sample concentrations.

**Background Radiation** - Radiation arising from radioactive material other than that under consideration. Background radiation due to cosmic rays and natural radioactivity is always present; background radiation may also be due to the presence of radioactive substances in building materials.

**Balloon Frame** - A type of building frame in which the studs extend from sill to eaves without interruption or cross bracing.

**Baseboard** - The finishing board covering a wall where it meets the floor.

**Basement** - A type of foundation where the bottom livable level has a slab (or earthen floor) which averages 3 feet or more below grade on one or more side of the building.

**Becquerel [Bq]** - The International System of Units [SI] definition of Activity. 1 Bq = 1 disintegration per second.

**Bias** - The systematic difference between the average value of duplicate measurements true value.

**Blank sample** - A control sample in which the detector is unexposed and submitted for analysis. Often used to determine detector background values.

**Blind Spikes** - Detectors exposed to known values and submitted for analysis without being labeled as such. Used to evaluate the accuracy of a laboratory's analytical process.

**Blower Door** - A device consisting of an instrumented fan, which can be mounted in an existing doorway of a house. By determining the air flows through this fan required to achieve different degrees of house depressurization, the blower door permits determination of the tightness of the house shell, and an estimation of the natural filtration rate.

**Bronchial Epithelium** - The surface layer of cells lining the conducting airways of the respiratory system.

**Calibrate** - To determine the response or reading of an instrument relative to a series of known values over the range of the instrument; results are used to develop correction or calibration factors.

**Calibration** - The determination of deviation from standard of measurement instrument to determine necessary correction factors (calibration factor).

**Canal Drain** - A means for collecting water in a basement by means of a large gap or channel between the concrete floor and the wall. Collected water may flow to aggregate beneath the slot "French Drain" or to a sump where it can be pumped away.

**Chase** - An open area that runs horizontally or vertically through a structure to accommodate installation of pipes, duct, and electrical wire.

**Chronic Effect** - An effect that becomes apparent only sometime after exposure, as opposed to an acute effect, which develops with a one-time or short-term exposure.

**Circuit** - The path for an electric current.

**Closed Building Conditions** - During any short-term test, closed-house-conditions should be maintained as much as possible while the test is in progress. In tests of less than 4 days duration, closed-house-conditions should be maintained for at least 12-hours before starting the test and for the duration of the test. While closed-house-conditions are not required before the start of tests that are between 4 and 90-days, closed-house-conditions should be maintained as much as possible.

**Coefficient of Variation** - The standard deviation of a number of samples divided by the average value of those of samples. See **Relative Percent Difference**.

**Cold Air Return** - The registers and ducting which withdraw air from various parts of the house and direct it to a central forced-air furnace or heat pump. The return ducting is at low pressure relative to the house because the central furnace fan draws air out of the house through this ducting.

**Column** - A vertical member, generally a beam or post, that supports some of the weight of a building.

**Concentration Gradient Diffusion** - One of the methods by which radon moves through a material (soil) by diffusion from a higher concentration (source) to areas of lower concentration. The rate of diffusion is generally determined by the porosity of the soil.

**Concrete** - A masonry mixture of Portland cement, sand and aggregate, and water in proper proportions.

**Condensation** - Water formed by warm, moist air contacting a cooler surface.

**Controlled Calibrations** - A controlled calibration refers to measurements made in a known radon environment (calibration chamber). Generally, detectors that require laboratory analysis (e.g., charcoal canisters and alpha track detectors) are placed in a calibration chamber for a known period of time and then sent to a laboratory for analysis. The laboratory result may then be compared with the known chamber concentration value to check the accuracy of the laboratory, (a "blind calibration"), or used to derive or verify the conversion factors for the detectors (a "spiked sample"). Real-time radon and RDP measuring instruments must be operated in a chamber on a regular basis to calculate the calibration factor.

**Convective Movement** - As used here, the bulk flow of radon-containing soil gas into the house as the result of pressure differences between the house and the soil. Distinguished from diffusive movement.

**Crawl Space** – A foundation in which the area beneath the lowest occupiable space in a building is elevated above grade level.

**Crawl Space Depressurization [CSD] (active)** —a radon mitigation technique designed to achieve lower air pressure in the crawlspace than in the rooms bordering and above the crawlspace. A radon fan, draws air from the crawl space and exhausts that air outside the building. Crawlspace depressurization is intended to mitigate rooms bordering and above the crawlspace but not the crawlspace itself. All CSD systems, for purposes of this practice, are active.

**Cubic Feet per Minute [cfm]** - A measure of the volume of a fluid (liquid or gas) flowing within a fixed period of time.

**Curie [Ci]** - A standard measurement for radioactivity, specifically the rate of decay for a gram of radium -- 37 billion decays per second. A unit of radioactivity equal to  $3.7 \times 10^{10}$  disintegrations per second.

**Damper** - A movable plate to regulate the air flow in a duct.

**Day Care Center** - Any child care facility or family day care home, as defined in New Jersey Statutes.

**Decay** - Decrease in activity of a radioactive substance due to the disintegration of an atomic nucleus resulting in the release of alpha or beta particles or gamma radiation. Decay process emitting ionizing radiation. The ions created alter the charge on an electret surface. Measurements of the charge on the electret surface

before and after deployment of the device can be used to calculate the radon concentrations in the room in which the detector was placed.

**Decay Product** - Radioactive materials degrade to give rise to decay products, often referred to informally as "daughters" or "progeny." The radon decay products of most concern from a public health standpoint are polonium-214 and polonium-218.

**Decay Series** - The consecutive members of a family of radioactive isotopes formed by sequential radioactive decay.

**Depressurization** – A negative pressure induced in one area relative to another. In houses, negative pressure exists when the air pressure inside the house is slightly lower than the air pressure outside or the soil gas pressure. The lower levels of houses are essentially always depressurized during cold weather, due to the buoyant force on the warm indoor air (creating the natural thermal stack effect). Houses can also be depressurized by winds and by appliances which exhaust indoor air. Radon-containing soil gas is drawn more rapidly into a house under the depressurized condition.

**Diagnostic tests** —procedures used to identify or characterize conditions under, beside and within buildings that may contribute to radon entry or elevated radon levels or that may provide information regarding the performance of a mitigation system.

**Diffusion**- The random movement of individual atoms or molecules, such as radon atoms, in the absence of (or independent of convective movement). Atoms of radon can diffuse through tiny openings, or even through unbroken concrete slabs. Distinguished from convective movement (See Concentration Gradient Diffusion).

**Downspout** - A vertical drain pipe for carrying rain water from the gutters.

**Drain Tile Depressurization [DTD] (active)** — A variation of the ASD technology, where the area around the foundation is depressurized by drawing suction on drain tiles. The suction point piping attaches to a drain tile or is located in gas-permeable material near the drain tile. The drain tile or perimeter drain may be inside or outside the footings of the building

**Ductwork** - Any enclosed channel(s), which directs the movement of air or other gas.

**Duplicates** - Two measurements made side-by-side as a quality control measure. The primary objective is to determine how close the resulting values are to each other, i.e. their precision.

**Dynamic Equilibrium** – The steady-state in which the entry rate of radon gas and its RDPs become equal.

**Eave** - The border of a roof that overhangs any wall.

**Efficiency** - The relationship between the number of events recorded (counts, voltage lost, tracks) and the number of radioactive particles incident up on the sensitive element of the detector per unit time. Efficiencies for radon detectors are commonly expressed in terms of the calibration factor, which is the number of events (counts) per time (hour or minute) per radon concentration (pCi/L). Methods with high efficiencies will exhibit more counts (signal) per time in response to a given radon level than will a method with a low efficiency.

**Elbow** - An L-shaped pipe fitting. A 90° fitting.

**Electret Ion Chamber** - A device for measuring radon. Radon diffuses into the chamber where it goes through its normal

**Entry Routes** - Openings through the flooring and walls where the house contacts the soil, providing pathways by which soil gas can flow into a house.

**Equilibrium Ratio** – A total concentration of radon decay products (RDPs) present divided by the concentration that would exist if the RDPs were in radioactive equilibrium with the radon gas concentration, which is present. At 100% equilibrium (i.e., at an equilibrium ratio of 1.0), 1 WL of RDPs would be present when the radon concentration was 100 pCi/L. The ratio is never 1.0 in a house. Due to ventilation and plate-out, a commonly assumed equilibrium ratio is 0.5 in which case 1 WL corresponds to 200 pCi/L. However, equilibrium ratios vary with time and location, and ratios of 0.3 to 0.7 are commonly observed.

**Exfiltration** - The movement of indoor air out of the house.

**Exhaust Fan** - A fan oriented so that it blows indoor air out of the house.

**Expansion Joint** - A joint between a concrete slab or two adjacent slabs that allows the concrete to move independently from the adjacent slab or wall. It is typically a ½ inch fibrous board which is impregnated with an asphaltic material. It is laid either between the first and second slab or between the wall and the adjacent floor.

**Exposure time** - The length of time a specific mail-in device must be in contact with radon or radon decay products to get an accurate radon measurement. Also called exposure period, exposure parameters, or duration of exposure.

**Exterior Wall** is a bearing or nonbearing wall that is used as an enclosing wall for a building, other than a party wall or fire wall.

**Field Blank** - A quality control measurement made using a detector which has not been exposed to radon or progeny. The purpose of this procedure is to determine the bias associated with the storage and shipping of devices.

**Fieldstone** - Building stone found loose on the ground (field) regardless of its exact variety.

**Floor** - that portion of a building included between the upper surface of a floor and upper surface of the floor or roof next above.

**Site diagram** - an architectural or construction drawings or schematic representations of a building which identifies clearly each floor and room by name or number and which is of sufficient detail to identify plumbing, electrical conduit and HVAC penetrations into a room and the locations of the test devices.

**Flue** - A passage in the chimney to convey smoke to the outer air.

**Follow-up Test** - An additional testing performed in a room that was previously tested to confirm radon levels or to determine more accurately the radon concentrations to which the occupants are exposed.

**Footing(s)** - A concrete or stone base which supports a foundation wall and which is used to distribute the weight of the house over the soil or subgrade underlying the house. The bases upon which the foundation and posts rest.

**Forced-Air Furnace (or Heat Pump)** - A central furnace or heat pump that functions by recirculating the house air through a heat exchanger in the furnace. Distinguished from a central hot-water space heating system or electric resistance heating.

**Foundation** - The supporting wall of a building below the first-floor level.

**French Drain** - A channel for collecting drainage water around a house for the purpose of diversion away from the foundation. In older homes this was a trench of large aggregate along or below a foundation that would allow water collected in the trench to soak down through the soil. If seepage or flooding becomes an issue in these older homes, "canals" or "channel drains" are created inside of a basement to divert water to

flow to the floor drains or a sump pit. This can sometimes be called 'basement dewatering'. Modern home construction practices use perforated pipe in a rock-filled trench around the footing to collect and divert water.

**Frost Line** - The depth of frost penetration in soil.

**Furring** - Wood strips fastened to a wall or ceiling for the purpose of attaching wallboards or ceiling tile.

**Gamma Radiation** - Short-wavelength electromagnetic radiation of nuclear origin, with energies between 10 kev to 9 mev. Smaller and faster than Alpha Radiation but not as damaging to lung tissue. Often referred to as photons of energy or pure energy.

**Grab Sampling** - The collection of a sample over a very short period of time (usually a few minutes). Is essentially an instantaneous measurement, and only indicates values existing at the time of sampling. Generally useful only for diagnostic purposes. See Kusnetz Method.

**Grade (above or below)** - Term describing the level of the ground surrounding a house. In construction, typically refers to the surface of the ground. Things can be located at grade, below grade, or above grade relative to the surface of the ground.

**Grade or Grade Line** - The level of the ground around a building.

**Gross Alpha** - A measure of the total alpha activity of a water sample, excluding radon. It can serve as a rough indication of the radium and uranium concentrations present in a water sample.

**Ground Fault Interrupter Switch** - A switch which is installed in the power cord leading to masonry drills, which are being used to drill or core holes through concrete slabs. If the drill bit touches anything metal beneath the slab (such as a gas line), the switch opens, shutting off the power to the drill before further damage can be done to the sub-slab line. A GFI circuit is also found in areas where water may be present, such as a garage or bathroom.

**Half-Life** - The time required for half the atoms of a radioactive substance present at the beginning to be disintegrated. For instance, beginning with 100 units, there would be 50 units not disintegrated at the end of the first half-life, 25 at the end of the second, and so forth.

**Heat Exchanger** - A device used to transfer heat from one stream to another. In air-to-air heat exchangers for residential use, heat from exhausted indoor air is transferred to incoming outdoor air, without mixing the two streams.

**Heat Recovery Ventilators** - Also known as air-to-air heater exchangers or heat exchangers.

**Hollow [Block] Wall Depressurization [BWD] (Active)** — A radon mitigation technique that depressurizes the void space within a foundation wall (usually a block wall). A radon fan installed in the radon system piping draws air from within the wall.

**HVAC System** - The Heating, Ventilating and Air Conditioning system for a building; it generally refers to a ducted air handling system.

**Indoor Radon Abatement Act** - Passed in 1988 as Title III of the Toxic Substances Control Act, this law establishes as a national goal - but not as a requirement - that air within buildings "should be as free of radon as the ambient air outside of buildings." The law directed EPA to conduct a variety of activities, and to fund three-year programs for States and Regional Radon Training Centers.

**Infiltrations** - The unwanted admittance of air through cracks and pores. The movement of outdoor air or soil gas into a house. The infiltration, which occurs when all doors and windows are closed, is referred to in this document as the natural closed-house infiltration rate. The reverse of exfiltration.



**Initial Test** - The first test performed in a ground contact and first floor habitable space to determine if elevated radon or radon progeny concentrations are present.

**Interior Footing Drains** - A perforated pipe located on the interior of the foundation typically in a porous fill material. The pipe runs continuously around the interior foundation and terminates in a sump or may travel to the exterior and be connected to a daylight drain.

**Ionizing Radiation** - Any type of radiation capable of producing ionization in materials it contacts; includes high-energy charged particles such as alpha and beta rays, and non-particulate radiation such as gamma rays and X-rays. In contrast to radiation (e.g., visible light and micro-radio waves) in which the waves do not ionize atoms.

**Isotope** - Any of two or more forms of a chemical element, having the same number of protons in the nucleus, or the same atomic number, but having different numbers of neutrons in the nucleus, or different atomic weights.

**Kusnetz Method** - A method of determining radon decay product concentrations (working level measurements) in air from grab samples. The decay products from a known volume of air are collected on a filter, and the alpha activity on the filter counted at specified time intervals. The results are in working levels, and do not provide concentrations of the individual decay products.

**Lab Blank** - A quality control measurement made to determine the counts that would be reported by an analytical system without the detector having been exposed.

**Large Building** - Any building other than a single family dwelling. Check state definition of 'single family'.

**Lifetime Risk** - The lifetime probability of dying of a specific disease.

**Linear Dose Model** - The dose-risk model that assumes that the excess risk is linearly proportional to the dose.

**Liter [L]** - A metric unit of volume equal to 1000 cubic centimeters, or 1.057 quarts.

**Lower Limit of Detection [LLD]** - The smallest amount of sample activity that will yield a net count, for which there is confidence at a predetermined level that activity is present.

**Make-Up Air** - Outdoor source of draft air (to address combustion appliance back-drafting) - As used here, an outdoor supply of fresh air provided into the house to provide the required draft air (and combustion air) needed for proper movement of products of combustion up the flues of combustion appliances. Such make-up air may be needed in cases where an ASD system is found to be creating back-drafting of combustion appliances through depressurization of the house. The term "make-up air" can also be used to describe the supply of outdoor air into the house in general, to prevent house depressurization by combustion appliances and exhaust fans, in cases where an ASD system has not been installed. "Make-up air" can also be used to refer to fresh air drawn into the cold air return of forced-air furnace systems, to ventilate and perhaps even pressurize the house.

**Manometer** - A pressure-sensing device that displays pressure differences between two locations by the level of a colored liquid. Two types of such manometers (including a U-tube and a curved inclined manometer) are commonly used as pressure gauges and permanently mounted on ASD installations.

**Mechanically-Ventilated Crawlspace System** —a radon-control technique designed to increase ventilation within a crawlspace by use of a fan.

**Micromanometer** - A differential pressure measurement device that reads in the thousandths of an inch of meter column.

**Mitigation** - the act of repairing or altering a building or building design for the purpose in whole or in part of reducing the concentration of radon in the indoor atmosphere.

**Mitigation System** —any system or steps designed to reduce radon concentrations in the indoor air of a building.

**Natural Draft Combustion Appliance** — Any fuel burning appliance that relies on natural convective flow to exhaust combustion products through flues to outside air.

**Neutral Pressure Plane** - A roughly horizontal plane through a house, defining the level at which the pressure indoors equals the pressure outdoors. During cold weather, when the thermal stack effect is occurring, indoor pressures below the neutral plane will be lower than outdoors, so that outdoor air and soil gas will infiltrate. Above the neutral plane, indoor pressures will be higher than outdoors, so that house air will exfiltrate.

**Occupiable Spaces** — Areas of buildings where human beings spend or could spend time, on a regular or occasional basis.

**Partition** - An interior wall (Wall: an exterior wall).

**Passive Monitor/Device** – A measurement tool that does not require external power or batteries to operate, such as charcoal detectors or alpha track detectors.

**Passive New Construction Pipe** – A pipe installed in new construction that relies solely on the convective flow of air upward for soil gas depressurization and may consist of multiple pipes routed through conditioned space from below the foundation to above the roof.

**Percent Difference** - The difference between two measurements with similar devices divided by the average of the two measurements--expressed as a percentage.

**Performance Audit** – An examination of a program, function or operation or of the management systems, procedures and records of a radon contractor to assess whether the entity is complying with the regulatory standards.

**Perimeter Drain** - A water drainage system that is routed around a footing either inside or outside the perimeter of a house. Typically refers to a perforated pipe laid in a rock filled trench designed to collect and drain water off a hillside or to a sump. Highly effective drain tile depressurization system that utilizes these to create a negative pressure field around and beneath the home.

**Permeability (sub-slab)** - A measure of the ease with which a fluid (liquid or gas) can flow through a porous medium. Sub-slab permeability generally refers to the ease with which soil gas can flow underneath a concrete slab. High permeability facilitates gas movement under the slab, and hence generally facilitates the **implementation of sub-slab depressurization systems for remediation.**

**Picocurie [pCi]** - A Curie is a standard measurement for radioactivity, specifically the rate of decay for a gram of radium--37 billion decays per second. A picocurie (pCi) is one trillionth of a Curie.

**Picocurie per liter [pCi/L]** - A unit of radioactivity corresponding to one decay every 27 seconds in a volume of one liter of air, or 0.037 decays per second in every liter of air 2.2 disintegrations per minute of radioactive material per liter of air.

**Pier** - A rectangular masonry support, either free standing or built into a wall.

**Plate** - A horizontal member in a wall framework, which rafters, joists, studs, and so forth, rest on or are secured to, as in "sole plate," "sill plate," "top plate."

**Plating Out** - The process whereby small particles or dust attach to walls, carpets, furniture, lung tissue, and so forth.

**Polyvinyl Chloride [PVC]** - A polymeric plastic material which is resistant to deterioration (e.g., by soil chemicals) and used in a wide variety of products. It is used to make rigid piping that is commonly used e.g., in residential sewer lines, and as the piping for ASD systems. Flexible PVC couplings can be used to join section of rigid PVC piping.

**Porosity** - A surface that has the ability to allow air or fluids to pass.

**Precision** - Degree of mutual agreement among individual measurements made under prescribed conditions, e.g., standard deviation among replicate measurements.

**Precision Error** - The uncertainty associated with the ability of a given instrument to provide the same results with repeated measurements.

**Pressure Driven Airflow (Convective Movement)** - One of the methods by which radon moves through soil from areas of higher to lower air pressure.

**Quality Assurance Plan** - A complete program designed to produce results which are valid, scientifically defensible, and of known precision, bias, and accuracy.

**Quality Control Measurements** - Measurements made to ensure and monitor data quality.

**Radon Progeny** - Radioactive element by-products from the decay of radon which emit either alpha radiation or beta radiation, and sometimes gamma radiation. (See Radon Decay Products)

**Radiant Heating** - Heating by radiating rays without air movement.

**Radiation** - The emission and propagation of energy by means of electromagnetic waves or sub-atomic particles.

**Radioactive Decay Series** - A series of isotopes that result following the decay of a parent radionuclide. There are three natural radioactive decay series, uranium-238, uranium-235, and thorium-232.

**Radioactivity** - The release of particles of energy from an atom as it decays. Units of activity are the Becquerel (Bq) and the Curie (Ci).

**Radium [Ra]** - An element often found in uranium ore. It has several radioactive isotopes. Radium-226 decays to Radon-222. It emits alpha particles and gamma rays to form radon.

**Radon [Rn]** - A colorless, odorless naturally occurring, radioactive, inert, gaseous element formed by radioactive decay of radium [Ra] atoms. The atomic number is 86. Although other isotopes of radon occur in nature, radon in indoor air is primarily Rn-222.

**Radon Chamber** - An airtight enclosure in which operators can induce and control different levels of radon gas and radon decay products. Volume is such that samples can be taken without affecting the levels of either radon or its decay products within the chamber.

**Radon Decay Product [RDP]** - A solid, radioactive particle produced by the decay of Radon [Rn].

**Radon Resistant Construction** - The installation of passive new construction pipe during new residential construction. Sometime referred to as Passive New Construction [PNC].

**Radon Source Strength** - The intensity, power, or concentration of radon action from its point of origin.

**Radon System Piping** - Active or passive soil depressurization piping composed of three parts: suction point piping, manifold piping, and vent stack piping.

**Random Error** - Variations of repeated measurements that are random in nature and not predictable individually. The causes of random error are assumed to be indeterminate or non-assignable. The distribution of random errors is assumed generally to be normal (Gaussian).

**Range** - The difference between the maximum and minimum values of a set of values. When the number of values is small (i.e., eight or less), the range is a relatively sensitive (efficient) measure of variability. As the number of values increases above eight, the efficiency of the range (as an estimator of the variability) decreases rapidly. The range, or difference between two paired values, is of particular importance in air pollution measurement, since in many situations duplicate measurements are performed as part of the quality assurance program.

**Re-entrainment** - The unintended re-entry into a building of radon that is being exhausted from the vent of a radon mitigation system.

**Relative Bias** - The estimated bias divided by the true or reference value and expressed as a percentage.

**Relative Humidity** - Ratio of the amount of water vapor in air to the maximum possible amount at the same temperature.

**Relative Measurement Error** - The standard deviation of a sample of individual measurement errors.

**Relative Percent Difference [RPD]** - A measure of precision, calculated by:  $Difference \div Average \times 100$

**Relative Precision** - The estimated precision/standard deviation divided by the sample mean and expressed as a percentage. Also called relative standard deviation or Coefficient of Variation.

**Relative Standard Deviation** - See Coefficient of Variation.

**Ridge** - The top edge of the roof where two slopes meet.

**Room** - An occupiable space in a building.

**Schedule** – The wall thickness of a pipe used for radon venting.

**Scintillation Cell** - A metal cylinder or flask coated with a material that will fluoresce or scintillate (give off a light flash) when contacted by alpha radiation. This device is used to measure radon concentrations in air samples collected in the cell.

**Screening Measurement** – An initial short-term measurement made under worst case conditions to determine whether a building is likely to have a radon problem. A screening measurement is intended to determine a next step of action. It is not intended to define average exposures and, therefore, should not be the basis for a mitigation decision unless confirmed with a second screening measurement or followed up with a long-term measurement.

**Secular Equilibrium** - A state in which the formation of atoms by decay of a parent radioactive isotope is equal to its rate of disintegration by radioactive decay. In nuclear physics, secular equilibrium is a situation in which the quantity of a radioactive isotope remains constant because its production rate (e.g., due to decay of a parent isotope) is equal to its decay rate.

**Sensitivity** - The ability of a radon or WL measurement method to produce reliable measurements at low concentrations. This ability is dependent upon the variability of the background signal (counts not due to radon or WL exposure), which the method records, as well as its efficiency. Methods with stable background rates and high efficiencies will be able to produce reliable measurements at lower concentrations than methods with variable background rates and low efficiencies. Sensitivity can be expressed in terms of the lower limit of detection or minimum detectable activity.

**Sensitivity Checks** - Sensitivity checks are used in the RMP Program to determine the lower limit of detection for a particular measurement system. Background radiation and inherent instrument design often limit the ability to measure very low concentrations of radon.

**Signal-To-Noise Ratio** - For radon and WL detectors, this term expresses the proportion of the number of counts due to exposure to radon or WP (signal) to the number of counts due to background (noise). Measurement methods with high signal-to-noise ratios will produce more counts due to radon or WL exposure (signal) in proportion to the background counts (noise) than will methods with low signal-to-noise ratios. A method with a high signal-to-noise ratio is more likely to exhibit good sensitivity, i.e., be able to produce reliable measurements at low concentrations.

**Slab-on-grade** - A type of house construction in which the bottom floor of a house is a concrete layer (typically about 4 in. thick and in direct contact with the underlying aggregate or soil), which is no more than 1 ft. below grade level on any side of the house.

**Soil Gas** - Gases found in or traveling through soil such as radon, methane, and pesticide vapors.

**Soil Gas Retarder** – A continuous membrane of 6 mil (3 mil cross-laminated) polyethylene or equivalent flexible material used to retard the flow of soil gases into a building.

**Spiked Samples** - See Blind Spikes.

**Stack** - A vertical pipe.

**Stack Effect** - The overall upward movement of air inside a building that results from heated air rising and escaping through openings in the building envelope, thus causing indoor air pressure in the lower portions of a building to be lower than the pressure in the soil beneath or surrounding the building foundation.

**Standard Deviation** - A measurement of the scatter of several sample values around their average.

**Standard Operating Procedure [SOP]** - A written document which details an operation, analysis, or action whose mechanisms are prescribed thoroughly and which is commonly accepted as the method for performing certain routine or repetitive tasks.

**Story** - The portion of a building included between the upper surface of a floor and upper surface of the floor or roof next above.

**Structural Change** - Any modification, replacement or repair of foundation, walls, floors, ceilings or roof assembly, or any addition to the existing building.

**Sub Membrane Depressurization or SMD** – A radon control technique designed to achieve lower air pressure in the space under a soil gas retarder membrane laid on the crawlspace floor and sealed, relative to air pressure in the crawlspace floor and sealed, relative to air pressure in the crawlspace by use of a vent or fan-powered vent drawing air from beneath the membrane.

**Sub-Slab Communication** - The effect of creating vacuum beneath a slab and being able to detect the vacuum at various locations under the slab.

**Sub-Slab Depressurization [Active]** - A radon control technique designed to achieve lower sub-slab pressure relative to indoor air pressure by use of a fan-powered vent drawing air from beneath the concrete slab.

**Sub-Slab Depressurization [Passive]** - A radon control technique designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a vent pipe (without a fan) routed through the conditioned space of a building and connecting the sub-slab area to the outdoor air. This system relies

primarily on the convective flow of warmed air upward in the vent to draw air from beneath the concrete slab.

**Suction Hole/Point** - The hole cut through a concrete slab from which either a vacuum cleaner (for diagnostic purposes) or a mitigation fan will evacuate the sub-slab soil gas.

**Sump** - A pit through a basement floor slab designed to collect water and thus avoid water problems in the basement. Water is often directed into the sump by drain tiles around the inside or outside of the footings.

**Sump Pit Depressurization [SPD]** — A type of active soil depressurization radon mitigation system where the suction point piping enters the sump pit, that has a sealed gasketed cover, through the side or through the cover.

**Sump Pump** - A pump to move collected water out of the sump pit to an above-grade discharge remote from the house.

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

**Thermal Bypass** - Any opening through the floors between stories of a house (or through the ceiling between the living area and the attic), which facilitates the upward movement of house air under the influence of stack effect.

**Time Integrated Measurement** - Sampling conducted over a specific time period (from a few days to a year or more) with results reported as an average value for that period.

**'True' Time Integrated Measurement** - Sampling conducted over a specific time period (from a few days to a year or more) with results reported as an average value for that period, without a correction factor.

**Unattached Fraction** - Refers to the portion of Radon Decay Products which have not yet adhered to other airborne particles or other surfaces, such as walls). Unattached RDPs might result in a higher lung cancer risk than will RDPs that are attached to larger particles, because they can selectively deposit in small areas of the lung.

**Uncertainty** - The estimated bounds of the deviation from the mean value, expressed generally as a percentage of the mean value. Taken ordinarily as the sum of (1) the random errors (errors of precision) at the 95% confidence level, and (2) the estimated upper bound of the systematic error (errors of accuracy).

**Uranium [Uranium 238]**- A naturally occurring radioactive element with the atomic number 92 and an atomic weight of approximately 238. The first radionuclide in the decay chain, which includes radium 226 and radon 222. Uranium-238 has a 4.5 billion year half-life and is naturally occurring in the earth's crust.

**Vapor Barrier** - A product or system designed to limit the free passage of a gas (typically water vapor) through a building envelope component (wall, ceiling, or floor). Such products and systems may be continuous or non-continuous discrete elements, which are sealed together to form a continuous barrier against air (or vapor) infiltration (most commonly, a plastic sheet under a house slab).

**Vent Stack Piping** — This piping collects the soil-gas from the suction point pipe of single suction point systems or from the manifold piping of multi-suction point systems. There are no branches in vent stack piping; soil-gas is collected at one end of the vent stack piping and is discharged from the building at the other end. In active soil depressurization systems, the radon fan is installed in the vent stack piping.

**Ventilation** —The process of introducing outdoor air into a building.

**Ventilation Rate** - The rate at which outdoor air enters the house, displacing house air. The ventilation rate depends on the tightness of the house shell, weather conditions, and the operation of appliances (such as fans) influencing air movement. Commonly expressed in terms of air changes per hour or cubic feet per minute. The ventilation rate includes both natural ventilation (infiltration) and mechanical ventilation.

**Water Column [WC]** - A term used to describe air pressure in hydrostatic terms; i.e., the height of a column of water that would exert an equivalent pressure to the pressure being measured.

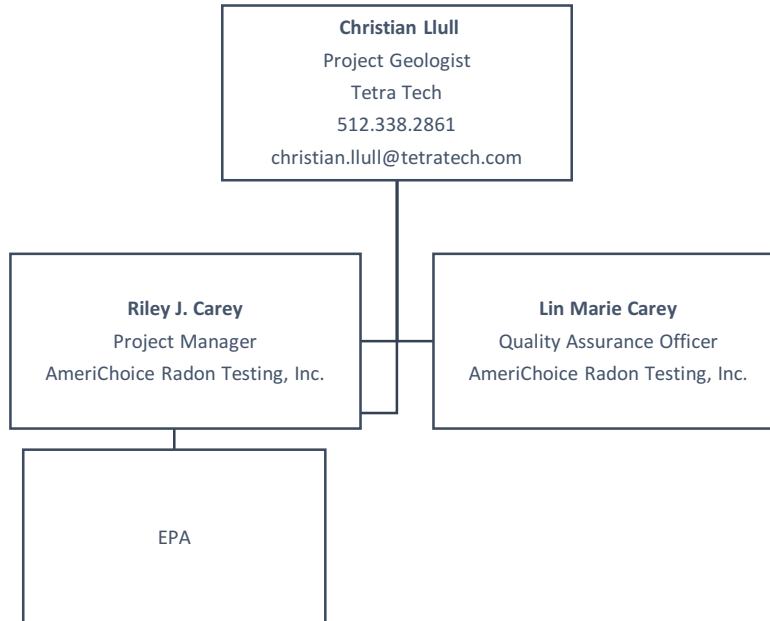
**Wind Induced Airflow** - The movement of air that results when wind creates higher or lower air pressures around and inside a building. For example, wind can produce elevated air pressures on the windward side of a house, and lower air pressures on the leeward side. Elevated air pressure in soil can force soil gas into a building; lower air pressure in a house can draw soil gas into a building.

**Working Level [WL]** - A unit of radon decay product exposure or any combination of short-lived radon progeny in 1 liter of air that will result in the ultimate emission  $1.3 \times 10^5$  [130 000] mev of potential alpha energy. This is approximately the total alpha energy released from the short lived decay products in equilibrium with 100 pCi of Rn-222.

**Working Level Month [WLM]** - a unit of exposure used to express the accumulated human exposure to radon decay products. It is calculated by multiplying the average working level to which a person has been exposed by the number of hours exposed and dividing the product by 170.

## 1. PROJECT MANAGEMENT

### A) Project Organization



### B) Radon Measurement Project Description Using Continuous Radon Monitors and EPerm® Electret Ion Chambers

AmeriChoice Radon Testing, Inc. is conducting an indoor radon measurement sampling in accordance with 32 ILAC 422 and USEPA Region 5 Radon Monitoring guidelines in response to a request by Tetra Tech of Austin, Texas.

The objective of this radon monitoring effort is to screen for elevated radon levels in 4 separate residential dwellings in East St. Louis, Illinois.

Data will be collected with Sarad Scout Continuous Radon Monitors deployed in all basement or lowest livable levels suitable for occupancy. EPerm® Electret Ion Chambers may be deployed in secondary or tertiary measurement locations according to 32 ILAC 422 regulations. A long-term or short-term follow-up test may be conducted in homes yielding elevated radon levels between 4.0 pCi/L and 8.0 pCi/L. A short-term follow up test may be conducted in homes yielding levels over 8.0 pCi/L.

### C) Quality Objectives and Criteria for Radon Screenings

Closed building conditions must be initiated at least 12 hours prior to any measurement lasting less than 96 hours. Measurements must be conducted during normal occupancy conditions such as HVAC operating in the range of 67-77 degrees. Measurements lasting less than 96 hours should not be conducted during periods of severe weather or high winds defined as sustained wind speeds of 30 mph or more.

#### i. Determining Precision



Duplicate devices will be performed as a quality control measurement to ensure the precision of measurement devices. Duplicates are placed simultaneously with the screening detectors for the same measurement duration. The number of duplicate measurements will be a minimum of 10% of the total devices deployed. Relative percent differences (RPD) will be calculated for duplicate measures and will be evaluated. Relative percent difference.

*ii. Determining Accuracy and Bias*

Known exposure measurements (spikes) may be employed as quality control measurements for passive Eperm devices in this project. Spikes are unexposed devices sent to a radon chamber for exposure to known concentrations of radon and subsequently analyzed for the evaluation of accuracy between laboratory and chamber processes. Spikes are typically performed by a measurement professional who has demonstrated proficiency in EPA's Radon Measurement Proficiency (RMP) Program at the rate of 3 per hundred devices placed with a maximum of 6 spikes each month. Known exposures will be performed at RadElec® laboratories located at 5716-A Industry Lane, Frederick, Maryland, 21704.

*iii. Sensitivity Checks*

Sensitivity checks are made to determine the LLD for a particular measurement system. Background radiation and inherent instrument design often limit the ability to measure very low concentrations of radon.

*iv. Measurement Criteria for Completeness and Comparability*

Initial screening measurements will be conducted in 48-hour to 96-hour increments and plotted on a site diagram. Logged results and site diagrams will be compared with records from any prior measurements conducted and used to determine an action plan which may conclude that no further action for the immediate future is required or may result in follow-up testing to confirm initial elevated measurements.

Follow-up testing will be conducted to confirm initial screenings in short-term or long-term increments based on initial screening results and may result in no further action for the immediate future or a reduction plan formulated.

D) Training and Certification

All current and/or future company personnel who perform radon Professional or Technician tasks are or will be licensed by the Illinois Emergency Management Agency, Division of Nuclear Safety prior to engaging in any license-required tasks. Training on safety and operational policies and proper use of equipment is provided to all personnel, licensed or unlicensed, in accordance with 32 ILAC 42.70(e). For each individual, the company maintains evidence of all training for the duration of employment and for five years past the end of employment. In addition, AmeriChoice Radon Testing, Inc. Personnel will:

- submit to background checks and pre-employment drug testing to ensure the highest quality personnel and lower liability risk.
- maintain the minimum Continuing Education credits as required by the State of Illinois.
- maintain records of all Technician CE credits.
- regularly submit to annual performance audits and obtain company-required continuing education within 90 days unless otherwise specified.

E) Documents, Data Management, and Record Keeping

All documents and records related to this project are carefully controlled by Riley J. Carey, Project Manager for no less than 5 years.

*i. Documentation*

All measurement devices, including duplicate measures and blanks, will be noted on the Device Placement Log and Site diagram by serial number and reconciled with measurement results for chain of custody validation and quality control. A site diagram will be completed for measurement in which radon or radon progeny measurements are made. Information and observations obtained during planning or device deployment shall be documented as Field Notes and referenced as needed throughout the project. Field Notes relevant to measurement analysis and interpretation will be closely correlated with the Device Placement Log and Site Diagram.

*ii. Record Keeping & Data Management*

The Device Placement Log, Site Diagram, and Field Notes shall be kept on file for at least 5 years and referred to prior to any subsequent testing and records auditing. Quality control measurement records shall be kept in AmeriChoice Radon files to be assessed and summarized at the end of each testing project. Project documents, records, and files will be backed up daily to cloud storage to ensure availability and are protected against fire, vermin, water, soiling, and deterioration and stored for no less than 5 years in the company database in accordance with AmeriChoice Radon document storage policies. A list of quality procedures is provided with this QAPP including procedures, programs, forms, and other documents related to radon activities. All are uniquely identified by document title, revision number, and date. Revisions are reviewed and approved in accordance with the AmeriChoice Radon SOP and undergo the same approval process as new documents.

Outdated documents are replaced and withdrawn from service. *The following items should be included in a separate QA logbook for each active instrument or passive method:*

1. Equipment calibration records (for analytical service providers), including:
  - The date of the calibration and the date the calibration expires.
  - The facility where the calibration was performed.
  - The procedures used (an SOP or calibration report can be referenced).
  - Calibration results.
  - Changes in calibration factors implemented.
  
2. Laboratory background measurements (for analytical service providers), including:
  - The date of the background measurement.
  - The location and type of measurement (e.g., aged air or nitrogen).
  - The procedures used (an SOP can be referenced).
  - Analysis results.
  - Changes in LLD or background values.
  
3. Field background measurements (for both analytical and residential service providers), including:
  - The date and location of the field background measurement.
  - The procedures used (appropriate documentation can be referenced).
  - Analysis results.
  - Changes implemented because of the results.

*iii. Reporting*

The AmeriChoice Radon project manager will complete a Final Written Report [Report Package] according to Section 10 of AmeriChoice Radon's standard operating procedures including the Device Placement Log and Site Diagram, for each test location in each building measured. AmeriChoice Radon radon measurement

reports will be distributed according to project protocol including but not limited to the distribution list indicated on [page iii] of this document.

## **2. DATA GENERATION/ACQUISITION**

### *A) Measurement Process Design*

Initial, short-term radon screening measurements will be made in the lowest level suitable for occupancy over each foundation. Sarad Scout continuous radon monitors will be used for initial measurements in every lowest level and EPerm® electret ion chambers will be deployed in duplicate in each secondary or tertiary foundation.

The measurements shall range in duration from 48 to 96 hours depending upon the weather and ability to maintain closed building conditions for 12 hours prior to deployment. Note: All short-term testing of 96 hours or less in duration requires closed building conditions initiated at least 12-hours prior to placement and for the duration of the test except for normal exit and entry. A long-term measurement shall range in duration from 90 days to one year depending upon the measurement device used. Closed building conditions must be initiated at least 12-hours prior to placement and for the duration of short-term tests of 96 hours or less in duration, except for normal exit and entry.

### *B) Variability*

#### *i. Measurement Uncertainties Variables*

In the process of conducting radon measurements, many variables exist that can cause uncertainty in results. It is imperative that measurement operators recognize these variables and assign QA standards to maximize certainty in results. Some variables:

- Equipment & measurement imprecision
- Measurement procedures
- Fluctuation in radon levels
- Non-compliant measurement procedures
- Interference
- Errors due to equipment or measurement providers.

The AmeriChoice Radon project manager will verify architectural drawings of the building, its characterization elements, and review the HVAC system prior to measurement activities in an attempt to verify suitable measurement conditions and characterize elevated radon levels. AmeriChoice Radon will attempt to identify and evaluate the impact on radon concentrations of inappropriate energy conservation applications, structural features that affect soil gas entry, such as expansion joints, utility chases, sub-slab access holes, utility access points, rooms used as return air plenums; and return ducts beneath the slab, crawlspaces, especially those used as return air plenums. The AmeriChoice Radon project manager may perform additional diagnostic tests as needed to complete characterization of the building and will review characterization elements as necessary.

### *C) Device Procurement and Chain of Custody*

The AmeriChoice Radon project manager may use a combination of active and passive testing devices in this project. Determining factors for the type of device used may include: project square footage, room and building use, occupancy, and availability of devices. All devices will be used according to manufacturer specifications and in compliance with EPA testing protocol in accordance with 32 ILAC 422.

D) *Measurement Methods*

i. *Measurement Locations and Identification*

Initial screening measurements shall be made in accordance with USEPA 402-R-92-014, 1993 with updated best practices indicated in ANSI-AARST MALB 2014, such as: all regularly occupied rooms shall be tested simultaneously, 10% of upper floors may be tested for better characterization or diagnostic purposes;

Device Placement Log [aka Field Data log] and Site Diagram shall be finalized for each school or building in which radon or radon progeny measurements are made. All measurement devices, including duplicate measures and blanks, shall be noted on the Device Placement Log and Site Diagram by serial number as provided in Appendix D of this project SOP. The AmeriChoice Radon project manager will perform concurrent short-term screening tests throughout the building while completing the Device Placement Log and Site Diagram. Additional diagnostic tests will be performed as needed to complete characterization of the building and will review characterization elements as necessary.

E) *Measurement Devices*

The AmeriChoice Radon project manager will use a combination of active and passive testing devices in this project.

i. *Continuous Radon Monitors - CRM*

A Sarad® Scout continuous radon monitor will be used in the lowest level suitable for occupancy of each dwelling to detect unusual radon fluctuations during the measurement period due to weather, mechanical appliances, or other interference. Sarad® Scout continuous radon monitor are solid-state silicon devices with a diffused junction diode detector. The Scout is operated on three D-cell batteries with a backup power source to continue measurement in the event of power failure as well as internal environmental detectors that read temperature, barometric pressure, and humidity, and a motion sensor to detect movement. CRMs are typically deployed for 96 hours or less due to limited data storage. As time integrating, active devices the Sarad® Scout generates a final result based on hourly readings integrated by the exposure time. Device-specific protocol, handling, and special equipment are indicated in Section 1 of the AmeriChoice Radon SOP.

ii. *Electret Ion Chambers - EIC*

An E-PERM®, also known as an Electret Ion Chamber (EIC), is a passive integrating ionization monitor consisting of a very stable electret mounted inside a small chamber made of electrically conducting plastic. The electret, a charged Teflon® disk, serves as both the source for ion collection and as the integrating ion sensor. Negative ions produced inside the chamber are collected on the positively charged electret, causing a reduction of its surface charge. The measurement of the depleted charge during the exposure period is a measure of integrated ionization during the measurement period. The electret charge is read before and after the exposure using a specially built non-contact electret voltage reader referred to as the SPER-1 Electret Voltage Reader. Using this data as input to the appropriate formula, one can determine the radon activity present over the duration of the test.

The basic components of the E-PERM® System consist of the electret reader, chambers, and electrets. There are chambers of different sizes and electrets of different sensitivities to meet a wide range of monitoring situations. They are known as “true integrators” because they are constantly collecting and “registering” the ions generated by the radon decaying inside the chamber. Device-specific protocol, handling, and special equipment are indicated in Section 2 of the AmeriChoice Radon SOP.

*iii. Sample Handling and Custody*

As radon gas samples are not retained, this section pertains to the Handling and Custody of sampling equipment.

AmeriChoice Radon prohibits the Use Of any owned or leased radon monitoring device by anyone other than AmeriChoice Radon trained and approved personnel approved by the AmeriChoice Radon Air Quality Administrator. Usage of AmeriChoice Radon owned devices will be logged by serial number, test number, start and stop dates, start and stop times, and reason for usage on a device-specific data log including performance tests, quality control measurements, field measurements, and demonstrations. The exact location of each device deployed in the field for measurement, quality control, or research purposes will be indicated on a site diagram of the test facility. AmeriChoice Radon will maintain and handle devices to ensure proper working order. Suspect devices will be sent to the manufacturer and/or an EPA-approved radon chamber for repair and recalibration prior to returning for use in the field. Device-specific chain of custody and/or handling procedures are listed under each device in the AmeriChoice Radon SOP.

*iv. Analytical Methods*

Analytical SOPS for Sun Nuclear CRM devices can be found in Section 1 of the AmeriChoice Radon SOP document. Analytical SOPS for E-Perm EIC devices can be found in Section 2 of the AmeriChoice Radon SOP document. Analytical SOPS for Air Chek AC devices can be found in Section 3 of the AmeriChoice Radon SOP document. Analytical SOPS for RSSI AT devices can be found in Section 4 of the AmeriChoice Radon SOP document.

*v. Quality Control Methods*

Quality can be achieved in many ways including conducting systematic checks and balance audits, maintaining consistency in procedures, and performing quality control measurements before, during, and at the end of the project. All quality controls are important but none as important as having a series of measurements that can be used to identify potential problems or to document the accuracy and reliability of the test results. Conducting periodic checks and balance audits on a representative number of measurement records randomly selected is a key element to maintaining consistency in procedures, and performing quality control measurements before, during, and at the end of the project.

All quality controls are important but none as important as having a series of measurements that can be used to identify potential problems or to document the accuracy and reliability of the test results. Blank samples will be conducted at total of 5% of the total project samples and duplicate measurements will be conducted at least 10% of the total project deployments for CRM devices. Passive devices will be deployed 5% Field Blanks and 10% duplicates in addition to known samples [spikes] deployed 3% or 6 month, which ever is less. Device-specific quality control measurements are indicated in Sections one through four of the AmeriChoice Radon SOP. Device-specific quality control limits are indicated in Appendix G of the AmeriChoice Radon SOP.

*vi. Instrument/Equipment Testing, Inspection, Maintenance, and Calibration*

Equipment handling and maintenance SOPS for Sun Nuclear CRM devices can be found in Section 1 of the AmeriChoice Radon SOP document. Equipment handling and maintenance SOPS for E-Perm EIC devices can be found in Section 2 of the AmeriChoice Radon SOP document. Equipment handling and maintenance SOPS for Air Chek AC devices can be found in Section 3 of the AmeriChoice Radon SOP document. Equipment

handling and maintenance SOPS for RSSI AT devices can be found in Section 4 of the AmeriChoice Radon SOP document.

*vii. Additional Supplies, Equipment, and Consumables*

Additional supplies equipment and consumables may be required to conduct accurate and precise radon measurements. These supplies will be procured, inventoried and maintained by AmeriChoice Radon Air Quality Administrator, Jay Littlewolf. Device and task-specific identification of these supplies are noted in each SOP for each specific device or procedure. Ref: AmeriChoice Radon Standard Operating Procedures.

**3. DATA VALIDATION AND USABILITY**

Lin Marie Carey is the Quality Assurance Officer in charge of assessing information related to this project including validating data and related information. Managing internal quality control procedures is key to the assurance of statistical certainty in radon measurements. Quality control measurements of radon devices must be performed routinely to test measurement accuracy and/or precision and determine validity of project data. All checklists, forms and calculations related to the data quality of each project is attached to all documentation for availability and assessment.

A) Quality Control Measurements for Data Validation

*i. Duplicate Measurements*

A duplicate measurement consists of two short-term test devices exposed side-by-side with identical exposure dates and times. The results of these measurements will be averaged and analyzed to track precision of instruments. The analysis of data from duplicates should follow the methodology outlined in EPA Radon & RDP Measurement Device Protocol, Goldin Section 5.3 1984/1992c. If the precision estimated by the user is not within the precision expected of the measurement method, the problem should be reported to the analysis laboratory and the cause investigated. These are made by exposing two or more detectors side by side to the same conditions to see how much they differ. Duplicate measurements provide a way to estimate the reproducibility of measurement techniques and determine precision.

The following table lists acceptable precision errors between duplicate (side-by-side) measurements for different devices:

<u>Measurement Device</u>	<u>Precision Estimate</u>
Continuous radon monitor	less than 10%
Electret ion chambers	less than 10%

*ii. Control Charts for Precision*

Ideally, the results of duplicates should be assessed in a way that allows for the determination of what level of chance is associated with a particular difference between duplicates. This will allow for the pre-determination of limits for the allowable differences between duplicates before an investigation into the cause of the large differences is made. For example, the warning level, or the level of discrepancy between duplicates which triggers an investigation, may be set at a five percent probability. This level is a difference between duplicates that is so large that, when compared with previous precision errors, should only be observed five percent of the time. A control limit, where further measurements should cease until the problem is corrected, may be set at one percent probability.

Control charts such as those in the following examples should be employed when documenting Quality.

The control limits for RPD can be obtained simply by multiplying the control limits for COV by the square root of two, or 1.41. These limits are shown in Graph 5-2. This sequential control chart for RPD should be used in the same way as the control chart for COV, that is, with the vertical scale in units of RPD and the horizontal scale in units of date and measurement numbers.

A control chart using the statistic RPD based on an “in control” level of 25 percent RPD is shown in Graph 5-1. The warning level and control limit are set at 50 percent and 67 percent, respectively. Use of these limits may be appropriate for measured radon concentrations less than 4.0 pCi/L.

Use of statistics such as the relative percent difference (RPD; difference divided by the mean) or the coefficient of variation (COV; standard deviation divided by the mean) can be used in a control chart for duplicate measurements at radon concentrations where the expected precision error is fairly constant in proportion to the mean, e.g., at levels greater than around 4 pCi/L or 0.02 WL. At lower concentrations, for example, between 2 pCi/L (or 0.01 WL) and 4 pCi/L (or 0.02 WL), a control chart may be developed by plotting these same statistics; however, the proportion of the precision error to the mean will be greater than that proportion at levels above 4 pCi/L or 0.02 WL at concentrations less than about 2 pCi/L, or 0.01 WL, the lower limit of detection may be approached, and the precision error may be so large as to render a control chart not useful.

Before a control chart can be developed, it is necessary to know, from a history of making good quality measurements with the exact measurement system (detectors, analysis equipment, and procedures), the level of precision that is routinely encountered when the system is operating well or “in control.” It is that “in control” precision error that forms the basis of the control chart, and upon which all the subsequent duplicate measurements will be judged. There are two ways of initially determining this “in control” level. The first, and preferable, way is to perform at least 20 duplicate pairs of measurements at each range of radon concentrations for which a control chart is to be prepared. For example, if you will only assess precision at concentrations greater than 4 pCi/L or 0.02 WL, you will need at least 20 pairs of measurements at concentrations greater than 4 pCi/L or 0.02 WL, to assess the “in control” level. The average precision error (RPD or COV) should be the “in control” level.

The second way to initially set the “in control” precision error level is to use a level that has been used by others, and that is recognized by industry and USEPA as a goal for precision, for example, a 10 percent COV (corresponding to a 14 percent RPD). After at least 20 pairs of measurements are plotted, it will become apparent whether the 10 percent COV (or 14 percent RPD) is appropriate for your system. If it is not, a new control chart (using the guidelines below) should be prepared so that the warning and control limits are set at the correct probability limits for the system.

### *iii. Measurement Uncertainties*

In the process of conducting radon measurements, many variables exist that can cause uncertainty in results. It is imperative that measurement operators recognize these variables and assign QA standards to maximize certainty in results.

Variables that may affect certainty in radon measurement results:

1. Equipment & measurement imprecision.
2. Measurement procedures.
3. Fluctuation in radon levels.
4. Non-compliant measurement procedures.
5. Interference.

6. Errors due to equipment or measurement providers.

#### **4. PROCEDURES FOR RESPONDING TO COMPLAINTS**

AmeriChoice Radon accepts, assesses, and responds to suggestions and complaints from customers, regulatory agencies, and others. This procedure includes documenting the suggestion or complaint, assessing it, determining how alternative resolutions may be applied, and carrying out a response.

##### **A) Reporting**

Complaints, suggestions, discrepancies, and/or disciplines from the AmeriChoice Radon will be recorded, tracked, and proactively used to amend the SOP and/or quality controls if deemed appropriate. An annual review will be conducted of complaints, suggestions, discrepancies, and/or disciplines from the State.

#### **5. PROCEDURES FOR CORRECTIVE ACTIONS**

- A) The AmeriChoice Radon corrective action program assures the prompt incorporation of the proposed remedy and the verification of its effectiveness. Corrective actions – whether they originate in a periodic review, annual review, or from suggestions or complaints – are determined and implemented in a timely manner.
- B) The AmeriChoice Radon SOP details appropriate corrective actions to specific procedural items.
- C) It is the policy of the AmeriChoice Radon to implement corrective actions immediately upon submission by the Quality Assurance Officer [QAO]. The QAO may delegate corrective action duties to an appropriate employee as necessary, with results expected in a timely manner.
- D) Noted trends of employee negligence and/or disregard for State of Illinois, project, or EPA protocols will result in immediate termination of personnel.
- E) Non-personnel related Quality Control errors or negative trends, including equipment failure, will be corrected immediately and recorded for future comparative analysis.
- F) Device manufacturers will be notified immediately of any corrective actions involving equipment failure or malfunction.





## **Standard Operating Procedures**

Residential • Commercial • Multifamily • Schools

For the radon measurement devices employed regularly or occasionally by AmeriChoice.

### Scope of Work:

- Residential
- Commercial
- Multifamily Buildings
- Schools

All relevant aspects of the AmeriChoice Radon Testing Inc. (AmeriChoice) radon activities are described in written, standardized procedures. Standard Operating Procedures are developed in accordance with 32 IL Administrative Code 422, subchapter b and stipulate necessary procedures, the development process, procedure format, procedure initiation, and how staff is trained in approved procedures use.



## **1.0 Procedures for Field Measurements – Continuous Radon Monitor [CRM]**

### **1.1 Deployment and Retrieval Procedures:**

- A) AmeriChoice will use Continuous Radon Monitors (CRM) as the primary testing device in all residential real estate related testing activities. All devices used will be used according to manufacturer specifications and in compliance with IDNS testing protocol in accordance with 32 ILAC 422.130 and 32 ILAC 422.140.
- B) A short-term measurement shall range in duration from 48 hours to 90 days depending upon the measurement device used.
- C) As outlined in Appendix D, Technicians and Professionals placing CRMs will ensure that Closed Building Conditions were maintained at least 12-hours prior to test start time for tests lasting less than 96-hours.
- D) Adherence to proper deployment protocols are strictly followed according to 32 ILAC 422.130 and indicated in Appendix A.
- E) Technicians and Professionals retrieving CRMs will ensure that proper retrieval protocols are followed according to 32 ILAC 422.130 and as indicated in Appendix C, including Closed Building Conditions outlined in Appendix D.
- F) Technicians and Professionals placing CRMs in unoccupied homes shall ensure that the HVAC system is set and operating in the normal range, such as 72 degrees F, plus or minus 5 degrees F.

### **1.2 Standards:**

- A) AmeriChoice prohibits the Use Of any owned or leased device by anyone other than the employees, contractors, or representatives of this company in accordance with 32 ILAC 422.
- B) This company will properly maintain and handle CRMs to ensure proper working order. Suspect devices will be promptly returned to manufacturer or authorized repair facility for inspection and/or repair.
- C) This company will observe IEMA protocols for Options in Real Estate Testing as indicated in Appendix F.

### **1.3 Calibration:**

- A) All CRMs will be calibrated annually and cross checked semi-annually with a recently calibrated monitor from the field. As well, CRMs in company custody will be cross checked upon returning to company custody from maintenance, repair, or inspection. Calibration will be performed at the monitor-specific laboratory indicated in Section 6.0 of the AmeriChoice SOP and in accordance with 32 ILAC 422.

### **1.4 Quality Controls:**

- A) Use of CRMs requires the property to have electricity or the device to have adequate battery back-up.
- B) Use of CRMs during short-term testing requires Closed Building Conditions 12-hours prior to placement and for the duration of the test.
- C) In accordance with 32 ILAC 422.130 and 32 ILAC 422.140, the use of CRMs during short-term and/or Real Estate Testing will not be used in tests lasting 96 hours or less during periods of severe weather or high winds.
- D) AmeriChoice requires the placement of each CRM in each property to be diagrammed in compliance with 32 ILAC 422.130, as indicated in Appendix B.
- E) The company requires a signed non-interference agreement prior to placement in compliance with 32 ILAC 422.130.

- F) Vacant properties are required to have HVAC systems running in “normal” mode and all tamper deterrent efforts must be maintained. Such tamper efforts may include one or all of the following: tamper tape on lowest level windows, property inspection, testing notification placards at each exit/entry of the property, and consultation with homeowner or owner’s representative.
- G) Field Duplicate measurements for quality control purposes will be conducted by licensed associates as directed by the QAO.
- H) Duplicates will be deployed, recorded, and charted for quality control purposes as indicated in Section 8.0 of the QAP.
- I) Annual Audits of all measurement activities including Professionals and Technicians, and a representative sampling of no less than 30% of their work, will be made at least annually.
- J) Specific Quality Controls for testing in real estate transaction are outlined in Appendix E.

**1.5 Additional Equipment Required:**

- A) Field Technicians and/or Professionals deploying CRMs will ensure that sufficient ancillary equipment is available for each job site such as:
  - Heavy Duty extension cords.
  - Tray tables or other equipment to store monitors at least 20” to 6’ from the floor.
  - Tamper tape.
  - Writing utensils.
  - Business cards.

**1.6 Worker Protection Program:**

- A) AmeriChoice will follow all OSHA guidelines when engaging in residential or commercial radon testing.
- B) The company will follow IEMA guidelines for worker exposure to minimize risk.
- C) Radiation exposure of employees shall not exceed 30 pCi/L or 0.3 WL, based on continuous workplace exposure for 40/hr/week, 52 weeks per year and shall not exceed 4 WLM over a 12 month period, using an equilibrium ratio of 50 % to convert radon exposure to WLM.
- D) Radiation exposure of all employees will be tracked and recorded continuously, to keep radiation exposure as low as reasonably achievable. Employees approaching the exposure limit will be reassigned non-exposure duties, such as office and support work. Exposure records will be reported annually to workers.
- E) Radiation exposure records will be retained in an Excel spreadsheet and retained for Agency inspection for 5 years.

**1.7 Record Keeping & Reporting:**

- A) SOP Section 8.0

**1.8 References**

- A) 32 ILAC 422.130
- B) 32 ILAC 422.140

**1.9 Attachments:**

- A) #3 Sample Device Custody and Employee Exposure Log

**2.0 Procedures for Field Measurements –Electret Ion Chamber [EIC]****2.1 Deployment and Retrieval Procedures:**

- A) An EIC may be used as a primary or secondary device in any radon measurement activity. All devices used will be used according to manufacturer specifications and in compliance with IDNS testing protocol in accordance with 32 ILAC 422.130 and 32 ILAC 422.140.
- B) A short-term measurement shall range in duration from 48 hours to 90 days depending upon the measurement device used.
- C) As outlined in Appendix D, Technicians and Professionals placing EICs will ensure that Closed Building Conditions were maintained at least 12-hours prior to test start time for tests lasting less than 96-hours.
- D) Adherence to proper deployment protocols are strictly followed according to 32 ILAC 422.130 and indicated in Appendix A.
- E) Technicians and Professionals retrieving an EIC will ensure that proper retrieval protocols are followed according to 32 ILAC 422.130 and as indicated in Appendix C, including Closed Building Conditions outlined in Appendix D.
- F) Technicians and Professionals placing an EIC in an unoccupied home shall ensure that the HVAC system is set and operating in the normal range, such as 72 degrees F, plus or minus 5 degrees F.

**2.2 Standards:**

- A) AmeriChoice prohibits the Use Of any owned or leased device by anyone other than company employees or its contracted representatives in accordance with 32 ILAC 422.
- B) The company will properly maintain and handle EICs to ensure proper working order. Suspect devices will be promptly returned to manufacturer or authorized repair facility for inspection
- C) The company will observe IEMA protocols for Options in Real Estate Testing as indicated in Appendix F.

**2.3 Calibration:**

- A) All EIC voltage readers will be calibrated annually and upon returning to company custody from maintenance, repair, or inspection. Calibration will be performed at the laboratory indicated in SOP Procedure 6.0 and in accordance with 32 ILAC 422.
- B) The calibration of each SPER-1 instrument must be checked once a week using two reference electrets (provided by the EIC manufacturer). Notation of results of this calibration check for each SPER must be logged, initialed, and dated in the “QC Log Book.” If one reference electret gives a wrong reading, a measurement of the second one in the set shall be made to reveal whether the problem is in the first reference electret or in the readout instrument. A voltage reading of a reference electret which differs by more than 2 volts from that specified for it by the manufacturer shall be considered unacceptable and is a cause for corrective action by the Owner in concert with the manufacturer.
- C) The zeroing accuracy of each meter must also be checked once a week and the results recorded, dated, and initialed in the “QC Log Book.” This is to be done by covering the electret receptacle on the reader with an electrically conductive material (e.g., the topside of an electret cover) and opening the slide. When tested in this way, the reading must show no more than a plus or minus 2-volt reading. If it shows more than this, corrective action must be taken in concert with the manufacturer.

**2.4 Quality Controls:**

- A) The use of EIC devices requires the proper hygiene and special care in handling. Additional electrets will be in plentiful supply in the event of accidental voltage depletion.
- B) The use of EIC devices during short-term testing requires Closed Building Conditions 12-hours prior to placement and for the duration of the test.
- C) The use of EIC devices during short-term testing will not be used in tests lasting 96 hours or less during periods of severe weather or high winds, in accordance with 32 ILAC 422.130 and 32 ILAC 422.140.
- D) AmeriChoice requires the placement of each EIC in each property to be diagrammed in compliance with 32 ILAC 422.130, as indicated in Appendix B.
- E) The company requires a signed non-interference agreement prior to placement in compliance with 32 ILAC 422.130. Attachment 1.
- F) Vacant properties are required to have HVAC systems running in “normal” mode and all tamper deterrent efforts must be maintained. Such tamper efforts may include one or all of the following: tamper tape on lowest level windows, property inspection, testing notification placards at each exit/entry of the property, or consultation with homeowner or owner’s representative.
- G) Field Duplicate measurements for quality control purposes will be conducted by licensed AmeriChoice associates as directed by the QAO.
  - **Duplicates will be deployed, recorded, and charted for quality control purposes as indicated in QAP Section 8.0 and Appendix E.**
- H) Annual Audits of all measurement activities including all Professionals and Technicians, and a representative sampling of no less than 30% of their work will be made at least annually

**2.5 Additional Equipment Required:**

- A) Field Technicians and/or Professionals deploying E PERMs will ensure that sufficient ancillary equipment is available for each job site such as:
  - Tray tables or other equipment to store monitors at least 20” to 6’ from the floor.
  - Tamper tape.
  - Writing utensils.
  - Business cards.

**2.6 Worker Protection Program:**

- A) AmeriChoice will follow all OSHA guidelines when engaging in residential or commercial radon testing.
- B) The company will follow IEMA guidelines for worker exposure to minimize risk.
- C) Radiation exposure of company employees shall not exceed 30 pCi/L or 0.3 WL, based on continuous workplace exposure for 40/hr/week, 52 weeks per year and shall not exceed 4 WLM over a 12 month period, using an equilibrium ratio of 50 % to convert radon exposure to WLM.
- D) Radiation exposure of all employees will be tracked and recorded continuously, to keep radiation exposure as low as reasonably achievable. Employees approaching the exposure limit will be reassigned non-exposure duties, such as office and support work. Exposure records will be reported annually to workers.
- E) Radiation exposure records will be retained in an Excel spreadsheet and retained for Agency inspection for 5 years.

**2.7 Record Keeping and Reporting:**

- A) SOP Section 8.0.

**2.8 References:**

- A) 32 ILAC 422.130
- B) 32 ILAC 422.140

**2.9 Attachments:**

- A) #1 Sample Non-Interference Agreement
- B) #3 Sample Device Custody and Employee Exposure Log

### 3.0 Procedures for Field Measurements – Alpha-Track Devices

#### 3.1 Deployment and Retrieval Procedures:

- A) AmeriChoice may use Alpha Track devices as the primary testing device in all residential non-real estate related, long-term testing activities. All devices used will be used according to manufacturer specifications and in compliance with IDNS testing protocol in accordance with 32 ILAC 422.130 and 32 ILAC 422.140.
- B) A short-term measurement shall range in duration from 48 hours to 90 days depending upon the measurement device used.
- C) Closed Building Conditions are not necessary.
- D) Adherence to proper deployment protocols are strictly followed according to 32 ILAC 422.130 and indicated in Appendix A.
- E) Technicians and Professionals placing Alpha Track devices in unoccupied homes shall ensure that the HVAC system is set and operating in the normal range, such as 72 degrees F, plus or minus 5 degrees F.

#### 3.2 Standards:

- A) AmeriChoice prohibits the Use Of any owned or leased device by anyone other than the employees, contractors, or representatives of the company in accordance with 32 ILAC 422.
- B) The company will properly maintain and handle Alpha Track Detectors to ensure proper working order. Suspect devices will be promptly returned to manufacturer or for inspection and replacement.

#### 3.3 Calibration:

- A) Alpha-Track devices will be calibrated according to the manufacturer's Calibration Plan outlined in AmeriChoice SOP Procedure 6.0 and in accordance with 32 ILAC 422.

#### 3.4 Quality Controls:

- A) Use of Alpha-Track devices does not require Closed Building Conditions.
- B) Alpha-Track devices will not be used in the testing of homes involved in real estate transactions.
- C) Field Duplicate measurements for quality control purposes will be conducted by licensed AmeriChoice associates as directed by the QAO.
- D) Duplicates will be deployed, recorded, and charted for quality control purposes as indicated in QAP Section 8.0.
- E) The company requires the placement of each Alpha Track device to be diagrammed in compliance with 32 ILAC 422.130.
- F) The company requires a signed non-interference agreement prior to placement in compliance with 32 ILAC 422.130.

#### 3.5 Worker Protection Program:

- A) AmeriChoice will follow all OSHA guidelines when engaging in residential or commercial radon testing.
- B) The company will follow IEMA guidelines for worker exposure to minimize risk.
- C) Radiation exposure of employees shall not exceed 30 pCi/L or 0.3 WL, based on continuous workplace exposure for 40/hr/week, 52 weeks per year and shall not exceed 4 WLM over a 12 month period, using an equilibrium ratio of 50 % to convert radon exposure to WLM.
- D) Radiation exposure of all employees will be tracked and recorded continuously, to keep radiation exposure as low as reasonably achievable. Employees approaching the exposure limit

will be reassigned non-exposure duties, such as office and support work. Exposure records will be reported annually to workers.

- E) Radiation exposure records will be retained in an Excel spreadsheet and retained for Agency inspection for 5 years.

**3.6 Record Keeping & Reporting:**

- A) SOP Section 8.0.

**3.7 References:**

- A) 32 ILAC 422.130
- B) 32 ILAC 422.140

**3.8 Attachments:**

- A) #3 Sample Device Custody and Employee Exposure Log



**4.0 Procedures for Field Measurements - Passive Charcoal & Liquid Scintillation Devices-[AC] [LS]****4.1 Deployment and Retrieval Procedures:**

- A) An AC/LS device may be used as a primary or secondary device in any radon measurement activity. All devices used will be used according to manufacturer specifications and in compliance with IEMA-IDNS testing protocol in accordance with 32 ILAC 422.130 and 32 ILAC 422.140.
- B) A short term measurement shall range in duration from 48 hours to 90 days depending upon the measurement device used.
- C) As outlined in Appendix D, Technicians and Professionals placing AC/LS devices will ensure that Closed Building Conditions were maintained at least 12-hours prior to test start time for tests lasting less than 96-hours.
- D) Adherence to proper deployment protocols are strictly followed according to 32 ILAC 422.130 and indicated in Appendix A.
- E) Technicians and Professionals retrieving AC/LS devices will ensure that proper retrieval protocols are followed according to 32 ILAC 422.130 and as indicated in Appendix C, including Closed Building Conditions outlined in Appendix D.
- F) Technicians and Professionals placing AC/LS devices in unoccupied homes shall ensure that the HVAC system is set and operating in the normal range, such as 72 degrees F, plus or minus 5 degrees F.

**4.2 Standards:**

- A) AmeriChoice prohibits the Use Of any owned or leased device by anyone other than the employees, contractors, or representatives of the company in accordance with 32 ILAC 422. The company will properly maintain and handle all AC/LS devices to ensure proper working order. Suspect devices will be promptly returned to manufacturer or authorized repair facility for inspection and/or repair.
- B) The company will observe IEMA protocols for Options in Real Estate Testing as indicated in Appendix F.

**4.3 Calibration:**

- A) AC and LS devices will be calibrated via AmeriChoice quality controls and at the analysis laboratory and according to the Calibration Plan outlined in SOP Procedure 6.0 and in accordance with 32 ILAC 422.

**4.4 Quality Controls:**

- A) Use of AC/LS devices during short-term testing requires Closed Building Conditions 12-hours prior to placement and for the duration of the test.
- B) Use of AC/LS devices during short-term testing will not be used in tests lasting less than 96 hours during periods of severe weather or high winds, as outlined in 32 ILAC 422.130 and 32 ILAC 422.140.
- C) AmeriChoice requires the placement of each AC/LS device in each property to be diagrammed in compliance with 32 ILAC 422.130, as indicated in Appendix B. The company requires a signed non-interference agreement prior to placement in compliance with 32 ILAC 422.130.
- D) Vacant properties are required to have HVAC systems running in "normal" mode and all tamper deterrent efforts must be maintained. Such tamper efforts may include one or all of the following: tamper tape on lowest level windows, property inspection, testing notification placards at each exit/entry of the property, or consultation with homeowner or owner's representative.

- E) Field Duplicate measurements for quality control purposes will be conducted by licensed associates as directed by the QAO.
- F) Duplicates will be deployed, recorded, and charted for quality control purposes as indicated in QAP Section 8.0 and Appendix E.
- G) Annual Audits of all measurement activities including Professionals and Technicians, and a representative sampling of no less than 30% of their work, will be made at least annually.

#### 4.5 Additional Equipment Required:

- A) Field Technicians and/or Professionals deploying AC/LS devices will ensure that sufficient ancillary equipment is available for each job site such as:
  - Tray tables or other equipment to store monitors at least 20" to 6' from the floor.
  - Tamper tape.
  - Writing utensils.
  - Business cards.

#### 4.6 Worker Protection Program:

- A) AmeriChoice will follow all OSHA guidelines when engaging in residential or commercial radon testing.
- B) The company will follow IEMA guidelines for worker exposure to minimize risk.
- C) Radiation exposure of employees shall not exceed 30 pCi/L or 0.3 WL, based on continuous workplace exposure for 40/hr/week, 52 weeks per year and shall not exceed 4 WLM over a 12 month period, using an equilibrium ratio of 50 % to convert radon exposure to WLM.
- D) Radiation exposure of all employees will be tracked and recorded continuously, to keep radiation exposure as low as reasonably achievable. Employees approaching the exposure limit will be reassigned non-exposure duties, such as office and support work. Exposure records will be reported annually to workers.
- E) Radiation exposure records will be retained in an Excel spreadsheet and retained for Agency inspection for 5 years. Attachment 3.

#### 4.7 Record Keeping and Reporting:

- A) SOP Section 8.0.

#### 4.8 References:

- A) 32 ILAC 422.130
- B) 32 ILAC 422.140

#### 4.9 Attachments:

### 5.0 Field Measurement Procedures – Testing of Commercial, Schools and Multifamily Buildings

#### 5.1 Deployment and Retrieval Procedures:

- A) AmeriChoice will develop and approve a Quality Assurance Project Plan for each project involving radon testing in commercial, multifamily, or school buildings, following USEPA's Quality Assurance Project Plan guidance.
- B) The company will develop and implement a Communication Plan for each project involving radon testing in commercial, multifamily, or school buildings with the intent to locate and evaluate the impact on radon concentrations of:
  - Unusual radon entry mechanisms and/or elevated radon concentrations on upper floors.

- Localized vacuums created by forced air systems such as: exhaust fans, spot exhausts, unbalanced air flows, leaky ductwork, sub-slab ductwork, and rooms used as return air plenums.
- C) Each Communication Plan will include an entry meeting, employee information sessions, and an exit meeting to explain findings.
- D) The company will attempt to characterize the effects on radon concentrations of:
  - Opened and closed doors.
  - Fresh-air makeup of rooms with exhaust fans but without makeup air.
- E) The company will attempt to identify and evaluate the impact on radon concentrations of:
  - Inappropriate energy conservation applications.
  - Structural features that affect soil gas entry, such as: expansion joints, utility chases, sub-slab access holes, utility access points, rooms used as return air plenums, and return ducts beneath the slab.
  - Crawlspace, especially those used as return air plenums.
- F) A company Professional will verify architectural drawings of the building, its characterization elements, and review the HVAC system.
- G) A company Professional will perform concurrent short-term screening tests throughout the building while completing the Device Placement Log and Floor Plan. Attachment 8
- H) A company Professional will perform additional diagnostic tests, as needed to complete characterization of the building.
- I) A company Professional will review characterization elements as necessary.
- J) A company Professional will complete a Final Written Report, which includes Device Placement Log and Floor Plan, for each building measured of the characterization. Attachment 8
- K) The company may use a combination of active and passive testing devices in commercial or school testing. Determining factors for the type of device used may be: project square footage, room and building use, occupancy, or availability of devices.
- L) All devices will be used according to manufacturer specifications and in compliance with IDNS testing protocol in accordance with 32 ILAC 422.130 and 32 ILAC 422.140.
- M) A short-term measurement shall range in duration from 48 hours to 90 days depending upon the measurement device used. A long-term measurement shall range in duration from 90 days to one year depending upon the measurement device used.
- N) All short-term testing, of 96 hours or less duration, of commercial, schools, and/or multifamily buildings requires Closed Building Conditions 12-hours prior to placement and for the duration of the test and as-best-as-possible for the duration of the test.
- O) Device Placement Log and Floor Plan shall be finalized for each school or commercial building in which radon or radon progeny measurements are made. All measurement devices, including duplicate measures and Blanks, shall be noted on the Device Placement Log and Floor Plan by serial number.
- P) Initial measurements shall be made in compliance with 32 ILAC 422.130(g). Such as:
  - Frequently occupied rooms shall be tested simultaneously.
  - The teacher or frequent user of the room being tested will be made aware of the detector and testing protocols.
  - The placement licensee shall perform and document a surveillance of the building to determine the rooms needing testing prior to placement.
  - Short-term measurements of at least 48 hours to 90 days, depending on the device used, and shall be made in all frequently occupied rooms in contact with the soil, whether the contact is slab-on-grade, a basement, berm, a room above a crawlspace or any combination.

- School and commercial building measurements of less than 96 hours duration shall be performed under Closed Building Conditions.
  - Frequently occupied rooms include classrooms, offices, conference rooms, gymnasiums, auditoriums, cafeterias and break rooms.
  - Testing will not be conducted in infrequently used areas such as storage rooms, stairwells, restrooms, utility closets, elevator shafts or hallways.
  - A minimum of one detector shall be placed per every 2,000 square feet of open floor area.
  - Schools and commercial buildings shall only be tested for radon during periods when the HVAC system is operating as it does normally when the buildings are occupied, even if the testing occurs when school is not in session or during long holidays.
  - Follow-up measurements shall be performed in every room with a short-term, initial measurement result of 4.0 pCi/L or greater.
- Q) Protocol requirements for specific schools and commercial building designs:
- Slab-on-Grade Design. Measure all frequently-occupied rooms in contact with the ground.
  - Open-Plan or Pod Design. If sections of a pod have moveable walls that can physically separate them from other sections, measure each section separately. If moveable walls are absent or inoperable, measure the pod as one room placing detectors every 2,000 square feet.
  - Crawlspace Design. Measure all rooms directly above an enclosed crawlspace.
  - Basement Design. In addition to measuring all frequently-occupied basement rooms, measure all frequently occupied rooms above the basement that have at least one wall with substantial contact with the ground.

## 5.2 Standards:

- A) AmeriChoice prohibits the Use Of any owned or leased device by anyone other than a company employees or its contracted representatives in accordance with 32 ILAC 422.
- B) The company will properly maintain and handle all devices to ensure proper working order. Suspect devices will be promptly returned to manufacturer or authorized repair facility for replacement, inspection, and/or repair.
- C) A Professional licensee, employed or contracted, by the company, will be on the job-site during all measurement activities.
- D) A Technician licensee, employed or contracted by the company, will operate under the direct-supervision of a Professional licensee at all times.
- E) Non-licensed company staff shall operate on a commercial jobsite in a support role only such as for documentation and record-keeping purposes.
- F) At no time will non-licensed personnel engage in activities requiring a measurement Technician or Professional license.

**5.3 Calibration:**

- A) CRMs and EIC volt meters will be calibrated annually according to the Calibration Plan outlined in Section 9.0 of the AmeriChoice QAP and in accordance with 32 ILAC 422. As well, all CRMs will be cross-checked semi-annually and upon returning to company custody from maintenance, repair, or inspection with a recently calibrated monitor in the field. Calibration will be performed at the laboratory indicated in Section 9.0 of the company QAP and in accordance with 32 ILAC 422.

**5.4 Quality Controls**

- A) Duplicate measurements shall be performed and shall represent 10 % of all the devices deployed, or a maximum of 50 devices, whichever is less, within the building.
- B) Blank measurements shall be performed and shall represent 5 % of all the devices deployed, or a maximum of 25 devices, whichever is less, within the building.
- C) A Device Placement Log and Floor Plan shall be finalized for each school or commercial building in which radon or radon progeny measurements are made. All measurement devices, including Duplicate measures and Blanks, shall be noted on the Device Placement Log and Floor Plan by serial number. Attachment 8
- D) All short-term testing of school and commercial buildings requires the operation of the HVAC system to be operating normally, as would be found during normal usage of the buildings.
- E) For example, tests will be conducted during times of normal usage and not during weekend, holiday or other times when the building is not being used in its most occupied intended use.
- F) A Device Placement Log and Floor Plan shall be finalized for each school or commercial building in which radon or radon progeny measurements are made. All measurement devices, including Duplicate measures and Blanks, shall be noted on the Device Placement Log and Floor Plan by serial number. Attachment 8

**5.5 Additional Equipment Required:**

- A) Use of EICs may require a back-up supply of electrets and the use of portable tables.
- B) Use of AC devices requiring suspension may require rope or thumb tacks.
- C) Notification placards or "Radon Testing in Progress" notifications are required and will be attached to every device deployed.

**5.6 Worker Protection Program:**

- A) AmeriChoice will follow all OSHA guidelines when engaging in residential or commercial radon testing.
- B) The company will follow IEMA guidelines for worker exposure to minimize risk.

**5.7 Records and Reporting:**

- A) AmeriChoice requires all Professionals and Technicians to document each test site in compliance with 32 ILAC 422.130. The company QAO, Lin Marie Carey, will control the maintenance of all records and State reporting duties.
- B) In compliance with 32 ILAC 422.130(g)(5), the Radon Measurement Professional licensee shall recommend in writing to the school or commercial building management, owners, or representatives that a decision to mitigate not be based on initial measurement results.
- C) The company Professional will complete a Final Written Report, which includes Device Placement Log and Floor Plan, for each building measured of the characterization. Attachment 8
- D) Additional records and reporting standards to be maintained according to SOP Section 8.0.

5.8 **References:**

- A) 32 ILAC 422.130

5.9 **Attachments:**

- A) #8 Sample Report for Commercial, Schools, and Multifamily Buildings

**6.0 Procedures for Calibration and Testing of Instruments**

6.1 AmeriChoice controls the use of instruments and testing equipment as listed below. Electronic devices are calibrated at least every 12 months and prior to their first use after purchase so that their accuracy is maintained within required limits. Further, the company ensures that each instrument is calibrated at the indicated laboratory below, prior to its first use after it has been repaired and/or shipped. The company also ensures that Performance Checks at each use are conducted and initial/Semi-Annual cross/checks are conducted when a monitor is returning from lab for service/maintenance and against a monitor calibrated within the last 45 days from the field. Blanks, Spikes and Duplicates are conducted with passive devices according to test environment and manufacturer requirements in accordance with 32 ILAC 422.130.

6.2 Documentation of calibration is maintained as a quality control record.

	Device	Vendor/MFR	Make/Model	Lab/Chamber	Lab/Chamber	Lab/Chamber
1.	CRM	Sarad	Scout	Rad Elec, Inc.		
2.	CRM	Sun Nuclear	1027, 1028, 1029, 1030	Bowser-Morner	Gemmill Lab	Sun Nuclear
3.	CRM	Femto-TECH	CRM 510	Bowser-Morner	Gemmill Lab	
4.	EIC	E-Perm	ST, LT	Rad Elec, Inc.		
5.	CRM	Radalink	Telemonitor	Radalink Inc.		
6.	CRM	Radalink	Air Cat	Radalink Inc.		
7.	Electrets	E-Perm	ST, LT	Rad Elec, Inc.		
8.	Voltmeter	SPER-1E	SPER-1E	Rad Elec, Inc.		
9.	AT	RSSI	Alpha Track	RSSI	Gemmill Lab	Bowser-Morner
10.	AC	Air Chek	Hanging Bag	Air Chek	Gemmill Lab	Bowser-Morner
11.	CRM	AccuStar Labs	RS300, RS800	AccuStar Labs	Bowser-Morner	
12.	AC	AccuStar Labs	Open/Diffusion	AccuStar Labs	Bowser-Morner	
13.	AT	AccuStar Labs	AT-100	AccuStar Labs	Bowser-Morner	
14.	LS Vial	AccuStar Labs	CLS-100	AccuStar Labs	Bowser-Morner	
15.	LS Vial	Pro-Lab	LS Vial	Pro-Lab	Gemmill Lab	
16.	AC	Alpha Energy	Plastic Tray	Alpha Energy	Gemmill Lab	
17.	AT	Landauer	Rad Trak	Landauer Inc.	Gemmill Lab	

Analysis Laboratories and Calibration Chambers			
	Lab/Chamber	Service	Address
1.	Bowser-Morner	Calibration, Analysis, Blanks, Spikes, Dupes	4514 Taylorsville Rd. Dayton, OH 45424
2.	Gemmill Lab	Calibration, Analysis, Blanks, Spikes, Dupes	P.O. Box 413 Paupack, PA 18451
3.	Rad Elec, Inc.	Calibration, Analysis, Blanks, Spikes, Dupes	5716-A Industry Ln. Frederick, MD 21704
4.	Radalink Inc.	Calibration	5599 Peachtree Rd. Atlanta, GA 30341
5.	Sun Nuclear	Calibration	3275 Suntree Blvd. Melbourne, FL 32940
6.	Air Chek	Calibration, Analysis, Blanks, Spikes, Dupes	1936 Butler Bridge Rd. Mills River, NC
7.	AccuStar Labs	Calibration, Analysis, Blanks, Spikes, Dupes	11 Awl Street Medway, MA 02053
8.	RTCA	Calibration, Analysis, Blanks, Spikes, Dupes	2 Hayes Street Elmsford, NY 10523-2502
9.	RSSI	Analysis, Blanks, Spikes, Duplicates	6312 Oakton St. Morton Grove, IL 60053

**7.0 Procedure for Initial and Semi-Annual Crosschecks**

- 7.1 AmeriChoice will regularly conduct Initial and Semi-Annual crosschecks on monitors to check for bias.
- 7.2 Cross checks will be performed prior to placing an instrument being returned to service after calibration and at 6 months (plus or minus a month) after calibration. In compliance with 32 ILAC 422.130(A)(2)(F), the following conditions shall be met:
  - A) Where feasible, a crosscheck shall begin with an instrument background measurement.
  - B) The crosscheck measurement shall be made in an environment that has been chosen for its stability and radon concentration that is above the lower limit of detection.
  - C) Crosschecks shall be side-by-side measurements.
  - D) One of the instruments shall have been calibrated within the last 45 days.
  - E) A measurement of at least 48 hours duration shall be conducted.
  - F) The bias of crosscheck measurements shall be monitored and recorded in the quality assurance records.
- 7.3 If the estimated bias is not within the bias expected of the measurement, the cause of the problem shall be investigated and corrective action taken.
- 7.4 Corrective Action to be taken if the estimated bias is not within the bias expected of the measurement.
  - A) The monitor outside the expected bias shall be returned to the calibration laboratory listed in SOP Section 6.0 for recalibration.



## 8.0 Procedures for Maintenance of Documents, Records, and Reporting

- 8.1 AmeriChoice requires all Professionals and Technicians to document each test site in compliance with 32 ILAC 422.130.
- 8.2 Professional Licensee and QAO, Lin Marie Carey, will maintain and disseminate all records and reports to clients and the Agency. Measurement documentation will be maintained for a minimum of 5 years and shall include at a minimum:
- A) A complete copy of the measurement report.
  - B) A description of any non-interference controls used and copies of signed non-interference agreements.
  - C) A record of any quality control measures associated with the test, such as the results of simultaneous measurements, diagnostic measurements, duplicated measurements, and calculations associated with the measurements.
- 8.3 Records will be maintained in digital form at the corporate headquarters of AmeriChoice located at: 902 Linden, Normal IL 61761 for no less than 5 years from the test date.
- A) Records and reports will be maintained in a digital database and backed up regularly to an external hard drive, stated in QAP, Section 7 Equipment, and saved in a manner that protects the back-up device from fire, floods, or other calamity.
- 8.4 Client Reporting
- A) AmeriChoice requires the dissemination of test results to the client within 45 days of test completion. All reports of radon results will only be distributed in Complete Form at all times. A Complete Form Report, at minimum, must include the following:
    - Signed Non-Interference Agreement
    - Address
    - Footprint Diagram including detection device location, or
    - Attachment A site diagram of detection device location(s).
    - A record of quality control measures.
    - All valid individual measurement results shall be reported and include:
      - Measurement results shall be reported in the units that the device measures.
      - Any measurement results based on radon gas shall be reported to no more than one decimal place, e.g., 4.3 pCi/L.
      - All valid individual measurement results shall be reported.
      - When using continuous radon monitors, hourly readings shall be included.
      - Measurements made in separate locations shall not be averaged.
      - The average of collocated measurement devices shall be reported, as well as the individual results. Standard mathematical rules shall be followed; i.e., if the average of two measurements produces a result of 3.95 pCi/L, the result shall be reported as 4.0 pCi/L.
      - Any quality control measurements shall be reported as such.
    - Averaged Radon Results
    - Identification of Company
    - Company contact information
    - Name and license number of Placement Technician
    - Name and license number of Retrieval Technician
    - Name and license number of the laboratory analyzing the device (short term only).
    - Identification of Monitor including serial number and test number.

- Last Calibration Date
- Placement Time
- Placement Date
- Retrieval Time
- Retrieval Date
- Placement location
- Customer Name
- A statement describing recommendations concerning retesting or mitigation provided to the client, the occupant, the owner of the building, or his/her representatives.
- A statement of whether a mitigation system was observed in the building during placement or retrieval, including whether the mitigation system was operating.
- A statement describing any observed tampering, interference, or deviations from the required measurement conditions.
- A description of any permanent vents that allow outdoor air into the building, such as crawlspace vents or combustion air supply to combustive appliances.
- A description of any Severe Weather Conditions.

8.5 At no time will AmeriChoice allow an incomplete report to be distributed to a client or client's representative. The company will ensure this compliance by merging individual pages of the report into a secure PDF that cannot be digitally separated.

**9.0 Procedures for Responding to Complaints**

- 9.1 AmeriChoice accepts, assesses, and responds to suggestions and complaints from customers, regulatory agencies, and others in accordance with Section 9.0 of this document. This procedure includes documenting the suggestion or complaint, assessing it, determining how alternative resolutions may be applied, and carrying out a response. For disputes regarding radon activities, where resolution cannot otherwise be achieved, the company refers the complaint and complainant to the Illinois Emergency Management Agency, Division of Nuclear Safety (DNS) and abides by the DNS resolution decision.
- 9.2 Customer complaints regarding measurement protocol will be received and addressed immediately upon receipt. Correction action may include suspension or termination of employee and notification of violation(s) to IEMA.
- 9.3 Complaints, suggestions, discrepancies, and/or disciplines from the State will be recorded, tracked, and proactively used to amend the company SOP and/or quality controls if deemed appropriate.
- 9.4 An annual review will be conducted of complaints, suggestions, discrepancies, and/or disciplines from the State.

**10.0 Procedures for Corrective Actions**

- 10.1 The AmeriChoice corrective action program assures the prompt incorporation of the proposed remedy and the verification of its effectiveness. Corrective actions – whether they originate in a periodic review, an annual review, or from suggestions or complaints – are determined and implemented in a timely manner.
- 10.2 The company SOP details appropriate corrective actions to specific procedural items.
- 10.3 It is the policy of AmeriChoice to implement corrective actions immediately upon submission by the QOA. The QAO may delegate corrective action duties to an appropriate employee as necessary, with results expected in a timely manner.
- 10.4 Noted trends of employee negligence and/or disregard for Company or State protocols will result in immediate termination of employee.
- 10.5 Non-personnel related Quality Control errors or negative trends, including equipment failure, will be corrected immediately and recorded for future comparative analysis.
- 10.6 Device manufacturers will be notified immediately of any corrective actions involving equipment failure or malfunction.

**11.0 New Construction Testing Conditions**

- 11.1 Newly constructed buildings shall not be tested for radon or radon progeny unless the installation of the following items is completed:
- A) All insulation
  - B) All exterior doors with associated hardware shall be installed prior to testing
  - C) All windows
  - D) All fireplaces and fireplace dampers
  - E) All heating, air conditioning, and plumbing appliances
  - F) All ceiling covers
  - G) All interior trim and coverings for the exterior walls
  - H) All exterior siding, weatherproofing, and caulking
  - I) All interior and exterior structural components
  - J) Any interior or exterior work that may adversely affect the measurement validity.
- 11.2 AmeriChoice employees and contractors will inspect for and indicate the presence of an active or passive mitigation system in New Construction homes and document the following information on the final radon report:
- A) Indicate the system design as PNC or ASD.
  - B) If PNC, inspect for compliance with PNC regulation according to 32 ILAC 422.160 including but not limited to:
    - Verify that the sump pit was not used as primary suction point unless the presence of radiant heat lines prevents the suction point location to be anywhere else.
    - All exposed and visible interior radon vent pipes shall be conspicuously identified with at least one label on each floor and in accessible attics. The label shall read "Radon Reduction System."
    - Verify the presence of an electrical circuit terminated to a single junction box in the attic.
    - Verify a minimum height of three feet piping length in attic to allow for the anticipated installation of a radon mitigation fan in the vent pipe.
    - If SMD is present, confirm the installation of an appropriate membrane according to 32 ILAC 422.150 and 422.160.
    - If ASD, confirm its functionality and indicate the mitigation tag number.
    - Confirm appropriate termination of radon vent pipe at least 12" from roof surface made watertight by an approved flashing without any other flashing or cap that would impede the exhaust from the radon vent.

**12.0 Post Mitigation Testing**

- 12.1 Post-mitigation measurements shall not be conducted if temporary radon reduction measures are in use.
- 12.2 Post-mitigation measurements shall be conducted to determine a system's effectiveness after a permanent radon reduction system has been fully operational for at least 24 hours but not later than 30 days following completion and activation of a mitigation system. The mitigation system shall be operated normally and continuously during the entire measurement period.
- 12.3 AmeriChoice employees and contractors will indicate the presence of the active mitigation system, confirm its functionality, and indicate the mitigation tag number for all systems installed after November 1, 2009.
- 12.4 Post-mitigation measurements shall be conducted in accordance with 32 ILAC 422.130, 422.150 and 422.160. Any deviation from these protocols warrant a request for variance from the Agency.

**Attachment A – Measurement Location Criteria and Placement Protocols**

- 1.0 Short-term or long-term measurements shall be made in each lowest structural area suitable for occupancy. For example, a split-level building with a basement, a slab-on-grade room, and a room over crawlspace shall have measurements made in each of the foundation types: the basement, a slab-on-grade room, and a room over the crawlspace.
- 2.0 Measurements shall be made in rooms that can be regularly occupied by individuals, such as family rooms, living rooms, dens, playrooms, and bedrooms.
- 3.0 Charcoal canisters of any type shall not be placed in bathrooms, kitchens, laundry rooms, spa rooms, or other areas of high humidity.
- 4.0 When the level of the home being tested is over 2,000 square feet, an additional test location is required for each 2,000 square feet of the level being tested.
- 5.0 Location: Measurement devices shall be placed in the general breathing zone and shall be:
- 6.0 Undisturbed during the measurement period.**
- At least 3 feet from doors, windows to the outside, or ventilation ducts.
  - Out of the direct flow of air from the ventilation duct.
  - At least 1 foot from exterior walls.
  - 20 inches to 6 feet from the floor.
  - At least 4 inches away from other objects horizontally or vertically above the detector.
  - At least 4 feet from heat, fireplaces and furnaces, out of direct sunlight, etc.
  - At least 7 feet from sump pits.
  - Measurement devices may be suspended in the general breathing zone and, if suspended, shall be 20 inches to 6 feet above the floor and at least 1 foot below the ceiling.
  - Measurements made in closets, cupboards, sumps, crawlspaces, or nooks within the foundation shall not be used as a representative measurement and shall not be the basis for a decision to, or not to, mitigate the radon level within a building.
- 7.0 Post-Mitigation Testing
- Post-mitigation measurements shall not be conducted if temporary radon reduction measures are in use.
  - Post-mitigation measurements shall be conducted to determine a system's effectiveness after a permanent.
  - radon reduction system has been fully operational for at least 24 hours but not later than 30 days following completion and activation of a mitigation system. The mitigation system shall be operated normally and continuously during the entire measurement period.
  - Post-mitigation measurements shall be conducted in accordance with subsections 1.0, 2.0, and 3.0 of Appendix A.
- 8.0 When Radon Measurements **Shall Not Be Made.**
- Measurements shall not be made unless reasonable certainty can be established that test conditions are acceptable and measurement protocols will be followed, in compliance with 32 ILAC 422. Conditions that shall warrant postponement of a test or re-test broadly include:
    - Extensive renovations involving structural changes or renovation of HVAC system.
    - When temporary radon reduction measures are detected. Any improper radon reduction efforts that may affect the measurement results identified prior to, during, or after initial, follow-up, real estate option, or post-mitigation measurements shall invalidate the

measurement results. The Radon Measurement licensee shall not conduct a measurement until the improper conditions have been corrected

- During periods of severe weather, where a test of less than 96 hours would be conducted.
- Suspicion of test interference.

B) Measurements shall not be made if temporary radon reduction measures have been implemented.

Temporary radon reduction measures include:

- The introduction of unconditioned air into the building; or
- Closure of normally accessible areas of the building; or
- Lowering the thermostat below its normal use range, such as 72 degrees F, plus or minus 5 degrees F.

9.0 Newly constructed buildings shall not be tested for radon or radon progeny unless the installation of the following items is completed:

- All insulation
- All exterior doors with associated hardware shall be installed prior to testing.
- All windows
- All fireplaces and fireplace dampers
- All heating, air conditioning, and plumbing appliances
- All ceiling covers
- All interior trim and coverings for the exterior walls
- All exterior siding, weatherproofing and caulking
- All interior and exterior structural components
- Any interior or exterior work that may adversely affect the **measurement validity**.

10.0 Prior to measurement device placement, the AmeriChoice licensees will also:

- Conduct an Initial Interview with seller/seller's agent and/or builder describing Closed Building Conditions
- Obtain a signed non-interference agreement signed by the homeowner; builder, seller, or seller's agent if testing is conducted for a real estate transaction. See Attachment 1.
  - Instructions describing closed-building conditions were provided for the person who controls the building.
  - If such an agreement cannot be obtained or will not be signed by the buyer, seller, occupant, real estate professional, or other individual in control of the property, the AmeriChoice licensee and/or contractor will indicate why the signature was not obtained. The agreement will be retained for inspection by the Agency. See Attachment 1.
- Place testing notice placards at each entrance of the building. See Attachment 2.
- Indicate test start time for accurate test retrieval time.
- Ensure the observance of Closed Building Conditions at least 12 hours prior to placement.
- HVAC system set to a normal temperature (68-77 degrees).
- Inspect for a passive or active radon mitigation system.
- Ensure that active mitigation system has been functioning for at least 24 hours prior to test start.
- Ensure that portable window fans are removed from the window or sealed in place.
- Leave a business card for the controlling party of the house.
- Conduct and document room surveillance via diagram. See Attachment 7.

- Diagram requirements must meet the following minimum criteria:
  - Drawn to scale and specify the diagram scale.
  - Identify areas of interest within each room, such as detector placement, primary secondary.
  - Indicate the direction of north
  - Specify the address
  - Specify the principal use of each room
  - Clearly identify each foundation type
  - Indicate all doors and windows
  - Include a key or legend



Attachment B – Sample Room Diagram Form

Section 422. Appendix E Diagram of Room Worksheet for Radon Measurements

This worksheet may be used in accordance with Section 422.130(o)(1)(L)(ii). Complete all areas of the worksheet and include a separate worksheet for each foundation type measured. A copy of each worksheet shall be retained as a permanent record and included as part of a measurement report in accordance with Section 422.130(o).

Placement of Measurement Devices

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

Measurement devices shall be (check all that apply):

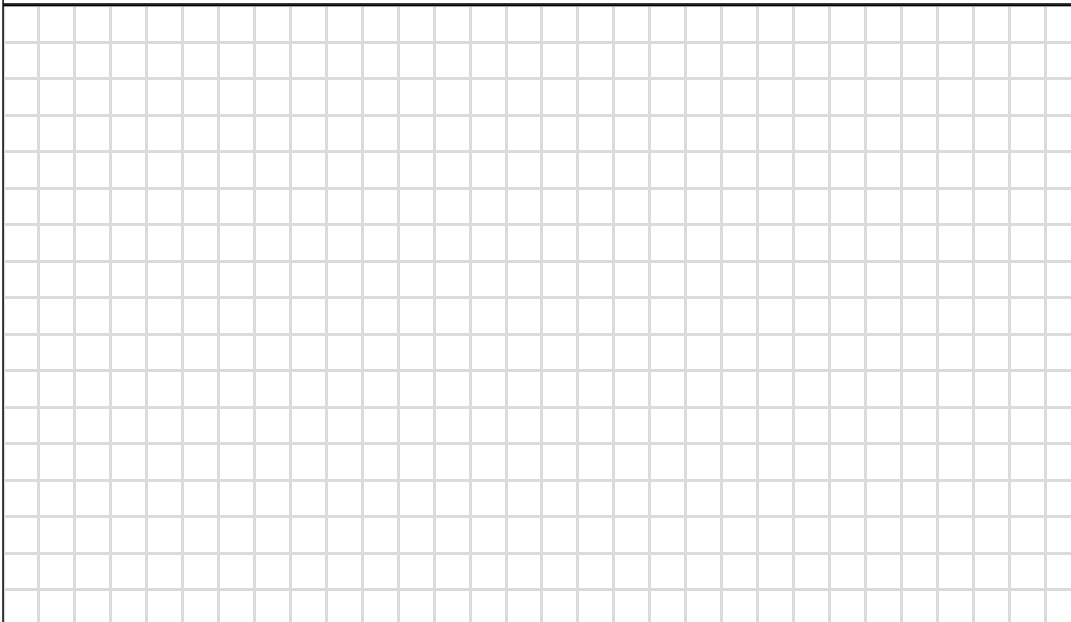
- [ ] Made in rooms that can be regularly occupied such as family rooms, living rooms, dens, playrooms and bedrooms.
[ ] Charcoal canisters shall not be placed in bathrooms, kitchens, laundry rooms, spa rooms or other areas of high humidity.
[ ] Undisturbed during the measurement period;
[ ] At least 3 feet from doors, windows to the outside, or ventilation ducts and out of the direct flow of air from the ventilation duct;
[ ] At least 1 foot from exterior walls;
[ ] 20 inches to 6 feet from the floor;
[ ] At least 4 inches away from other objects horizontally or vertically above the detector;

Diagram of Room Measured (The following information shall be included)

- 1) All windows and doors. Annotate exterior walls and the direction of north or the front of the building.
2) Factors that may effect the measurement, including but not limited to crawlspace vents, fireplaces, combustive appliances, floor drains, furnaces, dryers, water heaters and mitigation systems.
3) Include measurements (to the nearest inch) from the testing device to two separate walls.
4) Current room use (ex.: family room, bedroom, unfinished basement, playroom).
5) Address:
6) Device S/N(s)
7) Foundation Type

Key: D = Door, F = Furnace, EW = Exterior Wall, IW = Interior Wall, FD = Floor Drain, HW = Hot Water Heater
SP = Sump Pit, M = Monitor, SS = Security Sealed, EP = Ejector Pit, V = Ventilation, W = Window

One Square = . Height from Floor . X = Y =



**Attachment C – Measurement Retrieval Protocols**

- 1.0 Prior to retrieving any measurement device used in short-term or Real Estate Testing, the licensee shall ensure:
- A) All windows were kept closed during test.
  - B) All external doors kept closed except for normal entry and exit.
  - C) Whole-house fans were not operated during the test.
  - D) Window air conditioning units were only operated in recirculating mode.
  - E) Fireplaces or combustion appliances, except water heaters and cooking appliances, were not operated unless they are the primary sources of heat for the building.
  - F) Ceiling fans, portable dehumidifiers, portable humidifiers, portable air filters, and window air conditioners were not operated within 20 feet of the detector.
  - G) Tamper tape, if applied, was not disturbed.
  - H) HVAC system set to a normal temperature (6-77 degrees).
  - I) Detection devices were not disturbed.

**Attachment D – Closed Building Conditions**

- 1.0 A short-term measurement shall range in duration from 48 hours to 90 days, depending upon the measurement device used.
- 2.0 Closed Building Conditions shall begin at least 12 hours prior to the beginning of the measurement period for measurements lasting less than 96 hours.
- 3.0 Unoccupied homes shall be tested with the HVAC system set and operating throughout the measurement interval in the normal range, such as 72 degrees F, plus or minus 5 degrees F.
- 4.0 According to 32 ILAC 422.130.b.1.C, Subchapter b, the following conditions shall be complied with during closed-building conditions:
  - A) Operation of permanently installed HVAC systems shall continue during closed-building conditions. Radon Measurement licensees shall inform the resident in writing that operation of dryers, range hoods, bathroom fans, and other mechanical systems that draw air out of the building may adversely affect the measurement results.
  - B) In buildings having permanently installed radon mitigation systems, the mitigation system shall be functioning during the measurement interval.
  - C) Air conditioning systems that recycle interior air may be operated during closed-building conditions.
  - D) All windows shall be kept closed.
  - E) All external doors shall be closed except for normal entry and exit. Structural openings due to disrepair or structural defects shall be repaired to correct their condition prior to 32 ILAC 422.130, subchapter B initiation of Closed-Building Conditions. All exterior windows and doors shall be inspected by a Radon Measurement Professional licensee or Radon Measurement Technician at the placement and retrieval of the devices and the result of the inspection documented for the measurement file.
  - F) Whole-house fans shall not be operated. Portable window fans shall be removed from the window or sealed in place. Window air conditioning units shall only be operated in a recirculating mode. If the building contains an air handling system, the air handling system shall not be set for continuous operation unless the air handling equipment is specifically used for radon control and is so labeled.
  - G) Fireplaces or combustion appliances, except water heaters and cooking appliances, shall not be operated unless they are the primary sources of heat for the building.
  - H) Ceiling fans, portable dehumidifiers, portable humidifiers, portable air filters, and window air conditioners shall not be operated within 20 feet of the detector.

**Attachment E – Quality Controls for Residential and Real Estate**

- 1.0 AmeriChoice requires the placement of each CRM in each property to be diagrammed in compliance with 32 ILAC 422.130, including but not limited to:
- A) Drawn to scale and specify the diagram scale.
  - B) Identify areas of interest within each room, such as detector placement, primary secondary.
  - C) Indicate the direction of north.
  - D) Specify the address.
  - E) Specify the principal use of each room.
  - F) Clearly identify each foundation type.
  - G) Indicate all doors and windows.
  - H) Include a key or legend.
- 2.0 The company requires a signed non-interference agreement prior to placement in compliance with 32 ILAC 422.130. Attachment 1
- 3.0 Vacant properties are required to have HVAC systems running in “normal” mode and all tamper deterrent efforts must be maintained. Such tamper efforts may include one or all of the following: tamper tape on lowest level windows, property inspection, testing notification placards at each exit/entry of the property, and consultation with homeowner or owner’s representative.
- 4.0 Field Duplicate measurements for quality control purposes will be conducted by licensed Company associates as directed by the QAO.
- 5.0 Duplicates will be deployed, recorded and charted for quality control purposes as indicated in QAP Section 8.
- 6.0 “Radon Testing in Progress” sign will be posted at each exit and entry to the home in accordance with 32 ILAC 422.130. Attachment 2.
- 7.0 Annual Audits of all measurement activities including Professionals and Technicians, and a representative sampling of no less than 30% of their work, will be made at least annually.
- 8.0 Known Exposure Measurements (Spikes). Known exposure measurements or spiked samples consist of devices that have been exposed to known concentrations in a radon chamber. These devices, such as charcoal canisters, alpha track devices and EICs, are labeled and submitted to the laboratory in the same manner as ordinary samples to preclude special processing.
- A) Licensees using passive measurement devices shall conduct spiked measurements at a rate of 3 per 100 measurements, with a minimum of 3 per year and a maximum required of 6 per month. Devices shall be exposed in a radon chamber at a minimum of three different radon concentrations, such as approximately 4.0, 10-30 and 30-100 pCi/L.
  - B) Spikes shall be labeled in the same manner as field devices to ensure identical processing. The results of analyses of devices exposed to known radon concentrations shall be monitored and recorded. Any significant deviation from the known concentration to which they were exposed shall be investigated and corrective action taken.
- 9.0 Background Measurements. Background measurements are required both for continuous monitors and for passive devices requiring laboratory analysis.
- A) Licensees using continuous monitors shall perform sufficient instrument background measurements to establish a reliable instrument background and to act as a check on instrument operation.
- 10.0 Licensees using passive devices shall employ field controls (called Blanks) equal to approximately 5 % of the devices that are deployed, or 25 each month, whichever is smaller.

11.0 Duplicate Measurements. Duplicate measurements provide a check on the precision of the measurement result and allow the user to make an estimate of the relative precision.

- A) Duplicate measurements shall be side-by-side measurements made in at least 10 % of the total number of measurement locations, or 50 each month, whichever is smaller. The locations selected for duplicate measurement shall be distributed systematically throughout the entire population of samples.
- B) The precision of duplicate measurements shall be monitored and recorded in the quality assurance records. The analysis of data from Duplicates shall be plotted on range control charts. If the precision estimated by the user is not within the precision expected of the measurement method, the cause of the problem shall be investigated.
- C) Devices shall be treated identically in every respect. They shall be shipped, stored, opened, installed, removed, and processed together, and not identified as Duplicates to the processing laboratory.

**Attachment F – Options for Real Estate Testing****Option 1: Simultaneous Testing**

- Simultaneous testing shall be comprised of a minimum of 2 indoor radon measurements conducted simultaneously with similar measurement devices.
- Simultaneous tests shall be:
  - Co-located and spaced 4 to 5 inches apart;
  - Exposed for the same measurement period; and
  - Produce results in the same units (pCi/L or WL).
- The results of both measurements and the average of the simultaneous measurements shall be reported and shall be considered appropriate as the basis for determining the need for mitigation.
- Simultaneous measurement results that are both less than 4.0 pCi/L shall agree with a Relative Percent Difference (RPD) of less than 67 %. RPD is the difference between the 2 results divided by the average of the 2 results times 100. If the RPD is greater than 67 %, the Radon Measurement Professional licensee shall investigate, document and correct the sources of the error.
- When one of the measurements is equal to or greater than 4.0 pCi/L and one is less than 4.0 pCi/L, and the higher result is greater than twice the lower result, the client shall be informed of the large discrepancy and the simultaneous measurements repeated at no added cost to the client.
- Simultaneous measurement results that are both equal to and greater than 4.0 pCi/L shall agree with a RPD of less than 36 %. If the RPD is greater than 36 %, the Radon Measurement Professional licensee shall investigate, document, and correct the sources of the error.
- The precision of simultaneous measurements shall be monitored and recorded in the quality assurance records. The analysis of data from simultaneous measurements shall be plotted on range control charts. If the precision estimated by the user is not within the precision expected of the measurement method, the cause of the problem shall be investigated and corrective action taken in accordance with the company QAP.

**Option 2: Continuous Monitor Testing**

- This option requires an active continuous monitor that has the capability to integrate and record a new result at least hourly. Shorter integration periods and more frequent data logging afford greater ability to detect unusual variations in radon or radon progeny concentrations.
- The minimum test measurement period shall be 48 hours. The first 4 hours of data from a continuous monitor may be discarded or incorporated into the result using system correction factors. There shall be at least 44 contiguous hours of usable data to produce a valid average.
- The "backing out" of data (i.e., removal of portions imbedded in the 44 contiguous hours of monitoring) shall invalidate the measurement.
- The periodic results shall be averaged to produce a result that is reported to the client.