MS-QA Summary

This standard of practice specifies minimum requirements for measurement systems designed to quantify the concentration of ^{222}Rn gas in air, whose data are intended to be used to determine the need for, or success of, mitigation. This standard is applicable to the wide variety of radon measurement devices used for indoor measurements, primarily in residential environments or buildings not associated with the possession or handling of radioactive materials. These requirements do not directly apply to the measurements made by non-trained individuals such as homeowners because such measurements fall outside of a cohesive quality system. **The necessity for QA/QC is to document in-control (stable) operations, and a record (even of all passing) QC checks is necessary to defend the validity of reported measurements.**

All QC checks are for >= 48 h. ***Warning limits*** are set at the deviation from stable, in-control performance that would be expected to occur by chance only 5% of the time, and ***control limits*** are set at the deviation from stable, in-control performance that would be expected to occur by chance only 1% of the time. Failed checks should be repeated before investigation and correct action. Note that some checks may fail (5% and 1%) even if the system is in control. Document everything. All measurement professionals and labs need a QA Plan and logs of their QC checks.

CRMs, defined as an electronic device that (1) is capable of automatically recording a continuous series of numeric measurements of radon concentration averaged over time intervals of 1 hour or less; (2) has a minimum detectable concentration (MDC) of no greater than 4 pCi/L for a 1-hour measurement; and (3) has a calibration factor of at least 2 cph per pCi/L.

CRM QC: 3 requirements: instrument checks, comparison checks, and annual calibrations.

(1) **Instrument checks** as per manufacturer					
(2) **Comparison** checks		Average of the CRM and another measurement (may be another CRM), with RPD= (larger result – smaller result), although should document results so would notice a consistent bias which requires investigation			
Does not have to be another CRM. (If compare with another CRM of same model and calibration history, that is a true duplicate.)	Every 10th measurement		< 2.0 pCi/L	≥ 2.0 and < 4.0 pCi/L	≥ 4.0 pCi/L
Comparison check is recommended when receiving CRMs into custody from a recalibration or as new	These limits were derived from an assumed in-control imprecision represented by an RPD of 14% (this value is the same as a COV of 10%) for conc's >=4 and 25% RPD for conc's <4 using chi-squared statistics because there are 2 distributions, one for each in the pair	Warning Limit RPD		>50%	>28%
		Control Limit RPD	Absolute value of the difference between the results ≤ 1.0 pCi/L, or both are less than the MDC	>67%	>36%
(3) **Calibration**	Annually	Calibration exposure in chamber > 24 h	Background assessed for at least 16 h	Concentration as recommended by manufacturer	

Calibration exposures, ALL METHODS, must be conducted in chamber exposures between 10 and 80 pCi/L.
CRM calibration stickers that are visible on the outside of the CRM must include the date of calibration, due date for recalibration, serial number, and facility. *If there are factors that are required for the user to calculate concentration*, these must be included, such as instrument background value as assessed (or assumed, if necessary, for the method) in units applicable to the method (count rate or concentration), and calibration factor (response/concentration).

Exception: If instruments offer field results accessible only by the manufacturer or approved third parties, a calibration sticker shall provide field measurement providers with all relevant information that is required by state or other relevant credentialing authorities.
CRM calibration reports include all the information on the sticker, plus duration of exposure, average radon concentration(s) during calibration, temp, RH and BP (as per NIST recommendations and committee).

Field QC for ATD, CAD, EIC: *Must have a QA Plan (can be short if only deploying/shipping, but still must document QC,* ***especially if all pass, because without a QAP and a record of QC checks, there is no way to prove the system is in control, and data are not legally defensible) containing the following at a minimum:***

(1) blanks-5% or a maximum required of 25/mo. Investigate/corrective action if any blank > MDC (EICs if >6 v/m or as per manufacturer).
(2) Spikes-3%, or maximum required of 6/m, and no less than 3/y. Warning Limit if RPE (RPE is the same statistic as IPE=diff/spike value) outside the range of 0 ± 20%, and Control Limit if outside the range of 0 ± 30%.
(3) Duplicates-10%, with same limits as Comparison Checks for CRMs.

ATD, EIC, and CAD methods calibration: *If the device configuration is affected by temperature and relative humidity*, as are charcoal adsorption methods, calibration exposures are to expose at least five, and preferably more, devices at a time in an exposure calibration chamber to combinations of three parameters. These include separate exposures to environments of:

a) three different relative humidity ranges, including an RH less than 30%, an RH between 40% and 60%, and an RH greater than 60%;
b) two different temperatures, including one greater than 70° F; and
c) at least three different durations/integrated concentrations.

Recalibrations when QC results fail, there is a change in material (so batch-specific calibration factors are required), or new analyzers.

EIC ANALYSES: Use and record the QC electrets (zero electret and at least one reference electret) at least once every analysis session. Zero and reference electrets must be recalibrated annually. Initial and final voltage must be read by the same reader and in the same location, where RH is < 60% and does not change by more than 10% between the initial and final voltage readings, and temp and RH are documented. Spikes at 3% with 6/m the necessary maximum, and no fewer than 3/y.

Laboratory spikes: 3/100 devices; maximum necessary of six per month.
Laboratory duplicates (and/or recounts of same detector): 10%, and have the same limits as CRM comparison checks, although recommend that all labs (we hope already do) develop their own limits based on their own QC results.

LAB CHARCOAL: (a) analysis session background counts, (b) laboratory QC standards for session efficiency and (c) at a frequency of at least 3%, laboratory spikes.
LAB CAD-LS: Calibrations must be performed with Ra226, but daily instrument checks (DIC) can be done with H3 or C14.

If statistical analyses (examples listed in MS-QA) demonstrate that there is less than a 5% probability that the most recent set of QC checks come from a different population of QC checks (based on a comparison of both mean and variability) than either the original post-calibration set of at least 20 of each type of lab QC check or the set from the most recent QC interval, **the calibration period can be extended beyond 12 months**, for up to 5 years. The results of such analyses are to be available to auditors for review.