

Important Measurement Professional Course and Exam Content

Evaluate the Test Site / Measurement Tech Section

MAH 8.5.7 Report radon mitigation system status (if applicable)

Where a mitigation system or efforts to mitigate radon are observed, the test report **shall** include:

- a. a statement that a mitigation system was observed and whether it appeared to be operating.
- b. a statement regarding the condition of any temporary radon mitigation strategies that are not permanent installations, and
- c. a statement on the limits of the inspection. Providing a statement in the report that the test company offers no findings as to the proper installation and operation of the mitigation system is permitted.

Note—Appendix A in the attached MAH Companion Guidance discusses general inspection of radon mitigation systems

Perform the Test / Measurement Tech Section

Blanks: A type of quality control (QC) check that quantifies detector response due to factors other than the measurement itself. Blanks are devices deployed to measure effects on the measurement result from anything other than the environment tested, i.e., effects caused during storage, shipping, handling and transport. The purpose of blanks for in-control operations is to verify and document the lack of influence of factors encountered outside the measured environment; their records are necessary to support data validity.

Duplicate or Comparison Check Measurements: pairs of detectors or monitors deployed in the same location, side-by-side for the same measurement period. The purpose is to evaluate and track imprecision or agreement between detectors or monitors across time.

MS-QA 3.3.2 Field Operations—Blind Blanks and Spikes

Informative advisory—When field blanks and field spikes are processed at an independent analysis laboratory, they should be treated and labeled as other returned detectors and are not to be identified as blanks or spikes to the analyst because the objective of field QC is to monitor the stability of field operations and procedures. If there are more restrictive requirements, including those by credentialing authorities that may require the demonstration of a minimum proportion of QC detectors and chain of custody, then that authority supersedes this standard

MS-QA 5.2.1 Field Operation Blanks—Frequency and Procedures

Users of EIC, ATD, and CAD detectors **are responsible** for setting aside at least 5% of the number of measurements or a maximum required of 25 per month to be used as blanks. If using detectors with different configurations, even when from the same manufacturer, the same **requirement applies** for each different configuration, including differences in both the design of the detector as well as the type and source of the sensitive material used in the CADs and ATDs.

Procedures related to detector packaging and shipping, such as opening and immediately closing detectors, **shall** be done in conformance with manufacturer recommendations for handling blanks.

MS-QA 5.2.1 Field Operation Blanks—Distribution

Blanks **are to be** distributed among all the environments where the devices are handled, stored and transported. Therefore, careful logging of location and time for all detectors used as blanks is **required**.

Measurement providers **should** follow manufacturer’s instructions regarding the following three types of blanks:

- a. **Field Blanks** - A portion of the required 5% blanks **shall** be field blanks with additional blanks dedicated, if deemed necessary, to other evaluations such as for storage, office or trip blanks. Field blanks verify that there have been no unexpected influences during all conditions within the chain of custody. Therefore, field blanks **are to be** handled and placed exactly as the routine devices used for testing, except that the blanks are not used to measure radon concentration. Each field blank **is to be** carried through all steps in the measurement process, which, depending on the configuration of the device and seal, may include opening and immediately resealing the detector and may include doing so in the environment being tested.
- b. **Office/Storage Blanks** - Office blanks verify that there were no influencing factors that occurred during storage or in-office handling. If CAD or ATD inventories are stored in a low-radon environment, RH extremes are recorded, and this information is documented and available upon request to auditors, then office blanks **need not** be used, as long as this is consistent with the manufacturer’s directions. Otherwise, CAD and ATD users who cannot store devices in a monitored environment **are responsible** for setting aside at least approximately 5% of their devices (or as directed by the QA manager) as storage blanks.
- c. **Lab-Transit Blanks** - (or “trip”) blanks verify/document the lack of influences during shipping.

Detector Placement – Technicians should know WHY detectors should not be placed:

- inside closets, cabinets, sumps, crawlspaces, or nooks within the building foundation.
- near heat sources, such as on appliances, radiators, fireplaces or in direct sunlight.
- near drafts caused by fans or heating and air conditioning vents or in enclosed areas of high air velocity such as mechanical/furnace closets.
- within enclosed areas of high humidity such as bathrooms, laundry rooms and kitchens that are isolated from large open areas by partitions or other enclosures.

Exception: Such locations should be avoided but are permitted for detector types that are virtually unaffected by high humidity. Confirm manufacturer or laboratory requirements or recommendations prior to exercising this exception.

Informative Advisory—Avoid placing detectors on or near objects that may produce radiation such as natural stone (e.g., rock collections, granite counter tops, hearths, or slate pool tables).

MAH 5.4.1 Testing individual dwellings within a shared building

When testing only one or several dwellings that are part of a shared building (e.g., duplex, townhouse or apartment) and there are dwellings or occupied units above or below the dwelling(s) to be tested, closed-building protocol conditions **are required** for all portions of the building, including dwellings above and below the tested dwelling(s).

Exception—Testing **is permitted** if closed-building conditions in other dwellings are not achieved when it is beyond the control of the person(s) conducting the test. However, this situation **requires** that the conditions, circumstances, and appropriate recommendations are described in writing for inclusion with reports when distributed.

Note—It is best to choose test periods when closed-building conditions exist for the whole building.

Communicate Basic Radon Science / Measurement Professional Section

MAH 5.1.2 Long-Term testing

For test durations greater than 90 days, closed-building conditions are **not required**. However, if the goal of the long-term testing is to more closely evaluate annual exposures to radon in a home, the test period duration **is to include** heating season conditions that are not less than the percentage of the year when heating systems are active.

Manage QA/QC Program / Measurement Professional

Blanks: A type of quality control (QC) check that quantifies detector response due to factors other than the measurement itself. Blanks are devices deployed to measure effects on the measurement result from anything other than the environment tested, i.e., effects caused during storage, shipping, handling and transport. The purpose of blanks for in-control operations is to verify and document the lack of influence of factors encountered outside the measured environment; their records are necessary to support data validity.

MS-QA 4.2 CRM Comparison Check Requirements

Note—*Comparison checks are collocated*, simultaneous measurements conducted for at least 48 hours to verify and document the continued stable and in-control operation of a CRM by comparing a result to another radon measurement device not necessarily of the same method category. The purpose of both a *comparison check* and a *duplicate* is to verify and document that there have been no increases in the measurement system imprecision since the last passing QC check or calibration.

MS-QA 4.2.1 CRM Comparison Checks—Frequency and Procedure

Comparison checks are to be made with approximately every tenth measurement (i.e., 10%), so that the checks are distributed across the range of conditions, operators and usage patterns experienced by the radon measurement provider. CRMs used in a comparison check **are to be** operated in the manner that they are typically deployed in the normal course of business. The results of comparison checks **shall** be recorded and analyzed so that the QP better understands the expected imprecision during routine, stable operations (e.g., “in-control” conditions).

Duplicates - pairs of detectors or monitors deployed in the same location, side by side for the same measurement period. Their purpose of is to evaluate precision or agreement between detectors.

MS-QA 5.4.1 Field Operation Duplicates (EIC, ATD, CAD) —Frequency and Procedures

Field operation duplicates **are to be** deployed in approximately one in 10 measurements, or 10% the time. Large projects involving more than 20 measurements are to include some duplicates.

Conducting duplicates **is to** include exposing identical, collocated devices (see Definitions) simultaneously for at least 48 hours, submitting them for analysis without identification as duplicates (blind) and then comparing the two results. The results of each duplicate pair are to be recorded and plotted on control charts for evaluation.

MS-QA 5.3.1 Field Operations Spikes—Frequency and Procedures

Users of CAD, ATD and EIC methods **are responsible** for setting aside at least 3% of the devices deployed for field measurements as spikes, arranging for and interpreting their results with six per month being the necessary maximum and no less than three per year.

If using detectors of different configurations, even if from the same manufacturer, the same **requirements apply** for each different configuration, which includes both the design of the detector as well as the type and source of the charcoal or alpha track sensitive material. In addition

Conduct and Validate Measurement Data / Measurement Professional

MS-QA 3.5 Default Minimum Criteria for Warning and Control Limits for Duplicates and Spikes

In all cases, warning and control limits **shall** be equal to or more stringent than the minimums provided in this standard.

The default interim limits presented in this standard were derived assuming a conservative “in-control” imprecision of an average relative percent difference (RPD) (for duplicates and comparison checks) of 14% in an environment with a radon concentration ≥ 4 pCi/L, and an average RPD of 25% in an environment with a radon concentration between 2 and 4 pCi/L.

The default interim warning and control limits presented here for spikes were derived assuming in-control operations produce a distribution of spike RPE results centered on zero, with a sample standard deviation of 10%.

1. In an environment with a radon concentration ≥ 4 pCi/L,
 - a. The warning limit **is** a result of a duplicate pair or comparison check exhibiting an RPD $\geq 28\%$.
 - b. The control limit **is** a result of a duplicate pair or comparison check exhibiting an RPD $\geq 36\%$.
2. In an environment with a radon concentration between 2 and 4 pCi/L,
 - a. The warning limit **is** a result of a duplicate pair or comparison check exhibiting an RPD $\geq 50\%$.
 - b. The control limit **is** a result of a duplicate pair or comparison check exhibiting an RPD $\geq 67\%$.
3. If the average of a duplicate pair or comparison check is less than 2 pCi/L, the warning limit **is** reached when there is a difference between the two results of more than 1.0 pCi/L, or if both results are not less than the minimum detectable concentration (MDC).
4. Any single spike result exhibiting a relative percent error (RPE) (or individual percent error [IPE]) outside the range of $0 \pm 20\%$ **has** exceeded the warning limit, and any single spike result outside the range of $0 \pm 30\%$ **has** exceeded the control limit.

If any duplicate pair result exceeds these criteria, which may happen even in a small percentage of perfectly operating, in-control operations (especially at low radon concentrations), then an investigation in consultation with the analyst or laboratory is **required** as described in Section 3.

MAH 7.2 When Two Test Results Disagree

7.2.1 Acceptable

When two test devices were deployed to test the same testing location, the average of the two test results **is to be** used for determining needs for mitigation if:

- a. both test results are above the action level, or
- b. both test results are below the action level.

Note—Some variation between detector results is typical. However, if the variation between collocated (Side-by-side) detectors is unusually large, it might indicate problems in the measurement system. For more information, see the attached MAH Companion Guidance Appendix B for example control limits that guide professional services.

7.2.2 Where test results disagree on exceeding the action level

When one test result is above the action level and the other test result is below the action level:

- a. **Acceptable**—If the higher result is less than twice the lower result, the average of the test results **is to be** used to determine if this location needs mitigation.
- b. **Not acceptable**—If the higher test result is more than twice the lower test result:

1. For two collocated (side-by-side) tests conducted at the same time, a repeated collocated test for this location **is required** to obtain a valid measurement.
2. For two tests conducted in the same location but at different times, obtaining confirmation on whether mitigation is warranted **requires** additional testing.

Note—If one test result is above the action level with the other test result below the action level and the higher test result is twice or more than the lower test result, obtaining confirmation on whether mitigation is warranted requires additional testing.”

Report Findings and Make Recommendations / Measurement Professional

MAH 8.4 Minimum Requirements for Efforts to Verify Test Conditions

To fulfill minimum requirements for verifying test conditions, all of the following steps **are required**:

- a. Inform the person responsible for building operation of the required test conditions.
- b. Post notification of a Radon Test in Progress in conspicuous locations stating the required conditions of the test.
- c. Request a signature on a noninterference agreement and note in the report if this document was not signed.
- d. Conduct visual inspections.

Visual inspections of the dwelling that evaluate observed conditions and document deviations from protocol and temporary conditions that might affect the test result **shall** be conducted by a qualified measurement professional:

- i. upon detector placement to help ensure all closed-building conditions and other protocol requirements are met; and
- ii. upon detector retrieval of the detector(s) to help verify that:
 - 1) closed-building conditions and other protocol requirements are still being maintained.
 - 2) detector placement has not changed; and
 - 3) tamper seals, if employed, have not been broken.

MAH 8.5 Test Reports

.5.1 Essential information

The following essential information **shall** be included in reports:

- a) The complete address of the building measured.
- b) Name of the company, contact information, and identification of the measurement professional responsible for adherence to protocols and their current certification ID numbers or equivalent state certification ID numbers as applicable.
- c) **Radon Information Sources.** The report **is to** include contact information of the State Radon Office or other local authority for where the test is conducted and information for obtaining federal or state guidance documents.

.5.2 Measurement results

Test reports **shall** comply with all of the following requirements.

- a) The test report **shall** contain the final result for each measurement location. The report shall also include:
 1. the detector model or type, the detector serial number(s) and the name and identification number of the service or organization used to analyze detectors; and

2. the beginning and ending dates and times of the exposure period and information on the detector locations such as a diagram, photos or narrative description.
- b. Radon gas results reported in picocuries per liter (pCi/L) **shall** be reported to only one digit after the decimal (e.g., 3.2 pCi/L). If the average of two measurements produces a result of ≥ 3.95 pCi/L, standard mathematical rules should be followed, and such average **shall** be reported as 4.0 pCi/L.
- c. The average of collocated measurement detectors **shall** be reported as well as the individual results.
- d. Measurements made in separate locations **shall not** be averaged. Detectors located more than 8 inches (20 cm) from each other **shall** be considered to be in separate locations. They **shall** be reported individually.

MAH 8.5.4 Report temporary conditions

A specific client advisory and description **shall** be included in the test report of observed temporary building conditions or other factors that may cause the test to not reflect the client's risk from radon, such as unusually local severe weather. This requirement also extends to the following conditions that **shall** be included in the report if:

- a. the property tested was vacant during the test period
- b. systems were temporarily ventilating with outdoor air for seasonal comfort or energy savings during the test period, including:
 1. Closable passive crawlspace vents were open during the test period but are normally closed in cold weather because of energy penalties or the likelihood of frozen water pipes. Note—Crawlspace humidity control systems that function during all seasons are not a temporary condition
 2. Window air conditioners did not have closed outside air dampers during the test period
 3. Evaporative cooling systems were operating or not covered during the test period
 4. Energy recovery or heat recovery ventilators were operating under one or both of the following conditions:
 - o the system was not set to the lowest outdoor air ventilation rate that occurs for any season

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REPORTING ELEVATED CONCENTRATIONS

EQUIVALENT STATEMENTS FOR THESE ADVISORIES **SHALL** BE INCLUDED IN THE REPORT

- **Fix the building.** Test results indicate occupants may be exposed to radon concentrations that meet or exceed the action level, e.g., 4 pCi/L or greater.
- Efforts to reduce radon concentrations are not complete until retests provide evidence of effectiveness.
 - Initiate short-term radon testing no sooner than 24 hours after a mitigation system is operational and within 30 days after installation of the system(s).
 - Test again at least **every 2 years** to ensure that the system remains effective.

If tested with only a single short-term passive detector

- If this test is a first test conducted using a single short-term passive detector, test this location again.
 - If the first short-term test is more than twice the action level (e.g., 8 pCi/L or more): conduct a second short-term test immediately. While decisions to mitigate at any time are not prohibited, the second test aids confidence that decisions are not being made based on a faulty test result.
 - If the first short-term test is less than twice the action level (e.g., 4 to 8 pCi/L) conduct either a short-term or a long-term test.
- If the average of two short-term tests or the average of a long-term test meets or exceeds the action level (e.g., 4 pCi/L or greater), fix the building.

Note—If one test result is above the action level with the other test result below the action level and the higher test result is twice or more than the lower test result, obtaining confirmation on whether mitigation is warranted requires additional testing.” (See next page)

REPORTING LOW RADON CONCENTRATIONS

EQUIVALENT STATEMENTS FOR THESE ADVISORIES **SHALL** BE INCLUDED IN THE REPORT

- Consider fixing the building if test results indicate radon concentrations greater than half the action level, (e.g., between 2 and 4 pCi/L).
- Note that tests conducted when heating systems are active both day and night are more likely to provide a clear characterization of potential radon hazards.

For continued protection against long-term exposure to a radon hazard

- Retest the building **at least every 5 years** or to verify continued effectiveness of radon mitigation systems or efforts, at least every 2 years.
- Retest in conjunction with any sale of new or existing buildings.
- In addition, be certain to test again when any of the following circumstances occur:
 - a new addition is constructed or alterations for building reconfiguration or rehabilitation occur
 - a ground contact area not previously tested is occupied, or a home is newly occupied
 - heating or cooling systems are significantly altered, resulting in changes to air pressures or pressure relationships;
 - ventilation is significantly altered by extensive weatherization, changes to mechanical systems or comparable procedures
 - significant openings to soil occur due to:
 - groundwater or slab surface water control systems that are altered or added (e.g., sumps, perimeter drain tile, shower/tub retrofits, etc.) or,
 - natural settlement causing major cracks to develop
 - earthquakes, construction blasting, or formation of sink holes nearby; or
 - a mitigation system is altered, modified, or repaired.

Oversee and Train Measurement Techs / Measurement Professional

While the “typical equilibrium ratio” between radon and its RDPs is assumed to be 0.5 (50%), WHEN CALCULATING WORKER EXPOSURE, the Measurement Professional must assume a worst-case ER of 1 or 100%.