Public Review:
Performance Specifications for
Home Radon Alarm Listing Requirements

COMMENT DEADLINE: May 15, 2014.

REQUESTED PROCESS AND FORM FOR FORMAL PUBLIC REVIEW COMMENTS

Submittals *(MS Word preferred) may be attached by email to* RadonAlarmListingReview@gmail.com

CARST Home Radon Alarm Committee has developed a Performance Specification by which a Listing Agency would review devices as submitted by manufacturers and post a list of approved devices.

The intent of establishing a *Home Radon Alarm Listing* is to assist all Canadians in becoming aware if their home is exposing them to radiation caused by radon above 200 Bq/m^3.

The goal is to encourage installation of a radon alarm into all homes across Canada, including new home builds and existing housing stock. The result of having an approved listing would provide homeowner's and home builders with knowledge about which devices have met the requirements of these Performance Specifications.

Home occupants are advised to have a radon test conducted by C-NRPP certified radon measurement professional should the home radon alarm go into alarm, and if radon levels are elevated the home occupant would be advised to retain a C-NRPP certified radon mitigation professional to provide advice and services to mitigate the house.

1*) Do not submit marked-up or highlighted copies of the entire document.*

2*) If a new provision is proposed, text of the proposed provision must be submitted in writing. If modification of a provision is proposed, the proposed text must be submitted utilizing the strikeout/underline format.*

3*) For substantiating statements: Be brief. Provide abstract of lengthy substantiation. (If appropriate, full text may be enclosed for project committee reference.)*

REQUESTED FORMAT

Please include the following information on all submissions.

- Title of Public Review Draft: **Draft HRAL-01**
- **Name:**
- **Affliation:**
- **Clause or Subclause**:
- **Comment/Recommendation**:
- **Substantiating Statements**:
- [___] Check here if your comment is supportive in nature and does not require substantive changes in the current proposal in order to resolve your comment.

Repeat the seven above bullet items above for each comment.

Each Commenter must also submit **Contact Information** and a **Copyright Release.**

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The goal of this performance specification is to provide manufacturers, laboratories, chambers and certifying agencies with the design and performance requirements for Home Radon Alarms. Any device accepted by the Listing Agency shall have met the specifications set out in this document.
Note: *This document does not warrant nor imply that the devices meeting this specification pass CSA, ESA, ULC, or similar electrical or operating safety standards of any type.*

1. Scope

This performance specification provides a minimum performance criteria for devices used as home radon alarms to indicate elevated Rn^{222} (radon) gas concentrations in indoor air in a *residential situation* only. It includes devices which are designed and intended for *homeowners to use in their own home* to indicate the need to have a C-NRPP certified professional complete device radon test.

The details in this performance specification include guidelines for:

- Performance and testing criteria
- Device location specifications
- Device measurement time periods
- Device alarm requirements
- Independent Testing Requirements
- Calibration requirements
- Requirement for Ongoing Quality Assurance and Quality Control Program by Manufacturer
- Information required to be provided to homeowners

2. Purpose

This specification is intended to give minimum performance criteria for a class of radon testing devices that serves to alert a homeowner to the need to perform a radon test using a listed device that can enable them to make a mitigation decision. It is not intended to be used for devices for commercial purposes nor professional radon concentration measurements. It is not intended to cover devices used to make mitigation decisions.

3. Definitions

$Bq \cdot h/m^3$ - the time integrated radon concentration; has units of radon activity concentration multiplied by time

ElectroStatic Discharge (ESD) - The transfer of electric charge between objects bearing different electrostatic potentials (voltages) as a result of direct contact or close proximity to one another.

ElectroMagnetic Interference (EMI) - A disruption in the normal operation of an electronic device due to induced electromagnetic behaviour or electromagnetic radiation generated by an external source.

Exposure - (i.e. $Bq \cdot h/m^3$).

Integration Time Periods:

Continuous Integrated Test Reporting Duration - Period of time over which a mean radon concentration is calculated.

Minimum Test Reporting Duration - Period of time which a Measurement based on an air sample collected within a period comparable to the duration of the half-life of radon.

Minimum Allowable Elevated Integrated Concentration - Measurement based on an air sample collected over a period greater than 30 days.

Minimum Detectable Concentration (MDC) - The smallest amount of activity in a measurement sample that can be detected within a fixed level of certainty (typically 95%). It is the minimum radon concentration that must be present in a sample to give a specified probability of detection.

Occupiable Level - An area that may not be currently occupied but could potentially be occupied by an individual for periods of more than 4 hours per day

Quality Assurance (QA) - A program which has been established to monitor and evaluate activities, including the establishment and adherence to Type Testing procedures, use of proper documentation of the Type Testing results and implementing steps of Quality Improvement, as required to ensure standards of quality have been met. A QA program establishes Minimum Detectable Concentrations, Accuracy Specifications, and Audibility Requirements.

Quality Control - Conducting measurements to ensure the performance of a testing device meets pre-established performance standards; these measurements include back ground, response to known radon concentrations, and sound levels.

Quality Improvement - A dynamic process practiced by the Quality Department within an organization to ensure its Quality Control procedures comply with the evolving requirements of normative standards and industry guidelines

Reference Radon Calibration Chamber - A radon test facility (often called a "radon chamber") which provides a standard test atmosphere for radon concentration measurement and has been accepted by the listing agency. The chamber provides sufficient size, configuration, radon concentration range, and radon concentration controls that testing may be conducted in a radon-in-air atmosphere that is stable or can vary controls (increasing or decreasing) with precision that exceeds the precision of the device being tested.

Type Testing - A series of tests performed to qualify the design and performance of the device addressed by this protocol. Type Tests are performed on a single unit provided by the manufacturer for this purpose as a representative of the technology.

Type Test Unit (TTU) - A device provided by the manufacturer for type testing. The TTU is manufactured at the same facility, using the same personnel, procedures, equipment, and components/materials as the commercial units provided to homeowners at large.

4. Units of Measure

All measurements are expressed in International System (SI) or metric units. Base units are as follows:

- · length = metre (m),
- · mass = kilogram (kg),
- · temperature = °Celsius (°C),
- · pressure = pascal (Pa),
- · activity (decays per second) = becquerel (Bq)
- · exposure = Becquerel hour per cubic metre (Bq.h/m^3)

5. References

(Note: The most recent version of all References shall apply EXCEPT where noted.)

The following documents are for reference only. The listing agency is not able to demonstrate that the manufacturer has complied with the following standards and/or guidelines. These reference documents are simply listed as recommendations for the manufacturer to follow.

5.1 ANSI N42.17B-1989 (R1994) Performance Specifications for Health Physics Instrumentation - Occupational Airborne Radioactivity Monitoring Instrumentation (Note: *This document is obsolete, but provides an excellent operational reference.*)

5.2 ANSI/IPC-A-600H-2010, Acceptability of Printed Circuit Boards.

5.3 ANSI/IPC-A-610E-2010, Acceptability of Printed Circuit Board Assemblies.

5.4 ANSI/IPC-CM-770E-2004, Component Mounting Guidelines for Printed Boards.

5.5 ANSI/UL 5085-3, ‘‘Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

5.6 CAN/CSA-ISO 9001 - 2008, Quality Assurance Model for Quality Assurance in Design, Development, Production, Installation and Servicing.

5.7 CSA 22.1 - 12, Canadian Standards Association, General Requirements; Canadian Electrical Code, Part 1 and Ontario Amendments.

5.8 CEI IEC 61000-4-2, Electromagnetic Compatibility - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test.

5.9 ISO/IEC Standard 17025:2005(E) General Requirements for the Competence of Calibration and Testing Laboratories.

6. Materials and Workmanship

6.1 Materials, Assembly Procedures & Components

Materials, assembly procedures & components shall conform to high quality standards. Electronic components shall be new and sourced from the manufacturer's approved list of vendors/suppliers.

6.2 Workmanship

Workmanship shall comply with high quality practice to ensure reliable product operation to meet the performance requirements of this performance specification.

7. Performance & Design Criteria

7.1 Electrical Specifications

Service input power should be 115 ± 15 VAC, 60 ± 3 Hz steady state (CSA or UL listed plug-n Class 2 transformer/power supply is acceptable, battery powered is also acceptable). See Appendix B for Device Power Supply Recommendations

7.2 Operating Environment

Temperature: 21°C nominal (range 10°C – 30°C) (typical)
Humidity: up to 75% RH (non-condensing)
Pressure: 101.325 kPa (nominal)

7.3 Measurement Periods

7.3.1 Minimum Continuous Integrated Test Reporting Duration
- The integration period shall not be less than 48 hours

7.3.2 Required Continuous Integrated Test Reporting Duration
- The integration period shall not be greater than 30 days

7.4 Alarm Requirements

7.4.1 The device must provide a minimum audible alarm of 80dB and a visible alarm, at predefined exposure levels.

7.4.2 The device must have a 'mute' which silences the audible alarm for a period of no greater than 5 days. It shall then re-activate and alarm if the predefined exposure levels persists.

7.4.3 The visible alarm shall not be capable of deactivation.

7.4.4 Alarm Activation Levels:

7.4.4.1 The alarm MUST be set to activate when Minimum Allowable Elevated Integrated Concentration exceeds 144 kBq- h /m^3.

7.4.4.2 The alarm MAY be set to activate when the Continuous Integrated Minimum Test Reporting Duration integrated concentration exceeds 9.6 kBq-h/m^3.

7.4.5 The device may have a read-out on the device to indicate the radon level.

7.5 General Requirements for Type Testing

In the "Application for Listing," the manufacturer shall demonstrate the ability of the device to meet or exceed the overall specification requirements through type testing.

7.5.1 In the absence of a visible display, there must be an output signal that can be measured. The electronic devices requiring performance testing, must have some sort of measurable output signal (typically 4 mA - 20 mA; or 0 to 5 VDC) to provide information regarding the measurement levels. The output signal may be fed over a signal cable from the test chamber, through an A/D interface to a computer running software, with appropriate signal to radon concentration algorithms.

7.5.2 At time of application for device listing, the manufacturer shall supply the following documents to the listing agency:

7.5.2.1 General assembly drawing depicting all dimensioned sub-assemblies of the device, schematic(s) of all circuit boards,

7.5.2.2 Bill(s) of material listing all components (electronic and mechanical) a long with part numbers

7.5.2.3 Type test plan/procedure including name and address of EMC laboratory

7.5.2.4 Quality Assurance Manual
7.5.2.5 Copies of all documentation provided to the consumer
7.5.2.6 These documents must be re-submitted after any amendment.

7.5.3 The manufacture must demonstrate that the type test unit is not susceptible to ESD or EMI by testing the unit at an accredited EMC laboratory. In all EMC tests, the TTU shall be configured in a manner typical of home installation. All inputs and outputs of the TTU shall be connected to signal sources or monitoring equipment (as applicable) using at least two metres of cable (note: signal leads shall be shielded). Signal inputs and outputs shall be terminated in the characteristic impedance of the applicable cable. The 0 to 5V or 4 to 20 mA

outputs shall be monitored to assure performance levels are met.

7.5.3.1 The Electrostatic Discharge Immunity Test shall be conducted as per IEC 610004-2. Levels: Operator/User interface, Class 4 (8 kV contact or 15 kV air discharge). The test shall require 5 direct discharges each of positive and negative polarity on each identified discharge point of the TTU. In addition, indirect discharges shall be performed on both the front vertical face and top horizontal surface as per IEC 610004-2 requirements. A level of 8 kV contact or 15 kV air shall be applied to each user access discharge point as applicable (user access discharge points for the Radon Home Alarm shall be defined as switches (push-button, slide, toggle, etc.), displays (LCD, LED), and connectors).

7.5.3.2 The Electromagnetic Immunity Test shall require that a 3 GHz (minimum) cell phone be activated (used to initiate a call) 5 times in 1 minute intervals between activations, from a distance of 100 mm from the vertical face of the TTU; and repeated , from a distance of 100 mm from the top horizontal surface of the TTU.

Acceptance Criteria: Application of ESD and EMI does not result in the Type Test Unit error exceeding 20%. Note: A momentary alarm condition which self-clears in less than 60 seconds shall be noted on the test report but shall not be considered a test failure.

7.5.4 The manufacturer of the alarm device shall also perform the following additional tasks on the TTU

7.5.4.1 Determine and record the lowest concentration in air that it can measure at the 95% confidence level.

7.5.4.2 Express the minimum detectable concentration in the same units as the measured quantity.

Acceptance Criteria: The device shall have a Minimum Detectable Concentration (MDC) that does not exceed 50 Bq/m^3 for the minimum continuous integrated test reporting duration specified in Section 6.4.

7.5.5 Required TTU Labeling

The Type Test Unit shall be clearly and permanently identified with:

- Name of the Manufacturer
- Country of Manufacture
- Date of Manufacture
- Model Number and
- Serial Number

Circuit board(s) shall also bear a permanent serial number.

7.6 Radon Measurement Accuracy Specifications

Testing shall be conducted in a reference radon calibration center with stable and fixed concentration. The 95% confidence limit calculated from the test results shall fall within the confidence limits indicated in Table 1.

Table 1: Accuracy Specifications for measurement of Radon Gas Exposure

Range of Measurement	Overall Accuracy (95% Confidence)
≥ 108 kBq·h/m^3 to ≤ 180 kBq·h/m^3 *	± 20 %

* Equivalent range of 150 Bq/m^3 for 30 days to 250 Bq/m^3 for 30 days.

7.7 Performance Testing

7.7.1 Independent tests shall be performed through a recognized reference calibration center for radon

7.7.3 In addition to the manufacturers Quality Assurance program, independent tests shall be repeated after each 5,000 units manufactured, and after a significant manufacture change. Multiple and random representative samples shall consist of five (5) of the devices to the calibration center.

7.8 Biennial Calibration Notification Requirements

7.8.1 The device must have a prominent visual notification that advises the owner that the device has passed its calibration date.

7.8.2 Calibration is required every two years or 17520 hrs of operation.

7.8.3 This calibration warning shall not be capable of being cleared by depowering the device and the chronometer for calibration warning shall not be capable of being reset by depowering the device.

7.8.4 The calibration warning and the chronometer can only be reset by a factory authorized technician.

8. Quality Control/Quality Assurance

8.1 Quality Assurance Program

The objective of a quality assurance (QA) program is to implement a management system that ensures devices are accurate, repeatable, and verifiable. The following requirements represent the minimum basis for manufacturers to demonstrate to the listing agency that an effective quality assurance program is in place including clear, comprehensive and accurate descriptions of the quality assurance policy and quality objectives, and documented processes, procedures, and instructions to ensure effective operation and control of processes.

8.1.1 Procurement

8.1.1.1The purchase of equipment and material needed for accurate measurement shall be controlled by procedures established by the manufacture.

8.1.1.2 Suppliers shall be evaluated and selected based on their ability to meet specifications.

8.1.2 Change Control

8.1.2.1 Changes to equipment or processes shall be controlled by the manufacturer.

8.1.2.2 Proposed changes shall be reviewed and approved by qualified persons before implementation.

8.1.2.3 Records of proposed and implemented changes shall be kept as long as the device is listed

8.1.2.4 Records must be submitted as part of an annual review.

8.1.3 Calibration and Maintenance

8.1.3.1 Inspection, test, mensuration (scales, verniers, etc.), recording, and monitoring equipment used in association with this Performance Specification shall be calibrated at a certified calibration facility to appropriate traceable national standards, and bear a valid calibration sticker at time of tests herein. Calibration standards shall be traceable, where possible, to the National Research Council of Canada (NRC); the National Institute of Science and Technology of the United States of America (NIST); or to an equivalent National Laboratory in the Country of manufacture and testing.

8.1.3.2 Maintenance and calibration procedures shall be documented

8.1.4 QA Records

8.1.4.1 Records shall be prepared and retained as evidence of satisfactory accomplishment of activities and acceptability of results.

8.1.4.2 QA records regarding procurement, change control, and calibration and maintenance shall be submitted to the listing agency on an annual basis. Upon satisfactory review of the submitted records the device listing will be renewed for an additional year.

8.2 Quality Control

The objective of a quality control (QC) program is to implement a system emphasizing testing of products to identify defects and demonstrate the measurements are accurate, repeatable, and verifiable. Device manufacturers shall have a sufficient statistical quality control program in place to demonstrate conformance with the QC policy objectives for listed devices. The following requirements represent the minimum basis for manufacturers to demonstrate to the Listing Agency that an effective quality control program is in place.

8.2.1 Independent Testing

8.2.1.1 The QC program shall include independent testing as outlined in Section 6.7. Multiple and representative samples must be submitted as determined by the Listing Agency.

8.2.1.2 The manufacturer shall notify the Listing Agency immediately, in writing, when it fails an independent test.

8.2.1.3 Immediately repeat the failed test and submit the results to the listing agency. If repetition of the test results in a second consecutive failure the listing agency shall suspend the device listing.

8.2.2 QC Records

8.2.2.1 Records shall be prepared and retained as evidence of satisfactory accomplishment of QC activities and acceptability of results.

8.2.2.2 QC records shall be submitted to the listing agency on an annual basis. Upon satisfactory review of the submitted records the device listing will be renewed for an additional year.

9. Documentation to Consumer

Proper documentation to the consumer must be included with the device to indicate the following:

9.1 Basic information on radon including current Health Canada recommendations and its documented health impacts

9.2 Location Requirements for the device
(see Location Recommendations – Appendix A)

9.3 Clear explanation of factory calibration information and procedures

9.4 Procedures to follow if elevated levels activate the alarm device. These procedures shall include:

9.4.1 The instruction to retain a C-NRPP Certified Radon Measurement Professional to verify radon concentrations prior to making a mitigation decision;

9.4.2 Directions on accessing radon information from www.c-nrpp.ca

Minimum Requirements for Submitting a Listing Request to the Listing Agency
Submissions to the listing agency for listing a home radon alarm must include the following supporting documentation prior to initiation of Type Testing.

1. Documentation of the manufacturers established Type Testing procedures
2. Documentation of meeting all requirements for Type Testing for Measurement Instruments (listed in section 7.5)
3. Documentation of independent tests conducted by a recognized reference radon calibration chamber approved by listing agency
4. Copies of the Manufacturer Documentation provided to consumers
5. Proposed QA/QC measures for the device manufacture
6. Other Documentation required by the listing agency

Appendix A - Device Location

The device shall be installed in the lowest occupiable level of the home, whether finished or unfinished, and should be located:

- In a frequently occupied area, such as a bedroom, or a family room
- In a location where it will not be disturbed
- Where the audible alarm can be readily heard by occupants.

The device shall be mounted and located:

- at a height of 0.8 to 2.0 metres from the floor,
- at least 50 centimetres below the finished ceiling and above the finished floor,
- at least 20 centimetres from other objects so as to permit airflow around the detector,
- at least 40 centimetres from an adjacent interior wall,
- at least 50 centimetres from an adjacent exterior wall,
- at least 1 metre from windows, doors, or any other potential openings in the exterior walls, and
- in a location where it will not be impacted by regular cleaning activities.

The device shall not be located:

- On the ceiling or on an exterior wall,
- in kitchens, laundry rooms, bathrooms, closets, cupboards, sumps, crawl spaces or nooks within the foundation,
- in excessive air currents caused by heating, ventilation, air conditioning vents, doors, fans or windows,
- near heat sources, fireplaces, or wood stoves,
- in direct sunlight,
- in areas of high humidity, or
- near electrically powered equipment or appliances.

Care shall be taken to keep the device free from dust during the installation and any final construction.

Appendix B - Device Power Supply Recommendations

The device should be powered by a dedicated hardwired power source with an Alternating Current (AC) connector clip (similar to a smoke detector). Alternatively, the device may be powered using a 110v plug and a lead to the device with a means to prevent unintentional disconnecting of power to the device or the device may be battery powered.

Power supply to the device should be configured to eliminate power loss unless power is cut at the breaker panel, the house loses power, or the device is intentionally disconnected. In order to prevent unintentional power loss to the device, the power source shall not be connected to a switch.

A battery powered device shall use standard batteries that are readily available to consumers, such as a 9-volt alkaline battery, which shall provide sufficient power to the device for a minimum of 6 months. The device shall signal a low battery condition.

Appendix C

Example:
Five devices are sent to a calibration facility for performance testing. The calibration facility places the devices in a stable and fixed radon concentration of 2000 Bq/m^3 for a period of 72 hours. Therefore the target exposure is 144 $kBq \cdot h/m^3$. At the end of the test period the exposures recorded for the devices are:

Table 2: Example Performance Testing Results

Device ID	Measured Exposure ($kBq\ h/m^3$)
Dev-1	152.3
Dev-2	142.7
Dev-3	158.2
Dev-4	144.4
Dev-5	136.3
Average	**146.8**
Std. Dev.	**8.6**

The 95% confidence interval calculated from these results is 139.3 $kBq \cdot h/m^3$ - 154.3 $kBq \cdot h/m^3$. The accuracy limits from **Table 1** from Section 7.6 for a target value of 144 kBq/m^3 are ± 20%, therefore the specification limits are 115.2 $kBq \cdot h/m^{3.}$ - 172.8 $kBq \cdot h/m^3$. As these test results are within the specification limits outlined in the protocol these devices pass the performance test.