ANSI N42.51 Performance Specifications for Systems Designed to Measure Radon Gas in Atmospheres

AMUG Meeting

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Phil Jenkins

- Education:
  - BS ChE, Purdue, 1970
  - MS Bionucleonics (Health Physics), 1972
  - PhD Bionucleonics (Health Physics), 1975
  - Course work included computer programming, nuclear engineering and statistics.
  - Theses research on track registrations in plastics (not related to radon)

Phil Jenkins

- Work Experience:
  - TVA, 1975-1978
    - NEPA documentation for uranium mining & milling
    - Computer modeling of airborne emissions
  - DOE's Mound Facility, 1978-1991
    - Radon monitoring in the environments of several sites in the UMTRA and FUSRAP projects.
    - Helped design, build and operate radon chamber.
    - UMTRA & FUSRAP ended 1986
    - Chamber "blew up" 1989

Phil Jenkins

- Work Experience:
  - Bowser-Morner, Inc., 1991-present
    - Designed new radon chamber facility.
    - In operation since April 1992
- Miscellaneous:
  - ABHP Certification since 1980
  - Member of Ohio's Radiation Advisory Council
  - Member of AARST Board for fifteen years
  - Chair of ANSI N42.XY
  - Member of WHO IRP Working Group

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Status

- Core group of people have been identified that to work on this standard.
- AARST had years ago identified such a standard as a replacement for the EPA "Device Protocols."
- AARST has applied to ANSI to be an approved standards setting body; we received preliminary word last Friday that AARST has been approved.

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Status

- Assuming that ANSI approval is <u>officially</u> received, the standard will proceed following the AARST process.
- A working group will be selected, meeting the AARST criteria that all stakeholder groups are equitably represented.

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Stakeholder Groups

(incomplete list)

- Measurement
- Mitigation
- Manufacturers
- Regulatory States
- Nonregulatory States
- Reference Laboratories

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AARST Process

- The AARST Standards process operates totally independently from the AARST Board. There are only two instances where the AARST Board has authority to block a standard:
  - If the Board finds that the process was not followed
  - If the Board finds that the standard somehow causes a financial burden to AARST that would be irresponsible.

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Purpose & Scope

- This standard specifies the minimum performance requirements and performance testing requirements for systems that measure radon gas in atmospheres.
- "Atmospheres" might include: indoor air, outdoor air, underground air (e.g., mines and caves), soil gas, other gases (e.g., carbon dioxide).

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Purpose & Scope

- “Radon” must include thoron
- Thoron will be considered for two reasons:
  - As an interference to ^{222}Rn measurements
  - As a health hazard itself
- “Systems” includes devices that are analyzed post exposure in a laboratory, and electronic monitors that make measurements simultaneously with the exposure.

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Purpose & Scope

- Measurements could be for a number of purposes:
  - Indoor measurements for the purpose of determining the need for mitigation
  - Outdoor measurements (e.g., fenceline measurements to monitor releases from contaminated soils)
  - Occupational settings (e.g., Yucca Mountain)
  - Radon gas in consumer products (e.g., natural gas, carbon dioxide)

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Purpose & Scope

- The scope of this standard does not include:
  - Measurements of radon in water
  - Measurements of radon flux from soils or other surfaces
  - Measurements of radon in a phase other than gaseous

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Strawman

- A “strawman” draft is a simple draft of a proposal, report or manuscript intended to generate discussion of its disadvantages and to provoke the generation of a new and better document. Often, a strawman is prepared by one or two people prior to kicking off a larger project. In this way, the team can jump start their discussions with a document that is likely to contain many, but not all, of the key aspects to be discussed.

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Strawman

- Such a draft is in process. The "strawman writing group" has met three times and some draft materials have been written.
- The model for the strawman document is a combination of ANSI N42.17B and the IEC radon standards.
- Other documents that will be helpful:
  - Three EPA protocols documents
  - Existing drafts of the abandoned ANSI N13.34

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Strawman

- The strawman will include performance specifications for radon gas measuring devices specifically for home measurements.
- The strawman will specifically not include:
  - Measurements for occupational purposes
  - Measurements in outdoor air or underground air
  - Measurements in atmospheres other than air
  - Thoron
- It is anticipated that the official working group will include persons who can help in these areas.

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Time to Move Forward

- Now that the process by which this document has been settled, we can move forward to identify the official working group.
- It is essential that the process that ANSI approved be followed carefully.

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Goals

- Have the official working group identified by June 1.
- Assign tasks and work in June, July, August via emails and postings in the Standards Consortium area of the AARST website (will also post on AMUG website).
- Meeting of working group at the AARST International Symposium in Jacksonville in September.
- First rough draft by October 1.

Extra Topics (if time allows)

One of my Pet Projects

- Measurements of radiation are not always Poisson and therefore "counting statistics" can produce estimates of uncertainty that are erroneous.
- This is true for most measurements of radon and radon progeny.
- I think that this is potentially could impact the two ANSI standards in process.

Not Poisson

Radon Measurements

- Techniques are often based on measuring emissions from more than one radionuclide in the radon decay series with no spectroscopy (e.g., scintillation cell).
- This violates an underlying assumption that the observed counts are independent (not correlated).
- For Poisson statistics to be valid, one radon atom must result in no more than one observed count, but in a scintillation cell it is possible for one radon atom to cause as many as three observed counts.

Not Poisson

Radon Measurements

- This causes the true uncertainty to be larger than that predicted by Poisson "counting statistics."
- This is called "overdispersion."

Not Poisson

Radon Progeny Measurements

- The same thing often happens with measurements of radon progeny.
- However, this effect can be overpowered by the violation of another underlying assumption of counting statistics; i.e. that the counting time is very small compared with the half-life of the radionuclide being counted.

Not Poisson

Radon Progeny Measurements

- In the Modified Tsivoglou method, for example, gross alpha counting is used with counting times that are long compared with the half-lives of the radionuclides being counted.
- The “overdispersion” caused from observing correlated counts is overwhelmed by this second violation of assumptions.

Not Poisson

Radon Progeny Measurements

- The result is that the true uncertainty is less than that predicted by counting statistics.
- This is called "underdispersion."

Not Poisson

- The phenomenon of "overdispersion" can be observed in other counting situations where more than one radionuclide in a decay series are involved; e.g., gross beta counting of $^{90}Sr/^{90}Y$.

The Elusive 7% Bias

- Historically there has been a bias of about 7% among radon reference facilities in the U.S.
- Dr. Jim Burkhart (UC-CS) and I are the only two reference labs that now intercompare directly with EPA Las Vegas.
- In spite of the fact that we use identical scintillation cells for the intercomparison, and are calibrated to the same reference (EPA Las Vegas), we have observed differences on the order of 9% between us.

Became an Elusive 9% Bias

- For years we have suspected an effect due to altitude (i.e., differences in air density).
- To cut to the chase, after several "false starts" our research efforts have nailed down the effect.
- When we both calibrate to Las Vegas (elevation about 2000 feet), measurements made with the same scintillation cells are biased about 2% low in my lab in Dayton (820 ft) and about 7% high in Colorado Springs (6000 ft).

Lesson Learned

- In doing intercomparisons with EPA Las Vegas for several years, I noticed small biases appearing between our two facilities.
- After correcting for this one year, a bias of roughly the same magnitude would occur the next year.
- It was like my scintillation cells were becoming more efficient each year.

Lesson Learned

- I now believe that this was being caused by my own handling of the cells.
- It was my habit to leave cells on vacuum for extended periods of times (weeks) to cut down on background.
- The cells I am now using have a nice thick coating of ZnS.

Lesson Learned

- I now believe that leaving the cells on vacuum for long periods of time resulted in small quantities of ZnS to sublime, migrate, and redeposit on the window of the cell.
- Thus the area covered with ZnS, and therefore producing scintillations, was growing with time (i.e, the cells really WERE becoming more efficient.
- A change in handling seems to have eliminated this phenomenon.