

Radon Intercomparisons: Traceability is a Key to Accuracy

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We Take it For Granted

- We so often assume that products we buy are “calibrated,” in other words accurate, for example:
 - Thermometers
 - Odometers
 - Weights for shipping – lots of money involved



Who calibrates these? All of them have traceability to a standard.

Speedometer in Your Car



Your speedometer says you are going the speed limit.

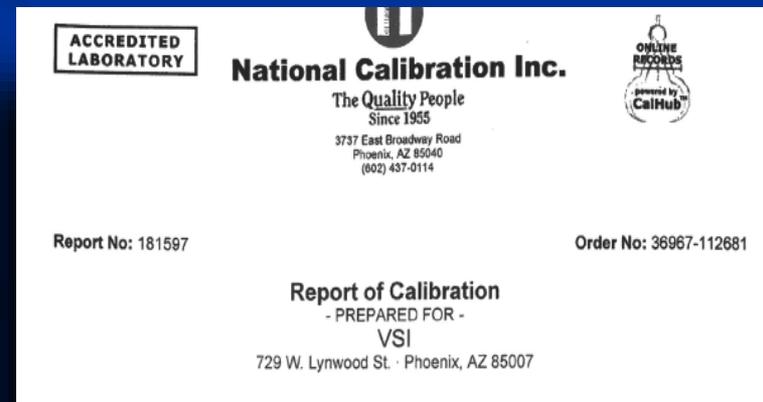
The policeman says you are doing 80 in a 65.

One is right, one is wrong, but which one? Or maybe both are wrong?



Traceability

- Every measurement depends on a “true” value
 - To design systems and to **calibrate methods so they continue to measure “true”**
- Measurements trace their authority for the accuracy of their results to a calibration standard that is used as the “truth” that is used as a benchmark.
 - For example, you can buy a cylinder of CO₂ from NIST at a known concentration for \$3000.
 - Calibrate your scales at a weights and measures lab and receive a traceability certificate.



ACCREDITED LABORATORY

National Calibration Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, AZ 85040
(602) 437-0114

ONLINE RECORDS
powered by CalHub

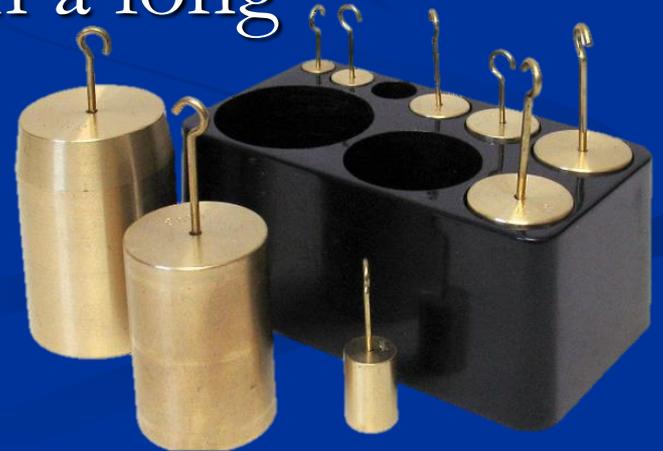
Report No: 181597

Order No: 36967-112681

Report of Calibration
- PREPARED FOR -
VSI
729 W. Lynwood St. · Phoenix, AZ 85007

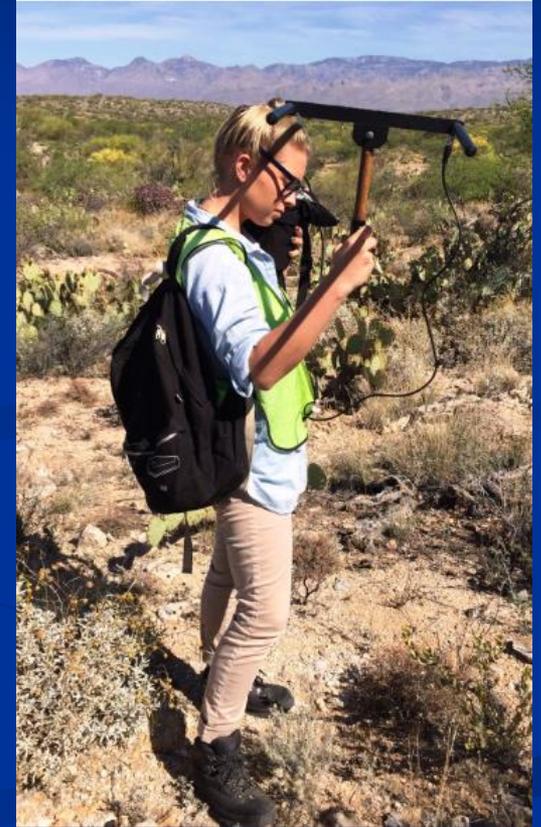
Calibration in the US

- “Weights and Measures” labs use their “gold standard” devices to **calibrate secondary devices**.
- These secondary standards are then used to **calibrate devices/labs down the line**, maintaining NIST-traceability to a “gold standard” method in a long “chain of traceability.”



Calibration in the US

- All measurement methods depend on traceability for their accuracy (except for “natural standards” like boiling and freezing).



Calibration for Radon and Other Gasses

- Radon, like ozone, is unstable and needs to be generated as needed to calibrate all device types.
 - Stable gasses, like SO_2 , have known-concentration cylinders that can be purchased to calibrate SO_2 detectors, but no similar system is possible for radon or ozone.

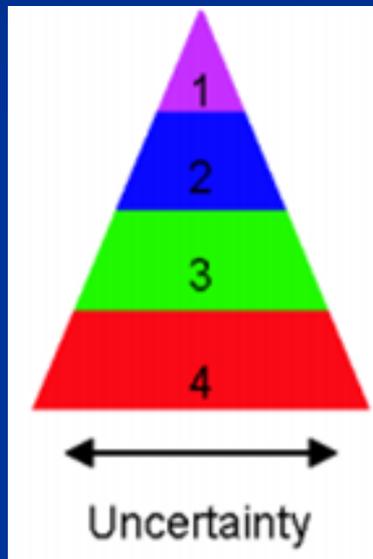


The Parallel to Ozone

- Like radon, ozone is a gas that is not stable.
- Like radon, gaseous ozone standards cannot be stored for any practical length of time.
- When an ozone monitor is calibrated, it is necessary to compare it to a “transfer standard” that is traceable to a more authoritative standard.

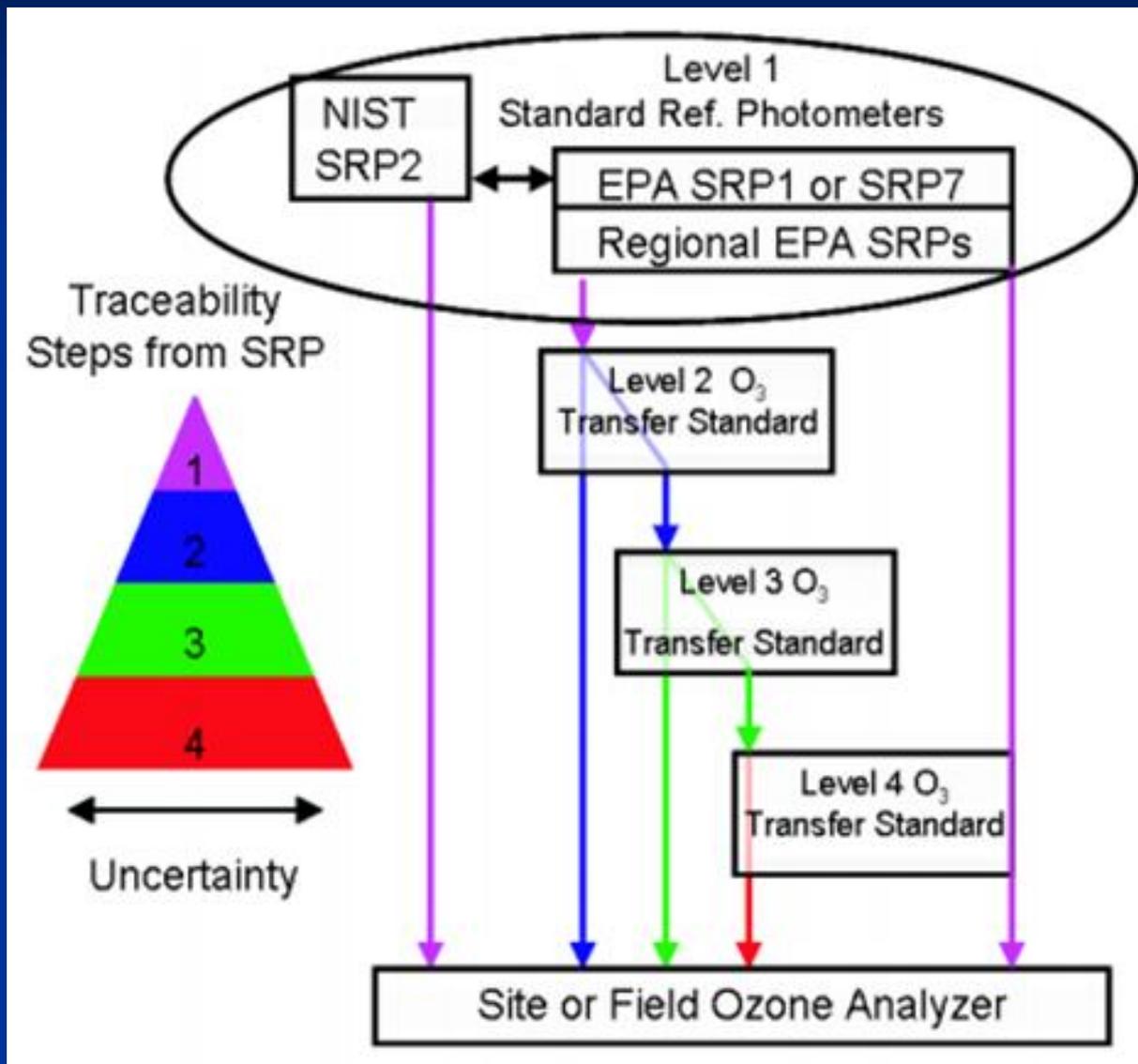


The Parallel to Ozone

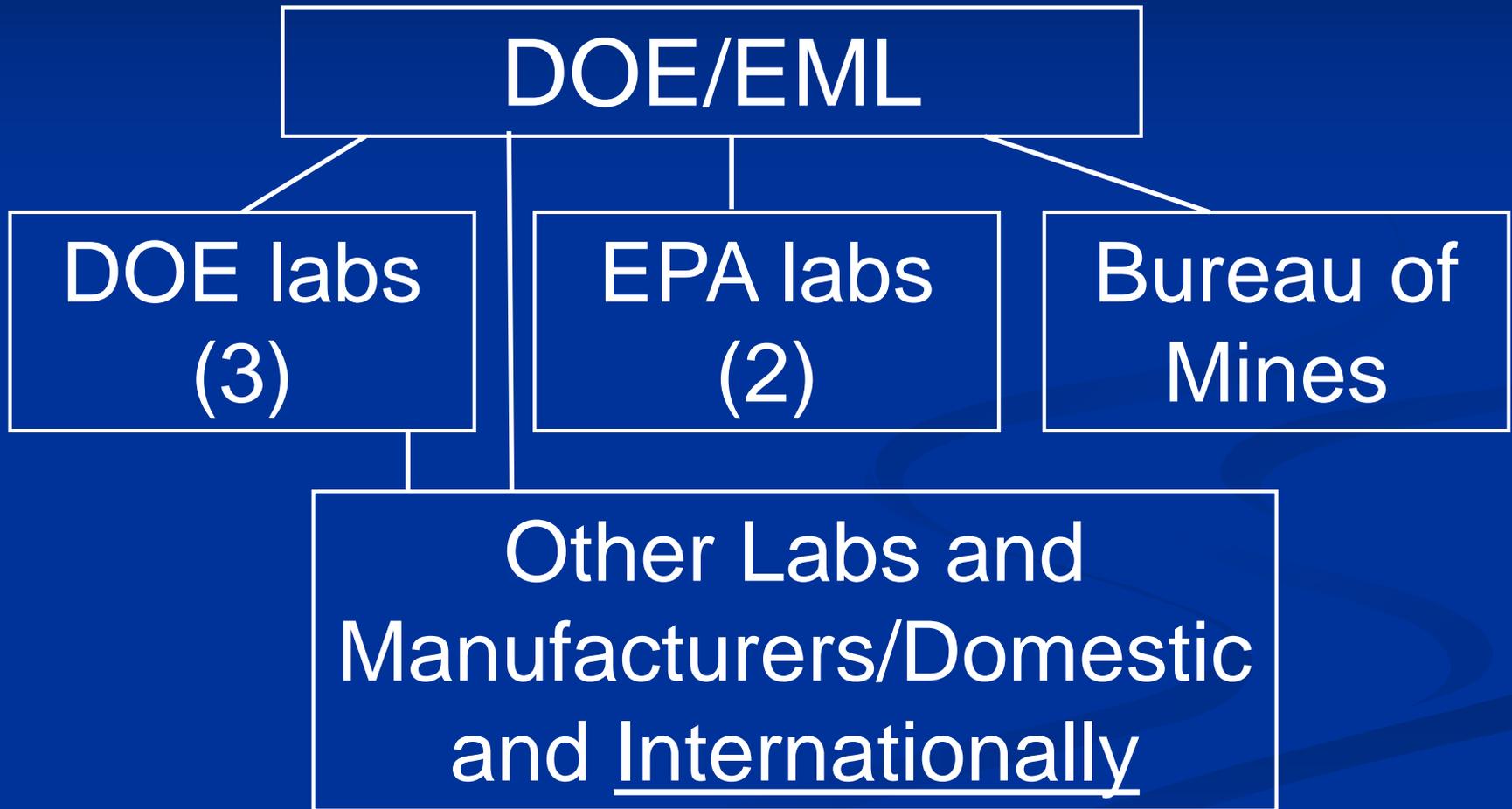


- Traceability is the “property of a measurement result whereby the result can be related to a stated reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.”

How it Works for Ozone



Prior to ~1998



After ~1998

EPA/LV

Certified Secondary Labs

Certified Tertiary Labs

Other labs and
manufacturers/domestic and
international

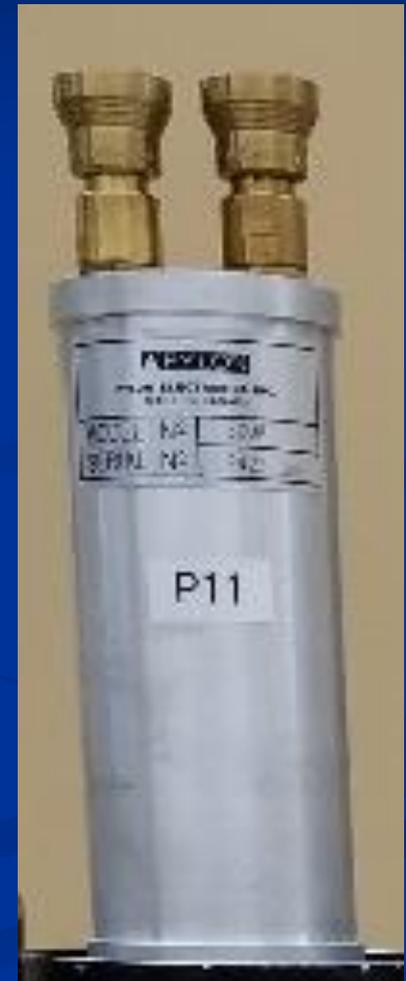
Reference Concentration of Radon

- For radon, calibration requires making a known concentration of the gas:
 - Radium-226 source emit radon gas atoms at a known rate dependent on the # of bequerels in the source.
 - The radon atoms are then mixed with an accurately known volume of air to produce a “true” concentration of radon.
 - This “true” concentration is then used to calibrate devices that can be used as “secondary standards” or “transfer standards.”



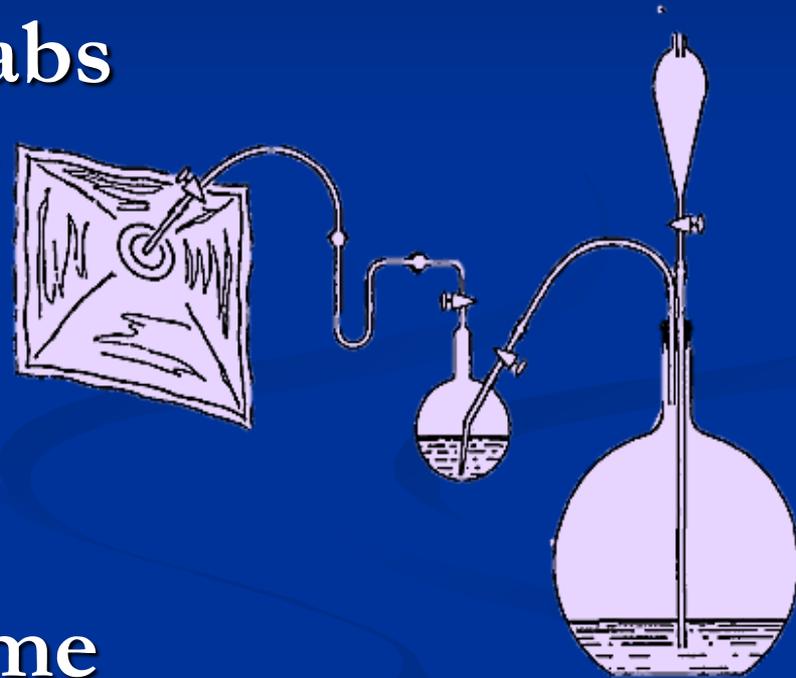
Intercomparisons with Primary Reference

- Each Secondary Lab sends four scintillation cells to the Primary Reference Lab.
- The Primary lab transfers radon quantitatively from a liquid ^{226}Ra source into a Tedlar bag.



Intercomparisons with Primary Reference

- Scintillation cells from both Primary and Secondary labs are filled from the Tedlar bag.
- Secondary cells returned: only date, time & barometric pressure at time of filling reported.



Intercomparisons with Primary Reference

- Primary lab reports “target value” radon concentration and **total*** uncertainty to NRPP.
- Secondary lab reports each radon measurement & average with uncertainties to NRPP.
- NRPP “grades” results/reports to Secondary lab.

*NIST1297 (GUM)-[not just counting statistics]

Intercomparisons with Primary Reference

- Current criteria for “passing” the intercomparison and maintaining Secondary Lab Certification:
 - Each measurement must be within $\pm 25\%$ of target value.
 - Average of the four measurements must be within $\pm 10\%$ of target value.



Primary to Secondary (Scintillation Cells)

EPA – NAREL
Montgomery, AL

BMI
Dayton,
OH

RSIC
Saskatoon,
SK

UCCS
CO
Springs

Intercomparisons among Secondary Labs - Plans

- AlphaGuard radon monitor (or comparable) used as “transfer standard.”
- Transfer standard calibrated at one lab; for example, BMI.
- Transfer standard shipped to next lab.



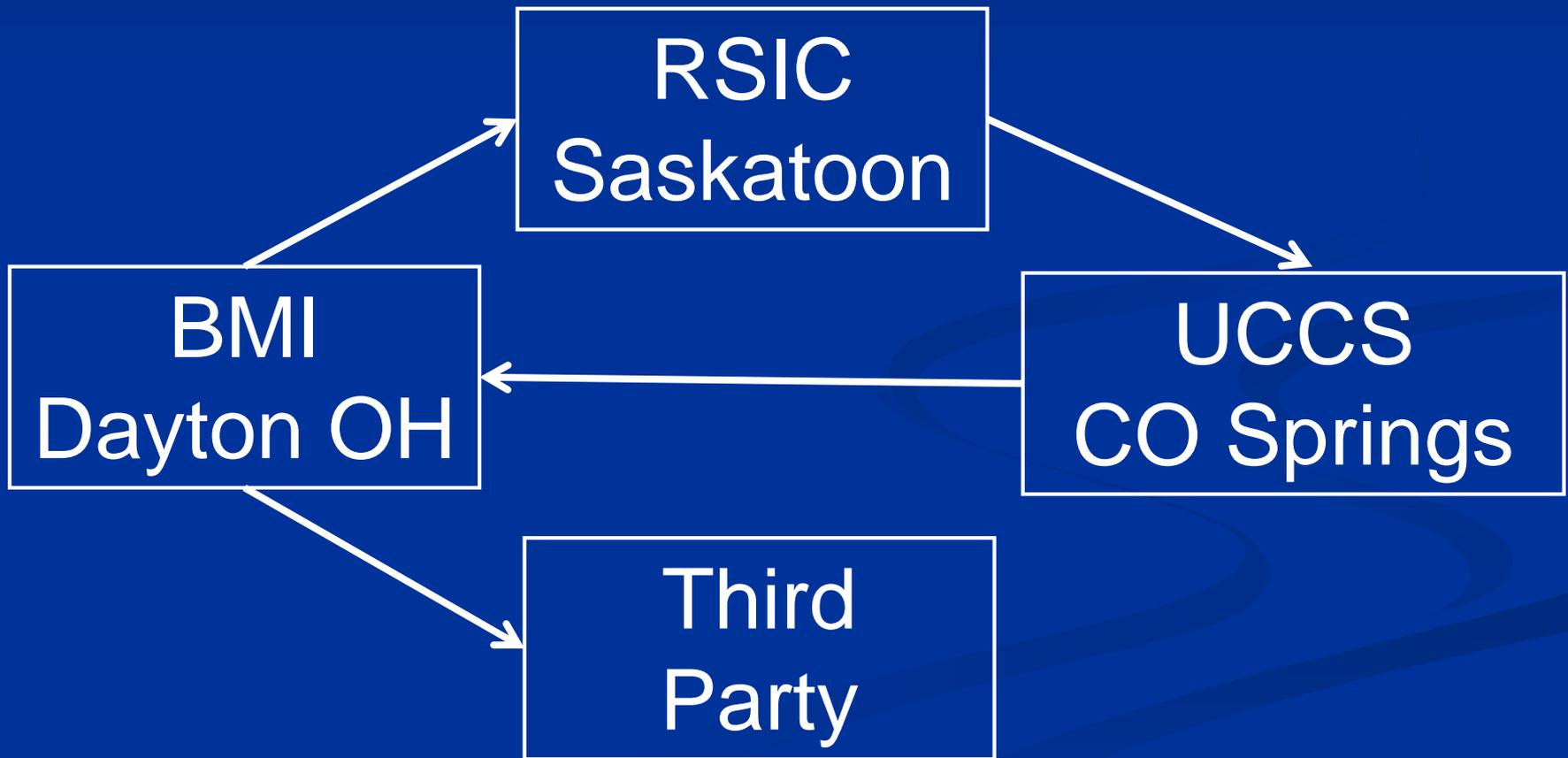
Intercomparisons among Secondary Labs - Plans

- **Transfer Standard:**
 - exposed in radon chamber (hopefully in blind manner)
 - shipped to next lab where process is repeated
 - shipped back to original lab for confirmation of calibration

Intercomparisons among Secondary Labs - Plans

- Transfer standard shipped to independent third party
- Data from all exposures downloaded and compared to chamber measurement results from each secondary facility
- Third party prepares report

Among Secondary Labs (Transfer Standard)



Intercomparisons among Secondary Labs - Objectives

- Verify comparable measurements among the Secondary Labs
- Correct any biases that are found
- Work out logistical problems before expanding intercomparison program
- Intercomparisons may also be made using other devices

Intercomparisons Expanded to Include Tertiary and Government

- The same process can be used to intercompare among tertiary radon chamber facilities and government entities
- It may be possible to include NAREL, despite its lack of a chamber, given some alternative procedures

The primary chamber, the bubbler system in NAREL, uses Ra-226 SRM to make "true" Rn-222 concentrations.

NIST-traceable pCi/L standard in scintillation cell

NIST traceability

Secondary chambers calibrate against EPA NIST-traceable scintillation cells.

traceability

T.S.

T.S.

T.S.

traceability

Tertiary chambers calibrate against AlphaGUARD transfer standards.

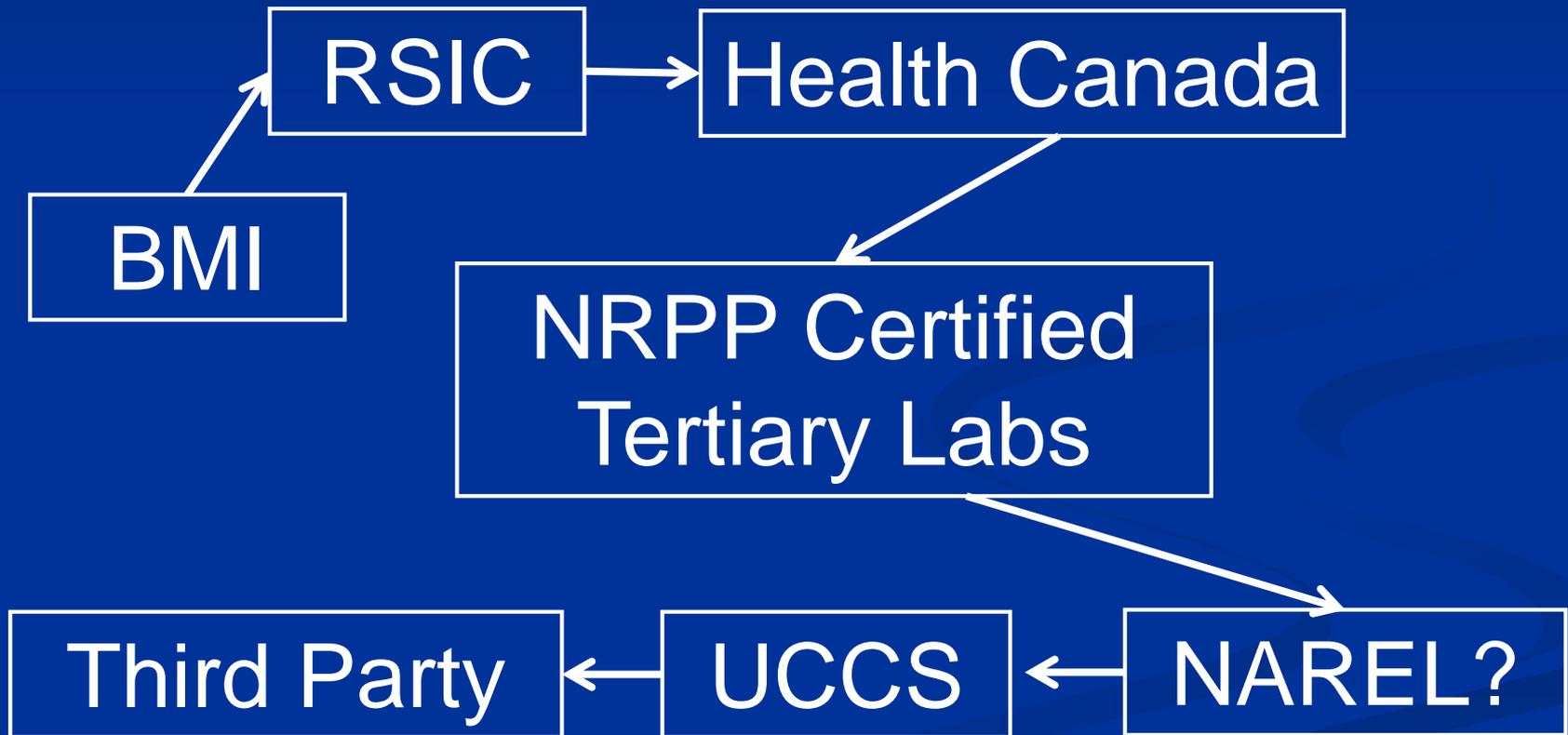
traceability

Rn test kit

Rn test kit

Rn test kit

Expanded Example (Transfer Standard)



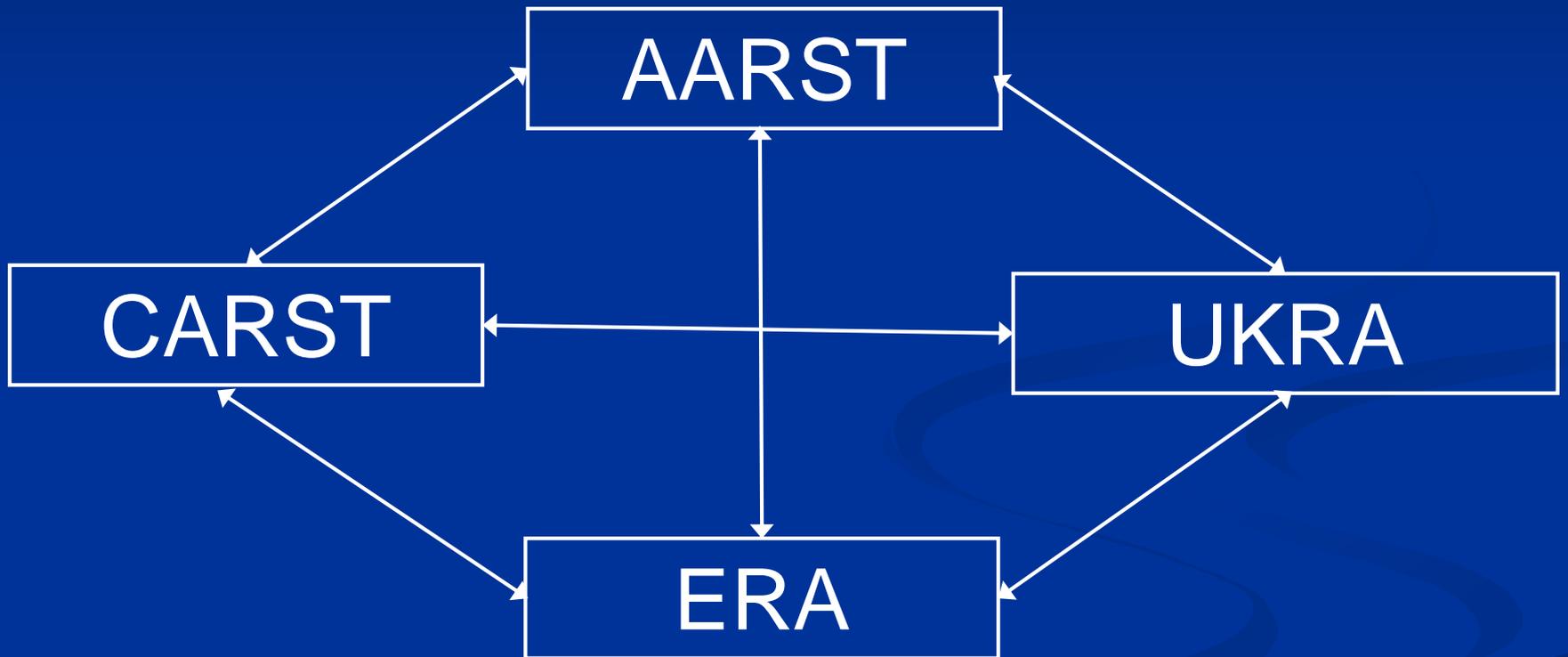
Intercomparisons Among COIRA Members

- Members of the Consortium of International Radon Associations (COIRA) are working together on procedures to use a transfer standard to intercompare internationally.

Intercomparisons Among COIRA Members

- There has been no formal intercomparisons of radon measurements between the US and other countries for several years (although many informal intercomparisons indicate agreement).
- It is important that radon measurements globally are in agreement.

COIRA Members



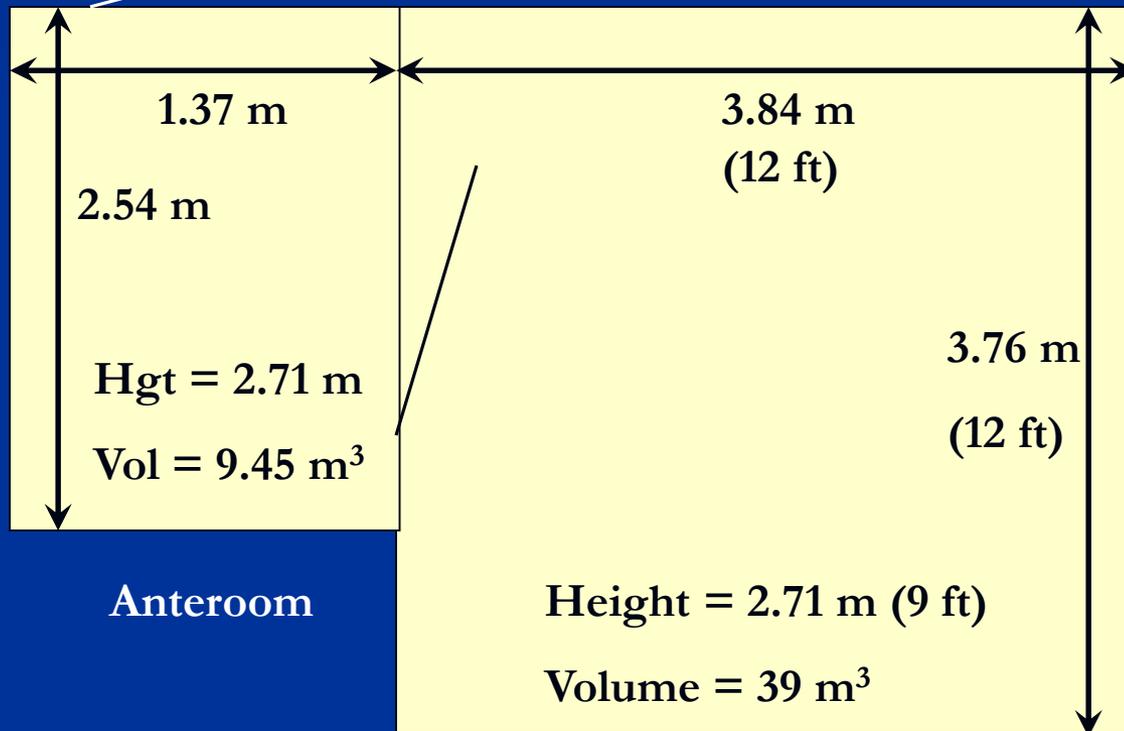
BMI Chamber – Built 1991

- **Bowser-Morner chamber design:**
 - Large walk-in room, 3.8 x 3.8 x 2.7 m
 - Volume = 39 m³
 - Recirculating flow
 - Source, two flow-through Pylon Ra-226 sources
 - External environmental chamber for temperature and humidity control (same as Mound)
 - Designed to minimize the amount of radium to purchase and license, as well as the amount of radon that would be released to the environment

Bowser-Morner Radon Chamber

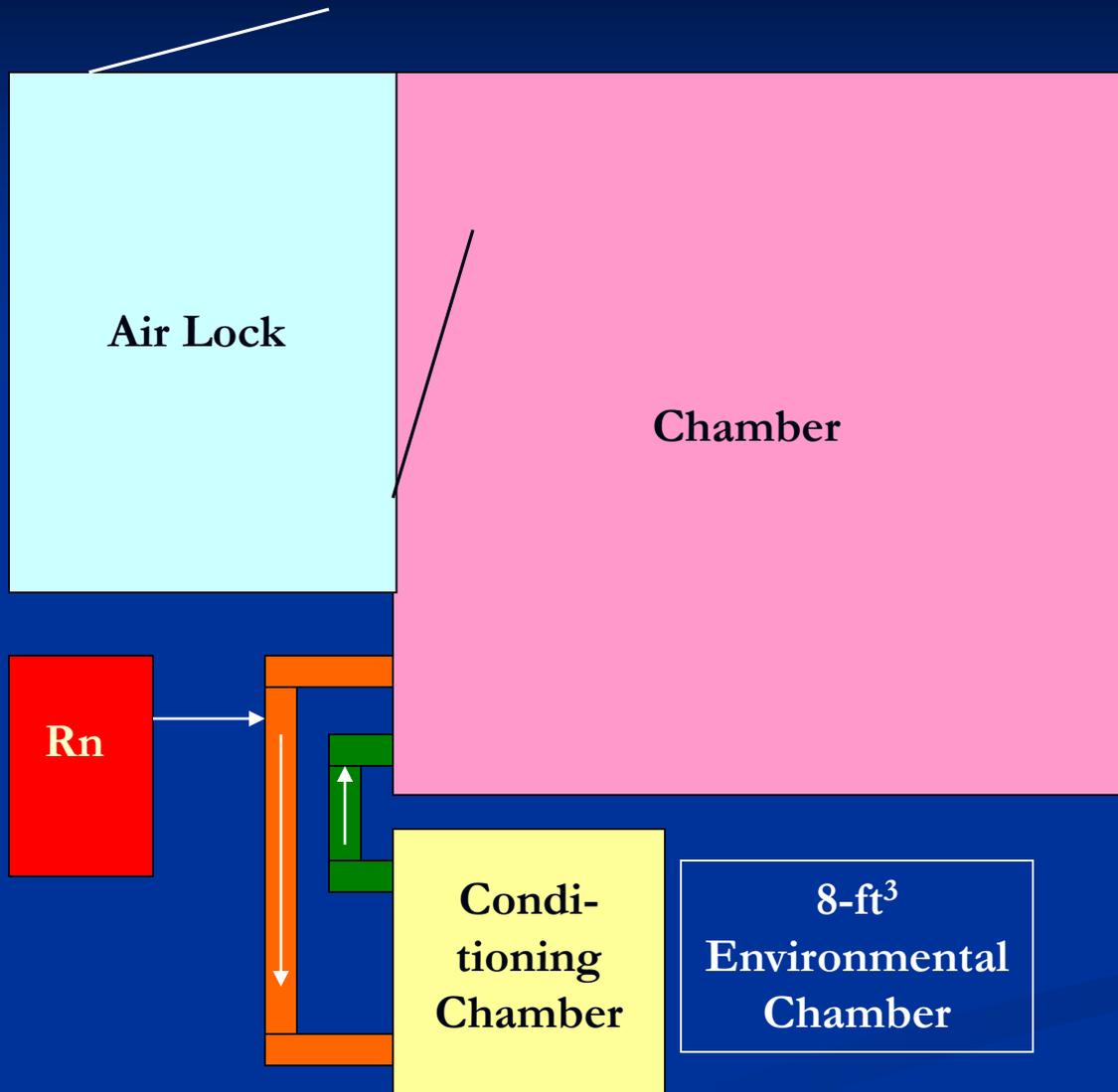


Chamber Layout (Similar to EPA/Las Vegas)



Bowser-Morner Radon Chamber





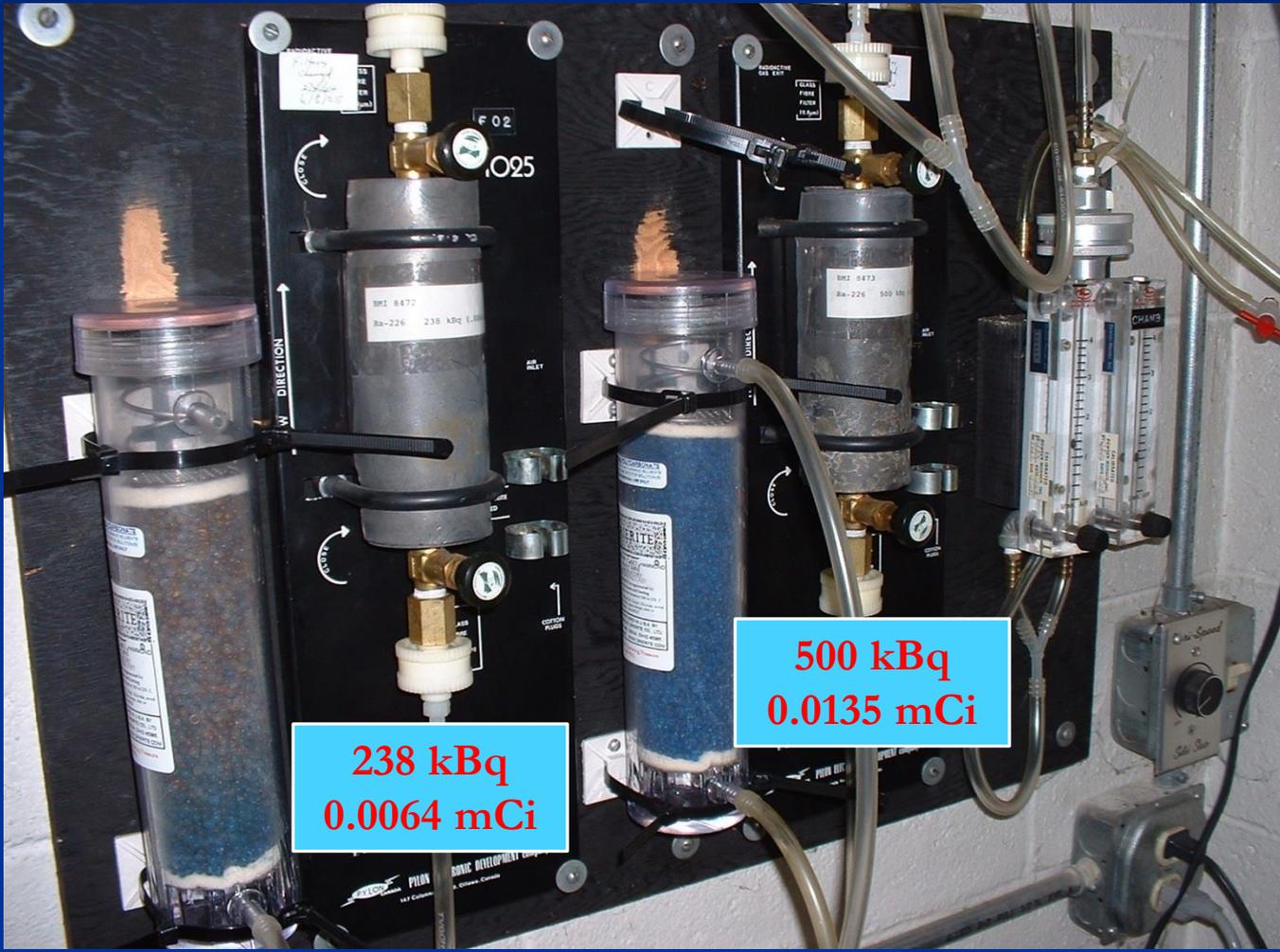
Conditioned air is blown from the environmental chamber, through the radon chamber and back at a rate of 100 cfm.

Air velocity in chamber is 5 – 15 fpm.

Radon is continuously pumped into return leg to environmental chamber.

Two chambers form a “closed loop.”

Radon Sources



238 kBq
0.0064 mCi

500 kBq
0.0135 mCi

Radon Measurement System



Three Eberline SACR-5
Photomultiplier Tubes/Scintillation
Cells

Tennelec Electronics and Counting
System (soon to be replaced with more
modern equipment)



Environmental Chamber



Chamber Interior



Chamber Interior



New Chamber – Open Soon



New Chamber Interior



Thank You for Your Attention