

**PASSIVE RADON MONITOR MEMORY:**  
**A CALL FOR A VOLUNTEER TEST PROGRAM**

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**ABSTRACT**

During the past era of radon monitoring, radon gas in the environment has been measured on the basis of accuracy and precision. Government radon chambers have provided fairly constant exposure rates for tested monitors, so that the two accepted success criteria could be met within the prescribed error limits.

In accommodating varied interests, the minimum measurement period believed to reflect an annual average of radon concentration has been reduced to 48 hours. Over the years, an evolution of testing devices has taken place, which are believed to meet the objective of sampling radon reliably in the home environment for 48 hours.

The retention capability of radon concentration over 48 hours by the monitors has not been considered a subject of testing. Radon chambers should be able to expose monitors under unchanged concentrations for accuracy and precision, as well as under changing concentrations, so as to measure the memory of devices. Evidence for the significance of the memory parameter and its influence on accuracy and precision in the field is presented, and Radon QC is calling for AC and LS manufacturers or laboratory volunteers to help establish a new memory label on their monitors as a measure of quality.

**INTRODUCTION**

In the early phases of the radon program, hefty charcoal canisters with about a half pound of activated charcoal were in use, and their normal exposure periods were up to seven days, with the first few days required just to ramp up the radon level in the canister. The appetite of the canisters for radon was attested by slumping radon levels in chambers during the first day or two, until things leveled out. This phenomenon even affected the validity of the EPA RMP Program at one point, in Round 7, it is believed. - It became customary for (government) chambers to run radon levels quite steadily, so as to find a reliable measure for the accuracy and precision of the devices and the laboratories tested. Examples of the DOE chamber EML as well as the BOM Federal Center chamber in Denver are given (Fig. 1a), as well as of the Radon QC chamber (Fig. 1b).

But with the progression of the radon program, testing periods of seven days for adsorbing monitors were considered to be too long. Shorter testing periods were considered acceptable, down to two days (1). Indeed, a consideration of the diurnal fluctuation of radon gas levels in the environment will support the validity of a relatively short sampling period, even of one day or two (Fig. 1b). Yet it was quietly assumed that the testing devices in use would reliably reflect the radon concentration existing at the sampling location for the total sampling period. But there was never a mechanism in place to test the retention capability or "memory" of testing devices (1).

Some of us come from the alpha track and electret monitoring fields, where we are used to a "cash register" working philosophy. Every track and every volt registered stays put during the whole sampling period - there is no dynamicism as with charcoal monitors and their "bee hive" philosophy. The latter need to ramp up and to keep on giving and taking radon (and water), and some of them may be more suited than others to reflect a true radon average.

Constant radon level exposure is by design insensitive to time. If we look at the projection of a straight light (laser) beam onto a plain, we cannot tell the length of the beam. A point source could be millimeters, yards, or even the distance of the moon away. We simply do not know. Equally, a (small) sampling device may hold radon concentrations from the last few hours only, or from the last day or two, or even longer. But without testing of its memory the radon gas measurement is believed to be incomplete.

Radon QC has drawn attention to this situation in our paper at the 1995 International AARST radon conference (3). Under the sub-heading Memory in a chapter on Puzzling phenomena in chamber work, we basically abstracted the present paper. A lot more evidence has been found since then, and we are surprised that no one has come forward to take corrective action. Thus it is apparently our turn to do so. Working with clients and helping them to perfect their measurement system has been practiced by Radon QC under the NJRMP program for seven years by now (4).

The purpose of this paper is to show first evidence of limitations of some devices under some conditions of fluctuating radon levels similar to or from actual field conditions. Then a specific testing program will be outlined, and Radon QC will solicit volunteer support from the radon industry to engage in a memory testing program with the goal to make memory testing an addition to device testing, and to create a label for accepted monitors that they have demonstrated a 48 hour or more radon concentration retention, and are thus fulfilling the minimum testing requirements of the EPA (1-p.35).

### **THE PERIL OF SHORT TERM TESTING**

The longer the measurement period can be made, the more accurately will it reflect the standard which has become known as "the average annual radon level" at the location of measurement. Ideally, this should be a year. There are monitors capable of being in place for a year, and that are registering either radon disintegrations or the resultant voltage discharges fairly reliably and irrevocably. Yet long term measurements have become very unpopular lately, as it has become known that short term readings "will do". Yet to our knowledge no scientific evidence has been presented that the acceptable devices for 48 hour use are indeed capable to give any reliable information about the radon regime during the sampling period. This omission is in need of attention before the books on radon measurement technology can be closed and the topic can be considered "finished". Otherwise the 48 hour sampling policy should be revised.

### **THE EVIDENCE**

At Radon QC, we have always maintained an experimental attitude toward the radon work. Several years ago, we inadvertently entered a 25 pCi/l spike for two hours in the middle of a 48 hour test with twenty four blind tests near the 4 pCi/l level - only to find that a reputed radon laboratory "did not see" the spike, but reported only the tail end concentration.(Reference withheld). Thusly encouraged, we have entered trends in exposures of adsorbing devices. Particularly the barrier devices based on the Grey design of the EPA could not be fooled, and all devices of some canister laboratories would integrate radon levels over 4 days or more, and would demonstrate adequate memory over a number of days beyond two days. Thus it is known that charcoal devices can reliably retain radon information for two days and beyond, though there is no testing mechanism in place at this time.

But we have also found in changing (rising or falling) exposure trends that laboratories would report the average of the last day or the last 12 hours only. In the absence of a recognized criterion for retention, they cannot be blamed, nor how should they know ? Examples are given in the following Fig.2. We have on file several dozen records of high readings in rising radon levels and low readings in dropping levels over two to four days, and of undetected spikes in any situation.

With the arrival of policy changes, privatization and changes in liability such as loss of immunity protection, the private industry may well be served in ascertaining the memory capability of their products.

## WHAT CAN WE DO ABOUT MEMORY TESTING ?

In a cooperative program between the private radon monitor manufacturers and the private radon chambers, we should undertake a well designed program to define the memory requirements of testing devices.

Radon QC will offer their services to the industry to test any charcoal monitor for its memory of radon retention. Other private chambers are invited to join in on the effort as they see fit. An attempt at a test program layout will be presented below. After successful completion of a test, the participant will be issued with a certificate, stating the result of the memory test, and the duration for which the tested monitor has been found to be accurately reflecting the average radon level. AARST will be invited to create a review board, and to lend authenticity to the certificate through their endorsement.

Any interested Federal or State agency, organization or AC or LS manufacturer or laboratory is invited to contact us with regard to the memory testing program which we are outlining in the following.

### OUTLINE OF A MEMORY TEST PROGRAM

1). The radon chamber will run three to five devices for 48 hours at near constant levels of radon concentration, to establish the accuracy and precision of the device type to be tested. The devices will be mailed off to the participant as a blind test.

2). Next, the chamber will run the test devices (3 to 5) in a rising environment, starting at, say 3 pCi/l and ending at 12 pCi/l within 48 hours. The devices will be mailed out.

3). Next, the chamber will run 3 to 5 devices at falling radon levels, starting at , say, 15 and ending at 6 pCi/l. Again, the devices will be mailed out as a blind test.

So far, nine to fifteen devices would be required, with three mailings, and the time required would be about a week. The cost to the participant should be minimal - maximum \$ 50 for each set of exposures, plus \$ 9 for priority return mailing. One may add 3-5 devices as spares/ blanks and in case of chamber screw-ups.

4). For additional testing, the chamber will start the test with a spike of, say, 30 pCi/l, for a few hours, then drop the exposure to 4 pCi/l for the remaining 44 hours and mail off the 3 to 5 devices. This could also be the only test to show existence or lack of memory for the test period.

5).Next, a spike could be administered at the halfway mark, at 24 hours.

The program is depicted in graphic form in Fig. 3.

Fifteen to twenty-five devices and five mailings would encompass the total test program, and it would take about two weeks to complete it. Cost would be inside \$ 50 per set (depending on number of participants), plus \$ 15 for five return priority mailings. Again, 3-5 extra devices should be added, as chamber radon manipulation does go wrong sometimes.

Needless to say, it would be cost- and time effective to test more than one participant at the same time. The information would be handled client-confidential. If applicable, improvement programs will be initiated, to help with qualifications down the road. Radon QC has carried out similar, confidential missions with clients under the NJ RMP Program over the years (4).

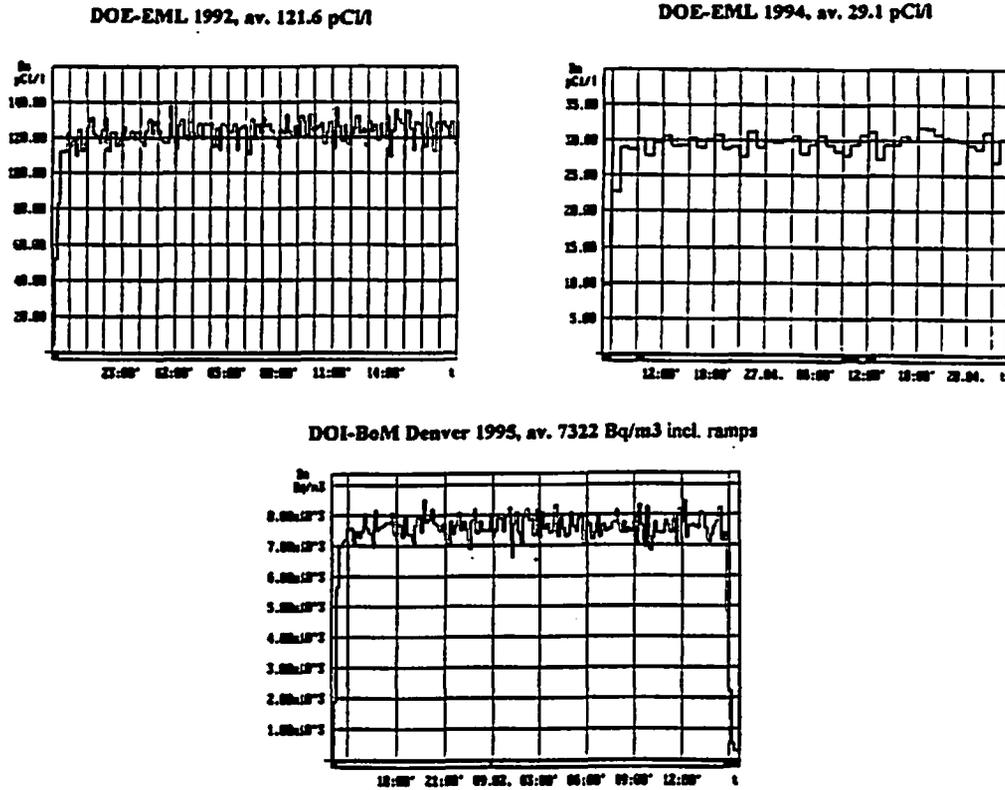
## CONCLUSIONS

1. There is evidence that, in addition to accuracy and precision of radon monitoring devices, their retention capability or averaging of radon levels - their memory during the minimum 48 hour sampling period - should be tested and documented.
2. As long as there are no testing procedures nor requirements in place, no manufacturer or laboratory can be expected to know nor can they be blamed for the performance of their monitors during the sampling time should they be found wanting. But it appears to be incumbent upon the radon industry and its representative, AARST, to demonstrate to the government and to the consumer that we have a continued interest in improving and developing our services for the benefit of all concerned.
3. Radon QC is soliciting the help and participation of radon monitor manufacturers and laboratories of the AC and LS type to donate between fifteen and twenty five devices for a memory testing program, (plus one set of 3-5 devices as spares), to take between one and two weeks, and to require between three and five return mailings to the participant, their (blind) analysis, and return of the results to the radon chamber. All results will be kept client confidential. The cost will be minimal, and will depend on the number of participants who will agree to test at the same time.
4. Radon QC will issue a certificate for successful memory test participation, and will assist others with the improvement of their products. We will request of AARST an endorsement of the testing and the participation, so that successfully tested products may use the results of the test in their product identification -THIS DEVICE WAS SUCCESSFULLY MEMORY TESTED OVER THE EPA RECOMMENDED SAMPLING PERIOD OF TWO DAYS, AND IS ENDORSED BY AARST (American Association of Radon Scientists and Technologists).
5. Similar to Radon QC's reporting requirements as a NJRMPP lab (4), we will develop a procedure to submit evidence of testing procedures and results to an AARST endorsement board in support of any endorsements requested, and for their permanent documentation.

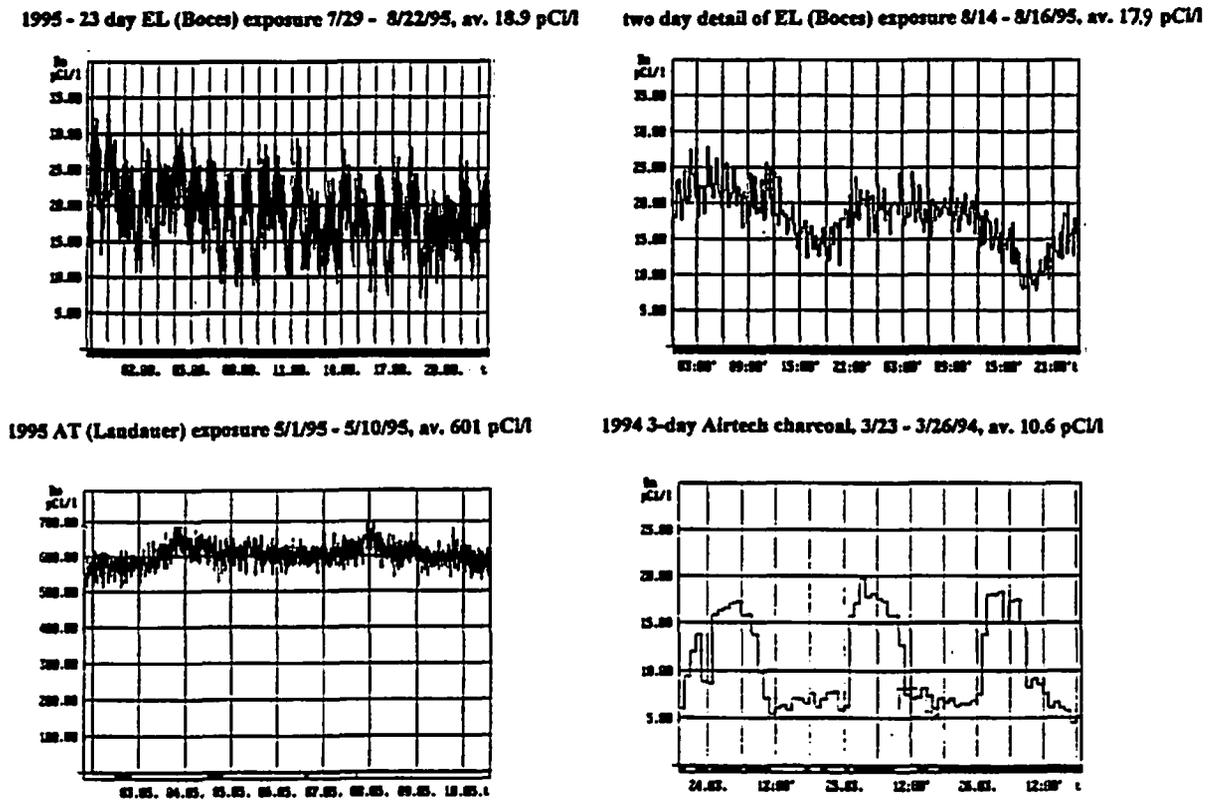
## REFERENCES

- 1) EPA Radon Measurement Proficiency Program, Handbook, esp. p.29/30, 5. Determining an appropriate method category, and exhibit 6-3, p. 35, Radon Measurement Test, Number of measurements and exposure duration.
- 2) EPA Radon Measurement Proficiency Program, Application Device Check Lists, EPA 520/1-91-007, December 1993, 17 (unnumbered) pages.
- 3) Calibration chamber services at Radon QC 1987-1995: What did eight years of experience teach us? by Judy Garcia and Bruno Sabels, Radon QC, 1995 International Radon Symposium IVP - 2.1- 2.8
- 4) Six years of New Jersey DEP-Radon QC contract collaboration - a model for AARST radon chambers nationwide in the post-EPA/RMP era, by Bruno Sabels and Judy Garcia, Radon QC, 1995 International Radon Symposium, IV - 10.1 - 10.7

# Figure 1a) - GOVERNMENT RADON CHAMBER EXPOSURES

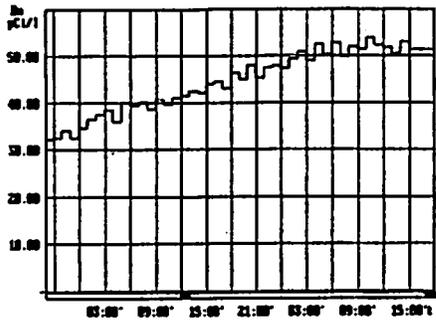


# Figure 1b) - RADON QC RADON CHAMBER EXPOSURES

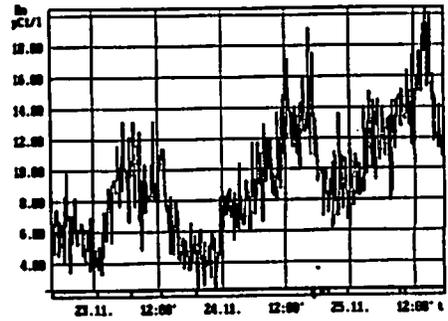


## Figure 2) - SOME RADON QC BLIND RADON TESTS

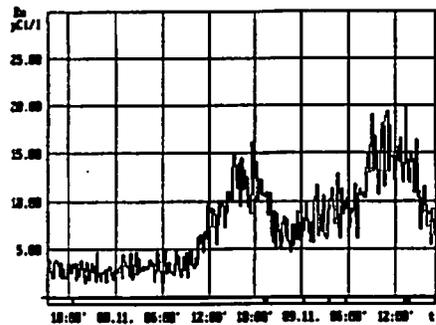
two days LS (11/6/93 - 11/8/93) - av. 44.6, rep. 51 pCi/l



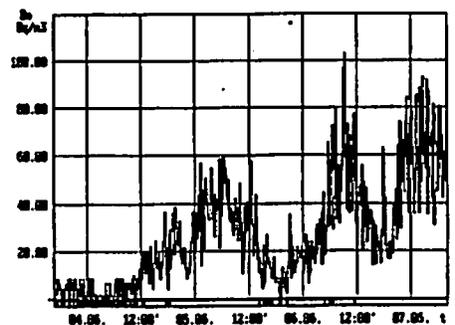
three days AC (11/22/95 - 11/25/95) - av. 9.3, rep. 14.6 pCi/l



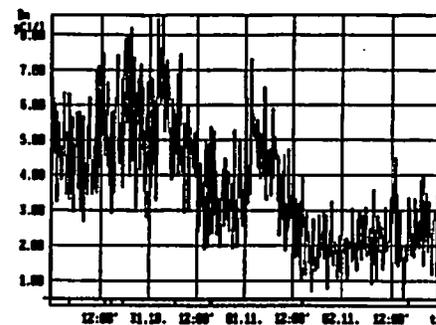
two days LS (11/7/95 - 11/9/95) - av. 7.4, rep. 13.2 pCi/l



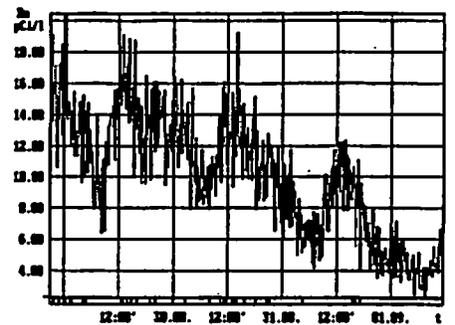
four days AC (6/3/93 - 6/7/93) - av. 26.7, rep. 48 pCi/l



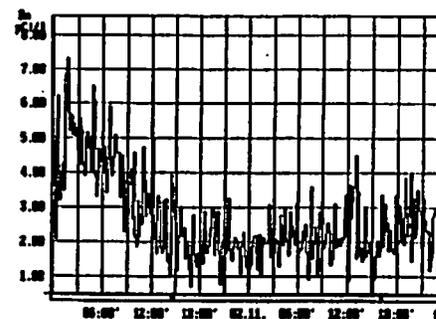
four days AC (10/29/95 - 11/2/95) - av. 3.7, rep. 2.2 pCi/l



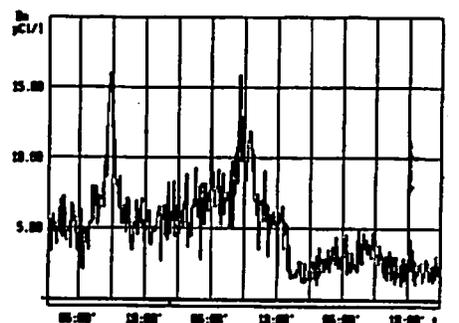
four days AC (8/28/95 - 9/1/95) - av. 10.0, rep. 6.2 pCi/l



two days LS (10/31/95 - 11/2/95) - av. 2.7, rep. 2.7 pCi/l

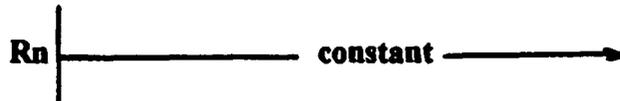


three days AC (11/22/94 - 11/25/95) - av. 5.0, rep. 2.6 pCi/l



**Figure 3) - PROPOSED RADON AC/LS (BLIND) MEMORY TEST**  
**18 - 30 devices - 3 to 5 tests, one to two weeks**

**1) Testing accuracy and precision of devices (constant radon conc.)**



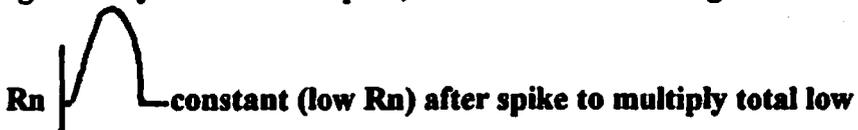
**2) Testing memory over 48 h in rising radon concentration**



**3) Testing memory over 48 h in dropping radon concentration**



**4) Testing memory of an initial spike, with 46 hours to "forget"**



**5) Testing memory of a half-way spike to check on one-day memory**

