

## **HOW IS RADON MEASUREMENT DOING ?**

*Observations of a commercial radon chamber operator  
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### **ABSTRACT**

This paper is intended as a tribute to Eric Geiger who started this particular business as well as commercial radon QA/QC as a whole.

As Eric has demonstrated in Pennsylvania, free-standing commercial radon chambers can hardly operate at a profit. The attention and service requirements are similar to that of a hobby. And there is no other source for this important service for the radon industry. This is why it is important that commercial radon chambers should be kept alive, and why routine spiking and calibration work should not be syphoned off through interagency agreements to government radon chambers.

Electronic monitors, both CRMs and WLMs, are usually exposed for short periods only, generally comprising 48 hours. Most instruments need at least 2 hours to ramp up or down and adjust to a new radon level. Yet hardly any manufacturer provides the software to help eliminate or correct for this error source. Factory calibration at high radon levels often leaves instruments stranded at low radon levels near 4 pCi/l or less. This is why even expensive instruments do not come out with greater accuracy and precision in comparison with passive detectors. Despite the supposed superiority of electronic-vs-passive monitors we have found CRMs that cannot even be calibrated. Just like a one-pellet shotgun, they produce a surprise every time. Yet there are evaluation reports by government agencies which endorse such trash.

Charcoal canisters appear to be in need of streamlining, as too many designs are in use from 2 to 7 days, regardless of ability. Some "see" only the last part of their exposures, while some fancy barrier canisters display what resembles artificial intelligence. They average even complex radon profiles over extended times.

Some superior passive monitors may satisfy this claim for long exposures at appreciable radon levels. But consumer and sales pressure have forced many devices into 48 hour service at ambient to low radon, despite the manufacturer's warning to chambers: Do not expose for less than 5 days at low radon!

Chambers sometimes need to operate at constant radon levels. Yet free floating work teaches invaluable insights into monitor capabilities and the lack thereof, especially if coupled with reliable data taking of other environmental parameters that drive radon, such as atmospheric pressure, humidity and temperature.

### **INTRODUCTION**

A respectable radon chamber will offer a variety of radon gas and progeny levels at all times. What Eric Geiger termed green, yellow and red chamber levels range in the low, middle and high levels between 4 and several 100 pCi/l. We have added the "blue" capability, the ambient background outside of the chambers which is between 0.5 and 2 pCi/l. Progeny levels can be between 0.02 and 2 WL, and exposures are only conducted when equilibrium ratios are between 0.3 and 0.5. Errors of up to 25% can result in WL calibration if the equilibrium ratios are not monitored and controlled.

Our walk-in chambers are fed radon gas from a man-made source, and there is no hole in the slab to bring in sub-slab radon as in some facilities. Yet the chambers are not free from atmospheric pressure variation and other meteorological influence. There is a very minute pressure difference between the red, yellow, green chambers and the outside atmosphere, controlled by an air pump near the outlet and by valves between the chambers. We have always believed that variations of radon levels would be similar to the situation in a home or basement. At low barometric pressure, more radon will enter the chambers, and at high pressure, the atmosphere will keep radon levels low. But as will be shown below, we found the opposite to be true. The analog for our chambers is the environment below the basement slab, where high atmospheric pressure makes radon levels rise, and low pressure makes radon escape and come down in concentrations.

Any radon chamber needs to intercompare with other chambers frequently and regularly. Radon QC intercompares with DOE-EML at least semi-annually, and with other chambers such as DOE-Geotech in Colorado on a regular basis. Intercomparison results are as shown in Figure 1, while the general flow of chamber levels is shown in Figure 2.

From the inception of our service in Illinois, we have regularly exposed some alpha track monitors to two chamber levels, and the client then had them analyzed by their contract laboratory. They have made available to us about two years worth of data, which show that with few exceptions, both the chambers and the laboratory seem to be doing satisfactory work. We like to think that the imperfect results should be due to the alpha track lab being off. We do not even like to mention any alternative thereto, though it may be humanly possible. The data is shown in Figure 3.

The primary monitors in our chambers are Eberline RGM-3s, the "standard of the industry". Similarly, Eberline WLM-1As are the working level primaries. For secondaries, we are using either alpha track or E-Perm monitors for radon, or Thomson-Nielsen WLMs or Eberline Alpha-6s for progeny. As of recent, we have had the opportunity to bring AlphaGUARDs for radon into the chamber. The multiparameter documentation made possible has aided our understanding of radon greatly.

Over the past 50 and some months, Radon QC has calibrated between 100 and 200 WLMs and near 100 CRMs. The number of passive monitors, both charcoals and alpha tracks, may be near 1000. We like to share some of the observations derived from this work, as they may help improve radon work in the future.

## WORKING WITH CRMs

Continuous radon monitors cost between \$500 and \$10,000, and they are certainly not twenty to a thousand times more accurate than passive monitors which can be had from \$10 to \$20 or so. But they are much more fun to work with, and they should be able to provide information which the passive monitors cannot provide. One of the functions of the radon chambers is to make sure that whatever information is provided should be accurate.

As can be seen from Figure 4, any CRM must settle into the chamber environment, and usually the CRM and the chamber primary come from different directions. It takes at least two hours - 10% of the first day or 5% of the total exposure period - for the two systems to come to agreement. We know of only two CRMs where this period can be corrected for or deleted. All other instruments include the ramping-in period. It may, of course, be corrected for manually if the data is available (not always). But manual corrections are shunned, as they look "manipulated", especially in working with a client. So - here we have a serious need for attention, instrument-makers!

# EML and Radon QC Intercomparison

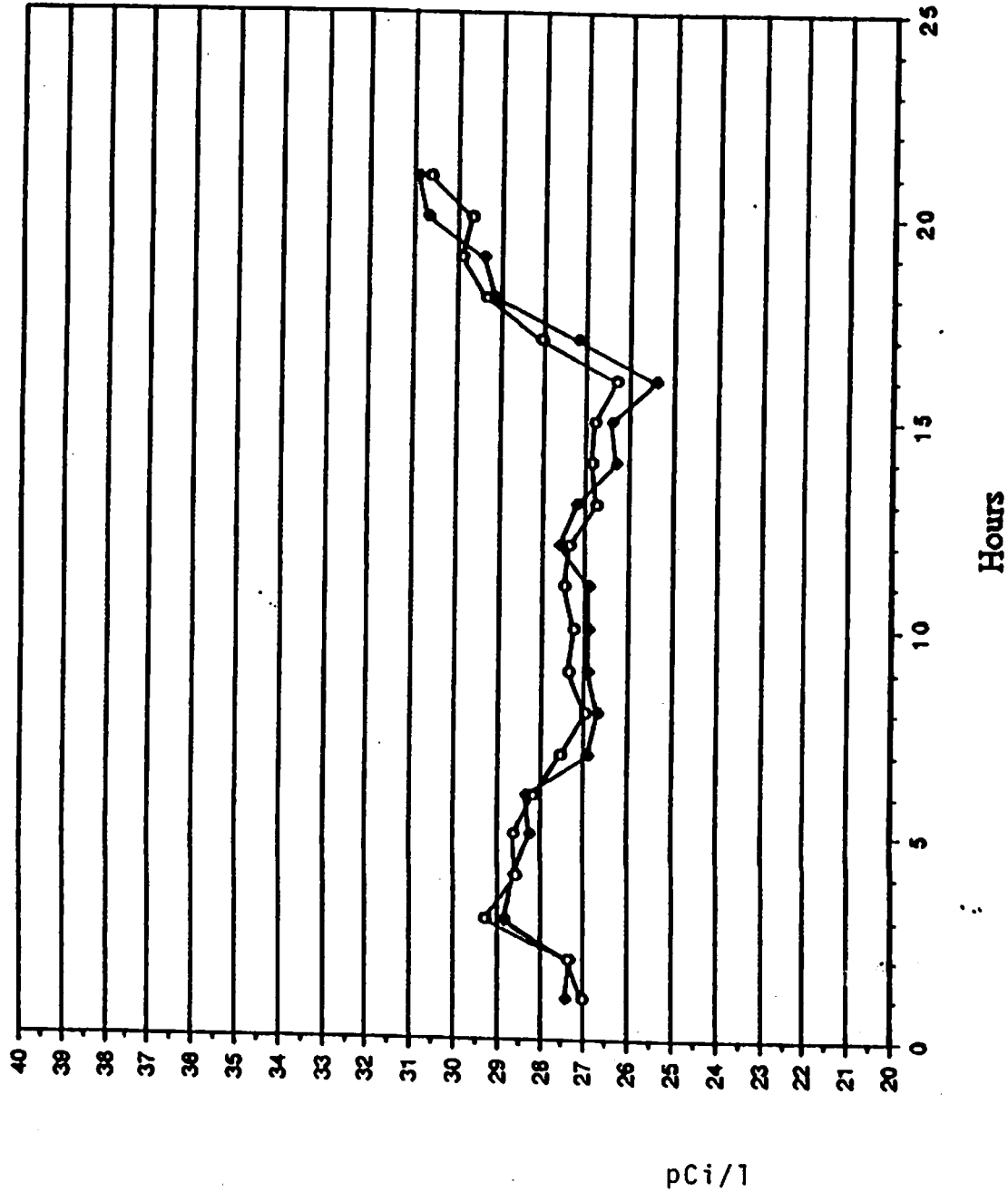


Figure 1. Radon QC / DOE-EML Intercomparison

—●— EML  
—○— Radon QC

(10/7-8, 1991)  
RGM-3 / 118 (yellow)

# Radon QC Chamber Levels

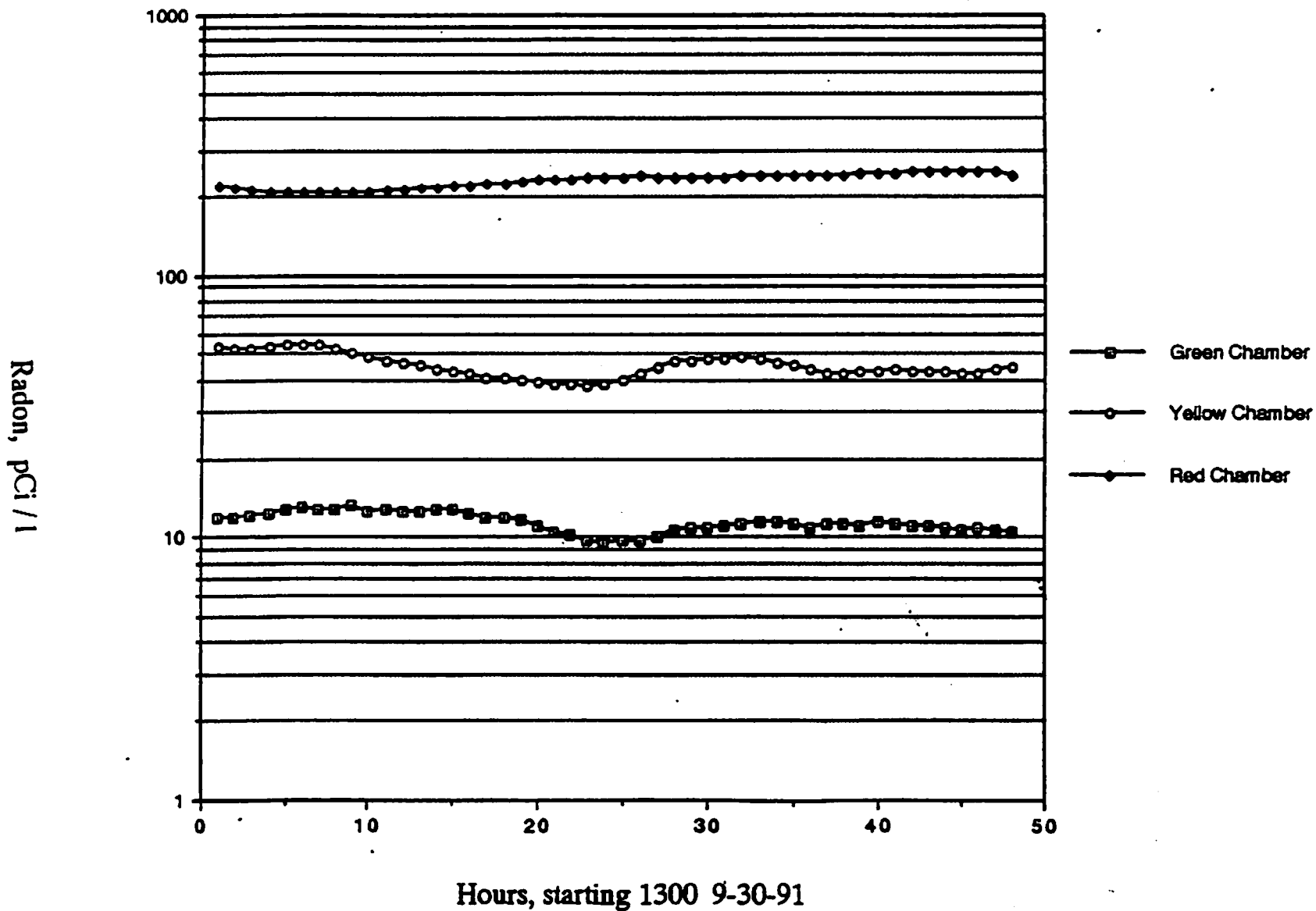
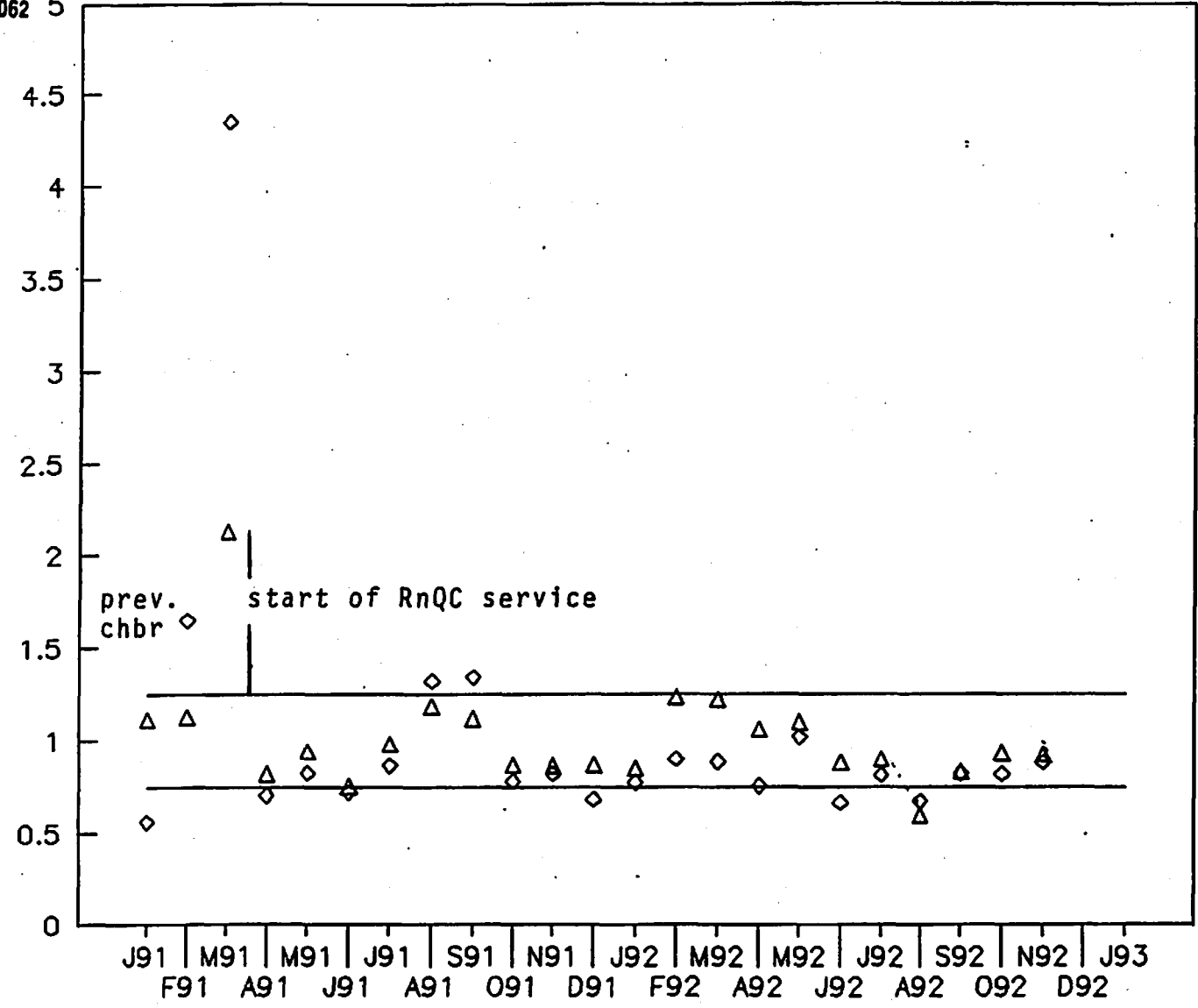


Figure 2: Radon QC Chamber Levels

RATIO OF MV1/IV1 OF major AI brand vs. Radon QC chamber exposure 1991/2 (monthly)  
 We simulate 2-60 day exposures, one level 1 <exp. <10, the other 10 <exp. <100 pCi/l

as if 60 days each



◇ MINIMUM RANGE  
 △ MAXIMUM RANGE

Figure 3: Long-term comparison of chamber exposure and (b)ind) alpha track laboratory analysis

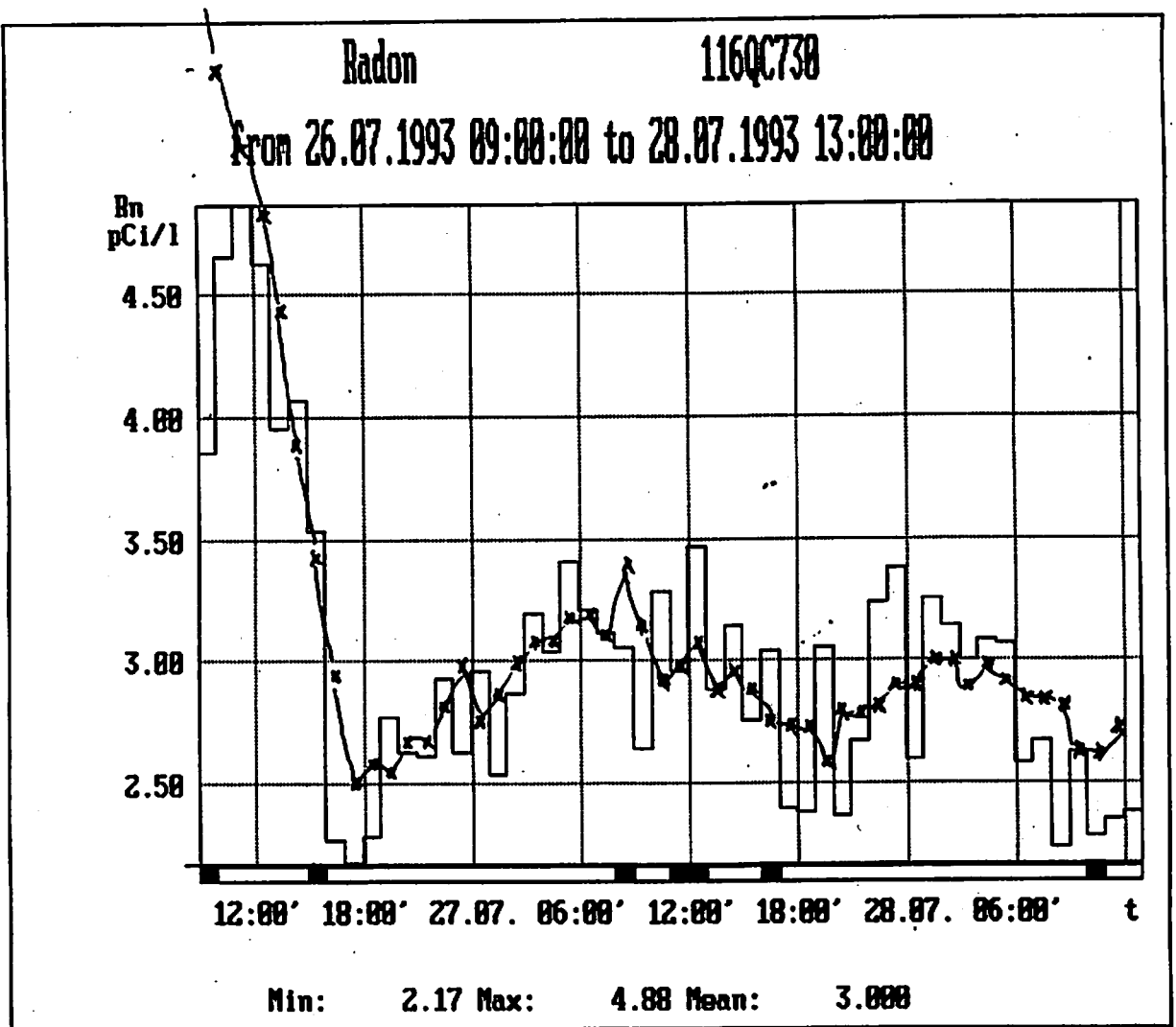


Figure 4: Radon chamber level (pencil line)  
 — suerimposed over CRM record.  
 Note the adjustment during the first few hours

Some CRMs also record atmospheric pressure, temperature, humidity, and motion of the monitor. Mostly, chambers will ignore this information, as we can do little about it anyway. But it would be a useful service to include a correction factor for these parameters as well, as will be shown below. They are most instrumental for the movement of radon concentrations. Yet, when questioned, most CRM users will admit that their multiparameters are of a qualitative nature, mostly for tamper protection and to either scare or impress the client. Here is an unopened Pandora's box, a source of information that we have not exploited. Some of the papers at the present conference will amplify on this subject.

The generation of CRMs which was designed during the last ten years mostly use thermal printers to print out their records numerically. More recent models also give thermal graphs, and some can interface with computers and allow representations of the records which can greatly enhance the information value. We are witnessing the arrival of more interactive CRMs at this time. Though they may not fit the typical home inspector's budget, they may well help to increase our understanding of radon and its motivators. Also, these new instruments will make chamber work better documented and therefore more useful to the radon instrument operator.

## **HOW A CRM CAN HELP UNDERSTAND RADON**

It was mentioned above that Radon QC chambers were believed to function like a house - rising radon levels in low atmospheric pressure, and falling levels with rising atmospheric pressure.

But good documentation, as shown in Fig. 5 air pressure and radon from August 7 to August 8, prove that indeed radon and air pressure go hand in hand, and do not vary inversely in our chambers.

With our improved understanding, we know it could not work any other way. The controller, the governor of our chambers is the atmosphere and its pressure. With high pressure, it makes it harder for the air pump to eject air from the chambers, and the flow rate goes down. With less radon being removed from the chambers, the concentration goes up. On the other hand, with dropping air pressure due to bad weather coming in, the air pump draws radonated air from the chambers more easily, and the source has a harder time keeping up. Hence-the concentration will drop.

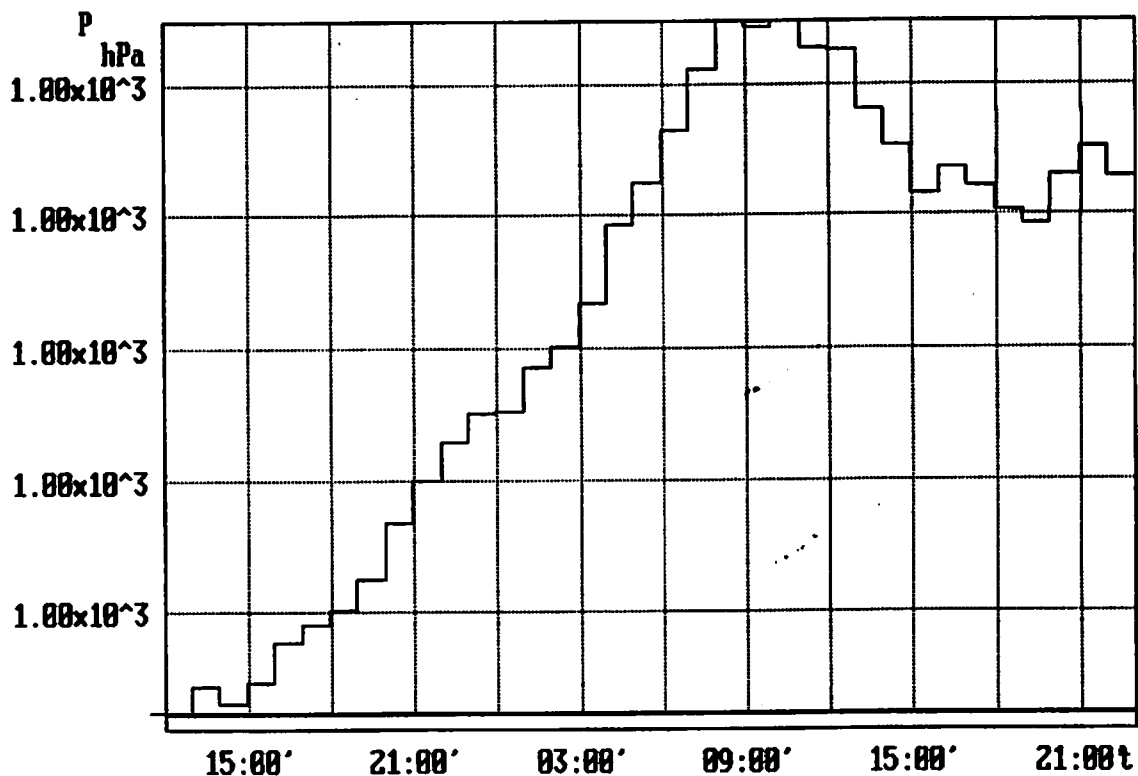
The same phenomenon will apply to the sub-slab environment of the typical dwelling. It is inverse from the situation above the slab, in the basement. Thus, our CRMs have taught us: The Radon QC chambers do not correspond to the radon regime in the basement of a home. Instead, they correspond to the regime below the slab, below the basement of a home. We are now in a better position to correct for changing radon levels. Instead of opening our wall valves for more radon, we now turn them down and the same for less radon - open up. How quickly the human mind adjusts to new insights but it takes a powerful and reliable CRM to turn your world upside down!

Some of the more powerful CRMs have large ion chambers. The Eberline's are 3 liters in volume. Consequently, the monitor can integrate over a comparatively large number of disintegrations, even in low concentrations, and the variations from reading to reading (generally hourly) will be smooth. The smaller the detection chamber of the instrument, the fewer measurements it will make, and the more restless the data will become. In some of the lower-priced or lower-volume instruments, we have found jagged data and the tendency to "fall through the bottom" in case of a change of radon concentration at low radon levels. One should be careful with low readings of CRMs with small detection chambers. They tend to produce false negative records, thus giving a false sense of security. In low-level work, a small CRM should be paired with passive charcoal monitors freely, just to be sure.

# Air pressure

116ANDYD

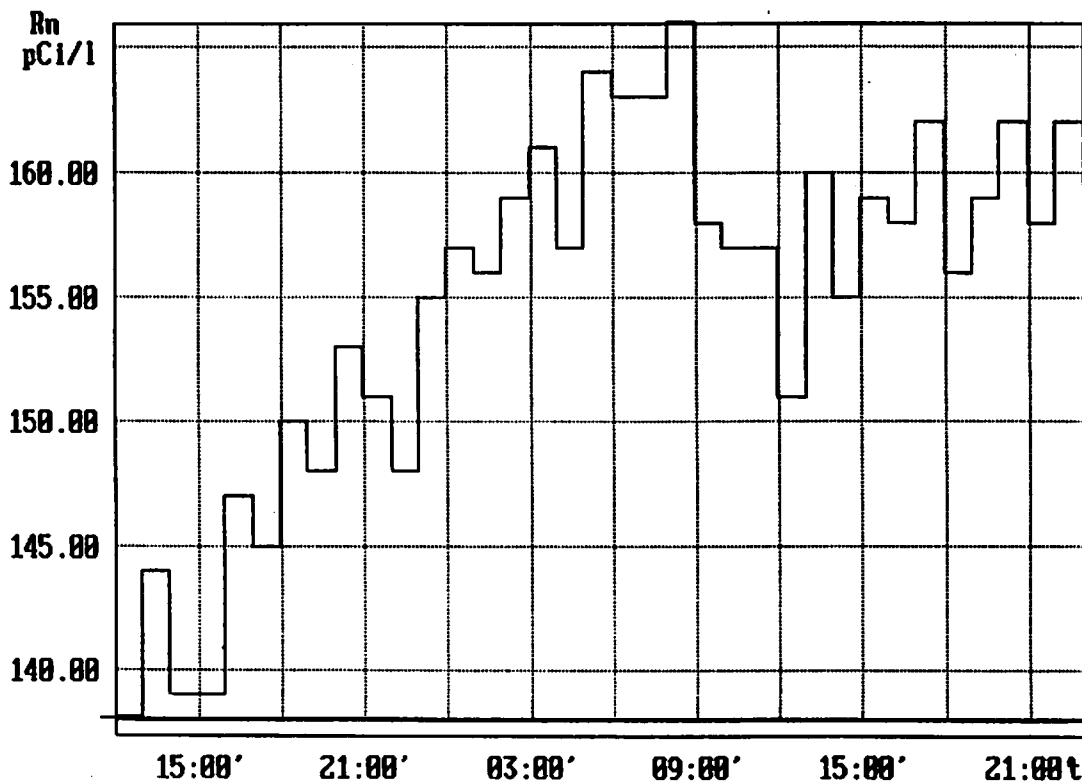
from 07.08.1993 12:00:00 to 08.08.1993 23:00:00



# Radon

116ANDYD

from 07.08.1993 12:00:00 to 08.08.1993 23:00:00



Min: 138.00 Max: 166.00 Mean: 154.771

Fig.5: Air pressure and radon in chamber (Pressure scale not printed)

## NOT SO POWERFUL CRMs

We were given twelve CRMs of a new kind and asked to find the best out of the lot, so they could be used to keep the others "honest"!

We did eight exposures of all twelve instruments, without ever even moving them in the chamber. We found variations in MVi/TVi from one exposure to the next that could vary by a factor of 2, totally unpredictably. Well, two of the instruments only varied by about 50%, but then, we only gave eight exposures. Thus, we came up with the descriptive term of the "one-pellet shot gun", as every shot would be unpredictable. We were surprised that we could not give a calibration factor for these instruments. Not surprisingly, the detection chamber was rather small. So - bigger is better for CRMs!

*(Data will be shown in the poster)*

## CHAMBER OPERATION BACKUP DATA

How helpful a powerful CRM can be in the operation of radon chambers is shown in the following Figure 6.

The top part depicts recent yellow chamber operating parameters, with radon around 30 pCi/l, the variations driven by air pressure, and the humidity kept at 80% RH due to frequent switching on of the humidifier.

At the same time, the green chamber (*lower part Fig. 6*) operated near 3-4 pCi/l, and the barometric pressure presented itself as the driving force again. Humidity was near 20% most of the time, as requested by client, and the air temperature rose inversely with the low humidity, as dehumidifiers have significant warmth output in return for their services.

Radon QC is a chamber providing RMP services for the State of New Jersey, and the data shown in Figure 6 was provided to the State as documentation for their passive monitor exposures. We are not aware of another radon chamber that will provide a complete documentation as does Radon QC.

## PASSIVE MONITORS CHARACTERIZATION

Though we have many records of "poor" charcoal performance in changing radon concentrations, there are some which give excellent agreement even in concentration changes between 4 and 8 pCi/l. These and other records will be shown in the poster, as they appear to be too many and varied to be included in this paper.

## CONCLUSION

To operate a radon chamber is fun, especially if one can take over a well-designed laboratory which is well-equipped and which, even after more than two years of new ownership, still carries indelibly the spirit and calling of its creator, Eric Geiger.

It helps to have supporting income of any kind - our collaborative set-up with Radon Environmental Monitoring, Inc. has certainly helped both organizations to make progress jointly, though totally independently. There is no one radon chamber that can boast that it stands freely and supports itself. This may be the case if the radon industry will succeed some day to be allowed into more profitable work that is presently carried out by our biggest friend and competitor, by our Government.

Pressure from interest groups have resulted in shorter and shorter exposure periods of passive and active monitors, until the line was held firmly at 48 hours - thank you EPA from a measurement point of view, and from the characteristics of radon and its dependence on climatic and weather change, it would be better if even longer periods had been maintained, such as several weeks to several months. After all, the "action level" is defined as an annual average of the radon concentration.

Though 48 hour charcoals and E-Perms are still being used heavily - it is hoped that longer measurement periods will be brought back, as charcoal barrier canisters with 4-6 days appear to give better and more consistent readings. This would also make E-Perms a good deal more credible, as most readings are taken in low environments with 2-6 pCi/l where few volts are drained and reliability is low - not unlike the low-volume CRM!

The endorsement of active CRM monitors by the users may need to be coupled with the availability of both capable and low-priced stock. Just cheap, and just bad is not acceptable. There is little low priced and good equipment available, and some high-priced and still not so good. It is hoped that, progressing from dear and good, it will not take long for good and inexpensive monitors to become available, perhaps similar to the household smoke alarm.

Considering the large number of calibrations that result in considerable changes of the user's calibration factors, there should be much more chamber use and abundance. Events like this conference can change the awareness and the politics that are required to make more commercially operated radon chambers possible.

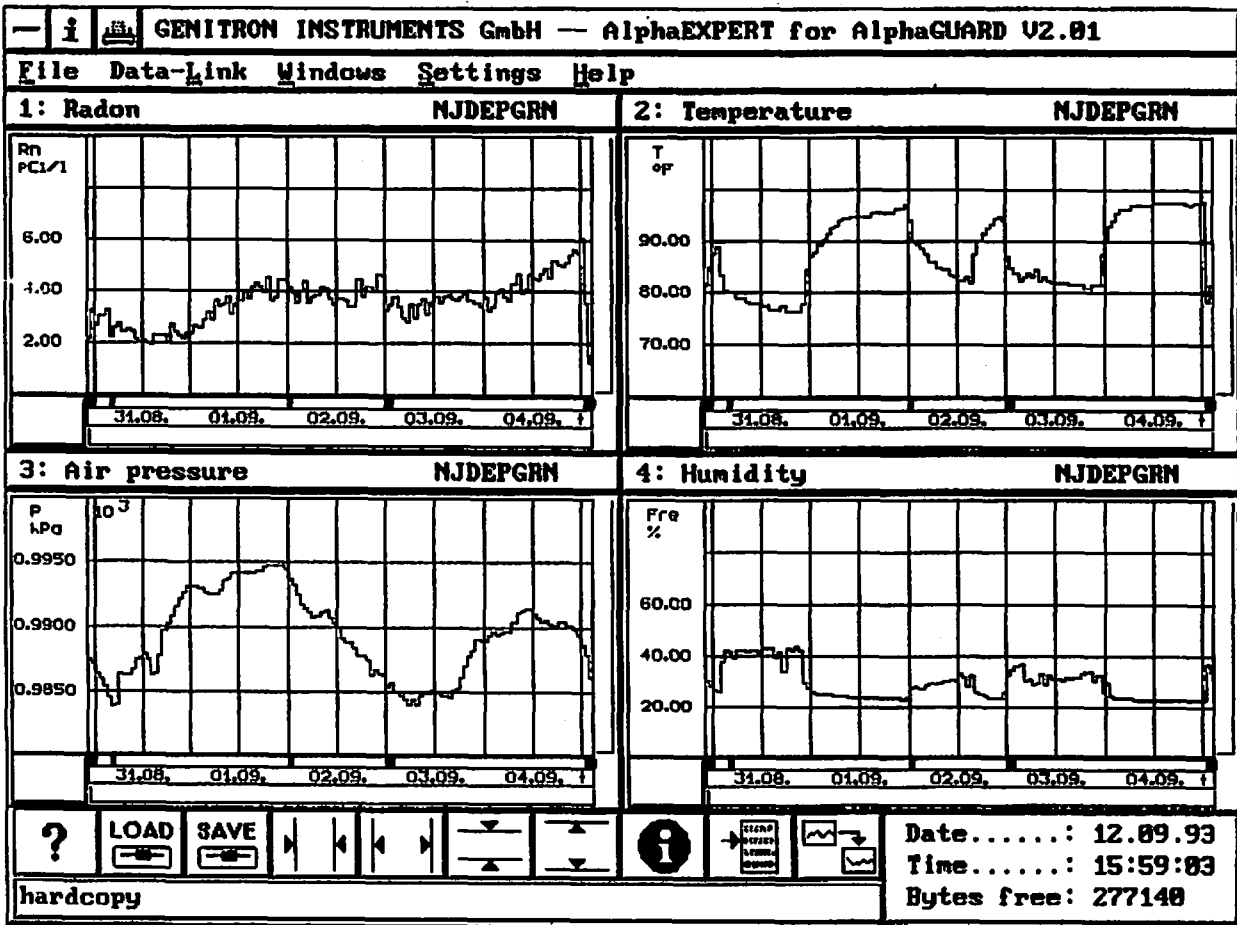
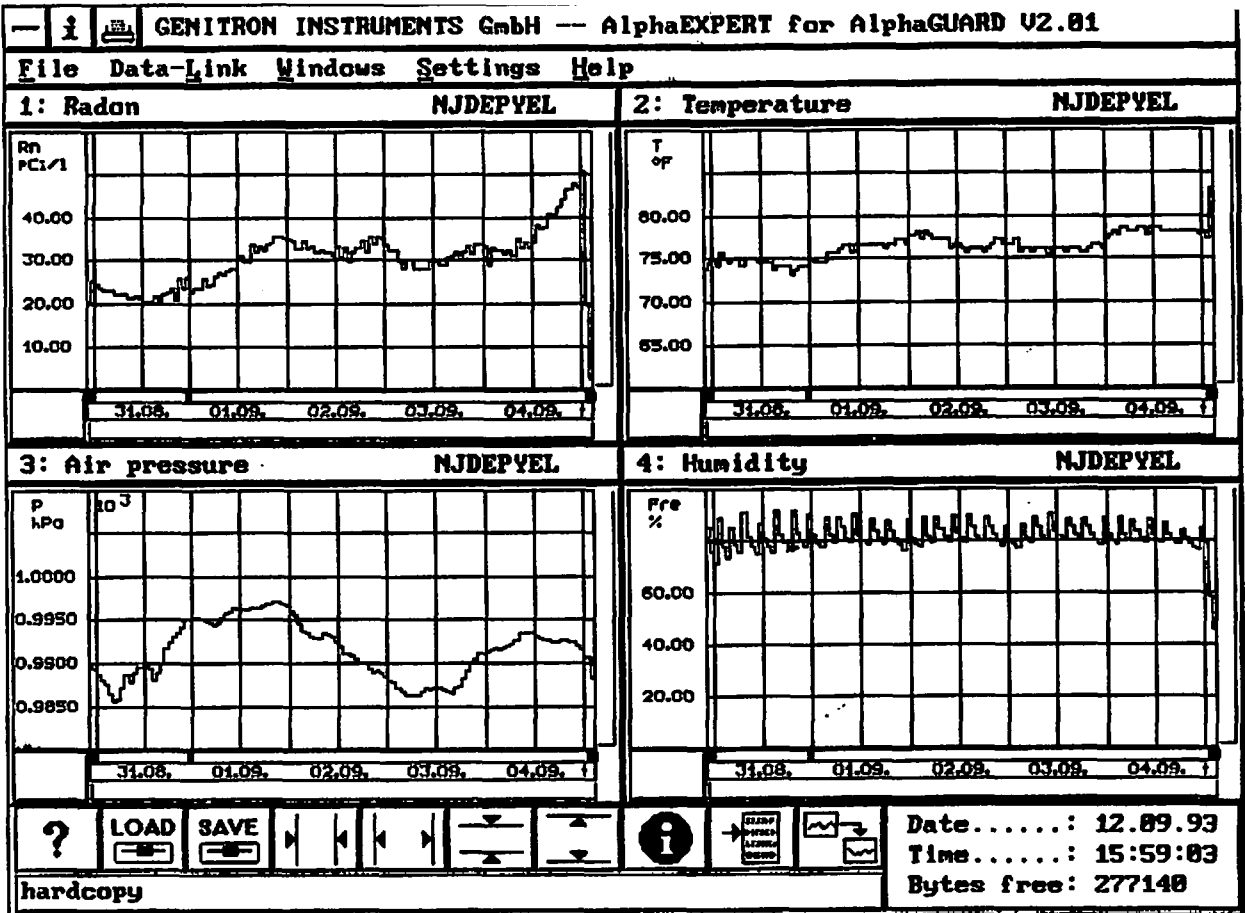


Fig.6: Documentation of chambers operation by AlphaGUARD