

**CALIBRATION CHAMBER SERVICES AT RADON QC: 1987 - 1995:**  
**WHAT DID EIGHT YEARS OF EXPERIENCE TEACH US?**

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**ABSTRACT**

During his four years 1987-1991 in operating the first commercial free-standing radon calibration facility (in the "good old days" of a bullish radon industry), Eric Geiger proved that a private radon chamber service is a much needed institution. He pioneered contract services for States as NJ and PA. He sold flourishing radon monitor manufacturers annual "memberships" costing upward of \$ 5,000. And he invested heavily in his company, both in funds and in health. Despite considerable sales, the cost of doing business outpaced Radon QC's income.

Since May 1991, Radon QC operated with less overhead, less volume, but without red ink. During two and a half years in Northbrook, IL, we subsidized as well as deprived our Radon QC work by carrying out other, full-time activities. But we did not realize the enormous training benefit that was available to us essentially from 1987 to 1993 - practicing a customer service attitude and, simultaneously, learning and teaching from scratch sensor development, making and processing from charcoals to LS to alpha track monitors and even CRM fundamentals, including automation and computer applications.

Since our move to Colorado, chamber service is our only responsibility. With minimal expenses and other commitments, we can devote ourselves to serving, learning and teaching in radon chamber applications. We are convinced that there is a great need out there for dedicated service and communications in radon. And we are welcoming the opportunities provided by AARST to further both their and Radon QC's cause.

**INTRODUCTION**

This appears to be a very appropriate time to look back at eight years of radon chamber work experience, as the EPA is engaged in a nationwide search and evaluation for alternatives to the present EPA RMP program . A draft radon chamber qualification (RCQ) proficiency program is making the rounds, and experts all over the country are making suggestions as to how to replace the present multi-million dollar EPA program with a technically equivalent alternative that will come with everything but the price tag.

Since 1990, Radon QC has been engaged with the State of New Jersey as their contract RMPP laboratory for the performance testing and certification of New Jersey radon technologists. We have summarized this experience in a separate paper in the proceedings of this conference, jointly with NJDEP Bureau of Radiation personalities who have been the architects of the NJ RMPP Program. But Radon QC has also been active with other state radon programs, such as Pennsylvania, Wisconsin, Iowa and New York. We are proud of a five year work history with N.I. Radon Detection Services, whose fleet of radon progeny monitors we have been keeping in good calibration and in good repair as well. Their network of radon technicians virtually spreads all over the United States, and we have learned how to serve their exacting needs with regard to turn-around, cost and service in a manner unmatched by anyone including the manufacturer.

The NJRMPP participant/analyst measured results report form contains as part of the report several line spaces for comments. There is no such space on the EPA RMP report form. We have learned that commenting and

communicating about our work with our clients is one of the most important aspects thereof. According to Myron Sonkin of N.I. Radon Detection, customer service is one of the scarcest commodities in the industry, let alone good or adequate customer service. So, at Radon QC, we may be doing calibration (or, as some prefer to say, performance testing), and we may be doing this by the use of radon chambers. But, most importantly, we are attempting to provide customer services in a manner as we have become known to our clients before we moved the chambers to Colorado, and as we have found to be a commodity as rare as gold .

As we will show in the following, we believe that the future in radon chamber work should emphasize neither bigness nor government control nor other vestiges of the old RMP/RCP hierarchy. There must be checks and balances to be sure. There must be ascertainment of quality and competence. But most of all, there must be an attitude for service with respect to the client, the radon community, and the general public. Service implies being there when needed, solving problems, learning, teaching, consulting, and never giving up until the work is done. Perhaps this attitude may be coupled with a celibate situation - freedom of interest in any given method of monitoring and detection, and in any make or manufacture of equipment. This, in a nutshell, is what eight years of experience have taught us.

### **THE PHYSICAL SET-UP - WHAT IS UNIQUE ABOUT RADON QC?**

Though Eric Geiger's chambers have now been materialized three times in three different states, with significant differences, there have been identities and similarities which are unique to our operation.

**Palmer, PA:** Everyone who ever visited the "original" chamber basement will never forget the 24 foot long hallway with the green, yellow and red heavy doors to one side, and the respective viewing and access windows. The "famous triple chambers" have remained our trade mark. We have always built them about 7 feet deep and 7 feet high as well as wide, including air locks. Eric's mobile stainless steel shelves accommodate enough monitors for all demands and allow for homogeneity of the radon concentration.

**Northbrook, IL:** The chamber configuration remained the same, including doors, ports, and all equipment. But we replaced the sub-slab radon source with localized radium-bearing materials in a "source box". The background levels were much lower than in the Palmer radon basement - also a requirement due to other radon activities such as manufacturing going on under the same roof. We did not realize during the years in Northbrook that the greatest difference in Radon QC's operation as compared to Palmer, PA became our service attitude, which became second nature in working with the clients of our host company whom we identified with for five years. An owner will be willing to make an extra effort where an employee often may not do so. And while Eric Geiger was a rare visitor in Palmer, we were always in the chambers at Northbrook. And our clients told us that they could notice the difference ! There are actual client data that prove this point.

**Lakewood, CO:** We fitted the same, basic floorplan of the chambers ontop of a flagstone patio in a large greenhouse in our home (Figure 1). While we were tenants in Northbrook, we now experience the freedom of property ownership. With virtually no overhead, we could adjust our price list downward! In addition, all of our time belongs to the chambers, as there are no other demands on our time as they were in Illinois. Therefore, our turn-around and other service parameters became even more unbeatable. In dealing with a variety of radon interests, we are noticing the great advantage of our familiarity with most all of the aspects of passive sensor manufacture, processing and analysis (including automation and computerization), from alpha track to liquid scintillation to charcoal monitors and their many adaptations to special applications.

After we followed an eight year learning curve, we are in a position to offer this unique facility and our personal situation to the radon community.

## WHAT DO OUR CLIENTS EXPECT OF RADON QC?

**WL Service:** At any time, monitors may be delivered, with the expectation to be returned to the operator after 24 hours, unless some service or repair are required. Therefore, we always maintain a chamber with elevated radon gas and increased humidity to ascertain a 40% to 50% equilibrium ratio. Next day turn-around with fax reporting to Client works most of the time.

**Radon Gas Exposures:** Continuous monitors come in prior to EPA RMP requirements or to update the annual comparison demands. We are aiming to expose monitors for several 48 h periods in several radon atmospheres, one of which will be near or below 4 pCi/l. Some clients desire exposures between 1 and 2 pCi/l, as they distrust manufacturer's high-level calibrations. Some smaller CRMs will let "the bottom fall out" when radon levels get low - statistics become awfully poor. We have found that one particular CRM cannot be calibrated at all. There appears to be no system in its variation for different exposures - no trend for correction or compensation.

The beauty about passive monitor exposure is that clients want matrices of conditions - durations, concentrations, humidities. Comparing today's passive monitors with those of yesteryear demonstrates the enormous evolution and specialization which has taken place. Clients want exposure durations from 2 to 7 days, at several radon concentrations and low, middle and high humidity, and they want everything returned overnight to arrive at their lab simultaneously, best on a Monday that is not a holiday. And most of the time we do it, too! They want lavish documentation of all the parameters and custody records.

After clients do their measurements, they want detailed comments and explanations as to why their passive monitors do or do not agree with our exposures. We then have to match wits with the likes of the equipment and processing industries. And yes, there are situations when we must realize the limitations of our knowledge, and when all we can offer is a repeat performance on the house!

We do spikes and other "routine" work for projects and radon technicians, but most of these requests also turn into challenges. A project manager discovers that the alpha tracks supplied need exchanging, or that the charcoal canisters were inadvertently swapped. We are "routinely" accepting rare and one-of-a-kind equipment that the owner/operator sometimes has never adjusted or even understood. If we are lucky, we can follow the manufacturer's manual and verify or change all the parameters. Time is no object. The satisfactory end result is worth the effort.

## WHAT DOES RADON QC EXPECT OF THEIR CLIENTS?

**Appropriateness of Devices:** It is nice when a device to be exposed matches the environment to be investigated. We will expose an LS device with 2g of charcoal for seven days at 80% humidity, but we will report, in addition to the seven days, the last 24 hours only, for a long shot that this may come close to the Client's reading. Free advice is available if the client appears open-minded.

We have exposed brand-new charcoal canisters at 20% humidity for varying durations, to learn from the client that the monitors came back lighter than they were sent out. Obviously, the weight correction will not work too well in these cases.

**Timely retesting:** Though we will calibrate any active device, it is good to see the CRM not too far out of date since the last calibration. Especially when a significant change in the calibration factor results, it feels better to know that the machine was not out there cranking out falso negatives or false positives for too long.

**Maintenance of monitors:** Some CRMs come in in sad shape. Batteries may be dead or missing, power supply wiring broken or damaged, LEDs in disrepair, and supplies as filter paper, recording paper, missing. - Some passive monitors may have loose retaining sieves or loose charcoal, or loose or missing gel packages or other components. Some of these may affect the precision of the test, never mind the accuracy. There is a reflection on

the client sending this equipment, as well on his supplier of passive monitors and the care which is given the random homeowner client. It boils down to the rare commodity of service which is on the endangered species list.

### **WHAT HAS CHANGED IN RADON QC'S OPERATION OVER THE YEARS?**

We are hardly ever using very high radon levels any more, except to simulate cumulative annual levels in electrets and alpha track devices. We are much more often using low to medium levels, often striking a balance or giving a combination of "natural" levels and good statistics for monitor evaluation.

Exposure times have gotten shorter, in keeping with EPA rule changes, except that grab samplers have all but disappeared (we do some, but not for home radon monitoring).

Our turn-around times have become shorter, and our services, in general, have become cheaper, as the cost of our operation has become lower as well.

Communications with clients have increased and improved, and we are giving more comments on our exposures as well as more back-up data than in the early days. There is more of an effort at interpreting and understanding the behavior of monitors and their strengths and limitations. This is perhaps also the most significant difference between working with our chamber and, say, the RMP program. Though, I remember Henry Singletary explaining extremely low LS levels in an RMP test and verifying that the technicians at the LV facility had forgotten to unscrew the vials. He admitted to having a red face as he made this confession, yet it was a proud moment in the EPA/RMP program. We will never know how many other unexplained mysteries have gone by due to lack of communications and lack of intestinal fortitude of which Henry Singletary sure did not suffer. Errors do occur with us, too, and we will face up and explain and make good as best we can, if possible.

### **"PHENOMENA" OF PUZZLING CHARACTER IN CHAMBER WORK**

Over the years, we have experienced a number of items that have either stimulated, frustrated or challenged us to varying degrees. Here are some of them, though the list may be much longer:

**Air velocity (NJ):** The NJRMPP rules specify air velocities in chambers to be between 2 and 14 liters per minute. We have never challenged this specification, though we do not believe it to be a true "velocity", such as feet per minute. Through using cigar smoke in chambers, we did verify that air volumes of cross sections of dm (deci-meters or 10cm x 10 cm) would move no faster than 140 cm per minute or 1 foot per 10 seconds. Still, the definition is a bit unusual - but one can live with it.

**Equilibrium:** We do feel a little bad about increasing condensation nuclei through increased humidity for working level exposures. We used to use Canauba Wax, as is also practiced at EML. But in long exposures, we found clogging of filter papers. Even elevated humidity will reduce air flow in some WL monitors, and therefore the technique requires a closing air flow determination and correction. We are getting good agreements with chambers such as EML and WL manufacturers, but the field technician who is using the calibrated instrument mostly experiences equilibrium levels below 40 or 30%, maybe even down to 20 and 10%. As long as he sticks to his progeny determination, he will be ok. But then we do find the occasional situation where a WL monitor is routinely operated in the "radon gas mode", by setting a switch and working on the assumption that there is a 50% equilibrium present, 0.02 WL equivalent to 4 pCi/l. While we are shooting for this condition in the chamber, it will hardly ever be duplicated in the field. Therefore, caution should be applied.

**Humidity:** We do know that some humidity is everywhere, and that it affects every measurement in some form. Life without humidity is unthinkable. On the other hand, chamber work is made much more interesting through humidity.

Some of the finest charcoal canisters go totally berserk in increased humidity, as water takes over for radon gas and intentions of designers and technologists are literally washed out. Andy George has preached these truths many years ago, but they manifest themselves today mostly in veteran devices that fall victim to humidity.

Weight gain during exposure of charcoal canisters requires a correction for proper radon levels. This assumes that the canister starts from zero water weight. We have recently exposed canisters at 20% humidity and heard from the Client that the canisters lost weight during exposure. This indicates that the manufacturer did not dehydrate the charcoal totally, and that the radon laboratory did not check/ verify/control this item either. One cannot take anything for granted.

Humidity will also affect electrets and, to an extent, active CRMs. We do not wish to pursue these phenomena any further at this point, except to note their existence.

Memory: One of the most significant humidity effects in passive adsorptive devices is on the memory of the monitor, or on its ability to accumulate and average radon levels over time. In high humidity, some devices will show a breakdown of memory after exposure times too short to satisfy EPA requirements. Some low-volume devices such as LS monitors can be shown to "forget" specific, high-level pulses of radon in the course of the same sampling day (24 h period) as if they never occurred.

Radon chambers that strive to run at very level concentrations at all times are depriving themselves and their clients a wealth of insights. We have found that one can "understand" the performance of monitors much better if radon is allowed to go through certain concentration patterns during adsorptive exposure.

We have found 4" canisters with "photographic memories". We have found some devices that would not allow more than a minimum of water inside, no matter how high the (noncondensing) humidity, and that kept their memory intact. And we have found memories that "went awash" and that even did not behave at all in keeping with correction factors provided by special consultants. The idea appears to be: What happens if a two-day detector does not get collected until 3 or 4 days into the exposure. The best answer: There is no rescue. Exposure beyond design specifications requires re-testing and timely collection!

Electret discharge: Why do some electrets give up voltage in transit ? The factory has addressed this point by hardware modifications. There may be unknown exposures to bona fide radiation sources on the way, known only to the discharged electret. There may be mechanical effects (shock, vibration). There may even be accidental discharge by the receiving technician upon removing/ inserting the device in the reader, who then blames the resulting voltage drain on past history.

We are cross reading all electrets before and after exposure, and, yes, we also have spurious/ accidental discharge from unintentional contact during manipulation (the latest happened yesterday). This wonderful method given to the World by Kotrappa and Ramsey et al. is neither foolproof nor perfect, but then so isn't any other method. But it does provide one of our puzzling topics.

Altitude: In Colorado it is customary to blame almost anything "on the altitude", whatever defies rational explanation. We were surprised, though, when Bob Holub of the Bureau of Mines Research Center showed us that his AlphaGUARD radon monitor did not indicate the accurate radon level, but the radon level reduced by the barometric pressure increment, which was 83% of sea level at the time. We have since run a comparison with several AlphaGUARD, one freshly returned from EML in New York with a 100% certification - and they all came out modified by the pressure increment. We understand that the factory is modifying the software, and in our own applications we are manually beefing up the readings, which we verify with RGMs and secondary monitors as E-Perms, to be sure.

Consequently, we have been keeping our eyes open for other active and passive monitors to show altitude effects. They are well known and documented for Eberline RGM-3s which come with a correction table, and for

RadElec E-Perms which come with a gamma correction factor which is a function of the elevation. Yet we are not sure that other monitoring devices are totally free of altitude effects. Therefore, we are going an extra mile in making sure that nothing is overlooked. We are presently preparing a site 10,000 feet or near two miles high near the Continental Divide, where we will be securing new data points shortly. This may be a paper for one of the next AARST conferences!

### **WHICH TYPE OF RADON CHAMBER IS IDEAL FOR YOU**

To summarize, here is a list of possibly available radon chambers:

A. Large government (EPA/DOE) radon chamber facility, usually far away and with schedule problems - limited availability to general user at any given time.

B. Dedicated (celibate) radon chamber doing nothing but what they are supposed to, and waiting for your business.

C. Multipurpose (manufacturer/contractor/mitigator) chamber with as-available potential, but generally not set up for performance testing, as specialized for owners' application.

D. Mini (pickle jar/ glove box) home chamber/ science project.

Now you can go ahead and shop with confidence as to where you will find communications and understanding of all your pressing radon problems.

### **OUTLOOK FOR THE EPA/AARST RCQ PROFICIENCY PROGRAM**

What did we learn in eight years (including our own pre-Radon QC four years and Eric's experience) that would have any significance for the future of the radon chamber industry, beyond the EPA RMP era ?

First off, communications and understanding and mutual confidence are buzz words that need to be totally redefined, as they were absent among the key words of the past RMP program.

Secondly, uncompromising accuracy, dependability and reproducibility of the chamber services must be understood as prerequisites of any form of radon chamber support. The aspect of celibacy of the chamber or absence of a conflict of interest may give the chamber a status similar to the government's, which is expected to be impartial and outside of a self-interest of any kind.

Thirdly, economy and low cost to the radon user/technologist as well as to the chamber business and very little if any genuine cost to the tax payer of these United States of America should be targetted as achievable within a relatively short time after start-up.

Fourthly, a controlling and overseeing system of checks and balances of the RCQ and operations so that it can be assured that honesty and fairness are being observed at all times by everybody.

### **CONCLUSIONS**

During our considerable involvement with the general radon industry from detector development and manufacture to CRM service and repair to radon mitigation, we have come to grips with most any problem a radon scientist or technologist, or a home owner may ever expect to encounter.

We believe that the original idea of Eric Geiger's was a sound one - that there is a need for an impartial, trustworthy and competent performance testing service known as a radon chamber. We have learned that the service aspect is more important than Eric Geiger anticipated, and that individual fees and accounts receivable may be considerably less than he projected at the time.

In the present trend of home based industries and services, the radon performance testing chamber holds a unique place. Almost full-time demands on an individual can be ideally matched in the home environment, and minimal overhead costs, retirement subsidies, a wealth of experience, good health, and being at the right place at the right time all seem to fall into place for the dedicated chamber operator. With this attitude we are eager to enter the next eight years of radon chamber services, and we do not expect to deviate very much from the path laid out by Eric Geiger. Our growth expectations relate first of all to service, communications and satisfaction. Everything else is open. We are remembering all the people who we used to know in the radon industry and who used to have big plans for the future. This keeps our memory, and our mind sharp. Because the past eight years have taught us that you never know for sure in the radon industry what may come up next. Whatever it may be, we are ready for it!

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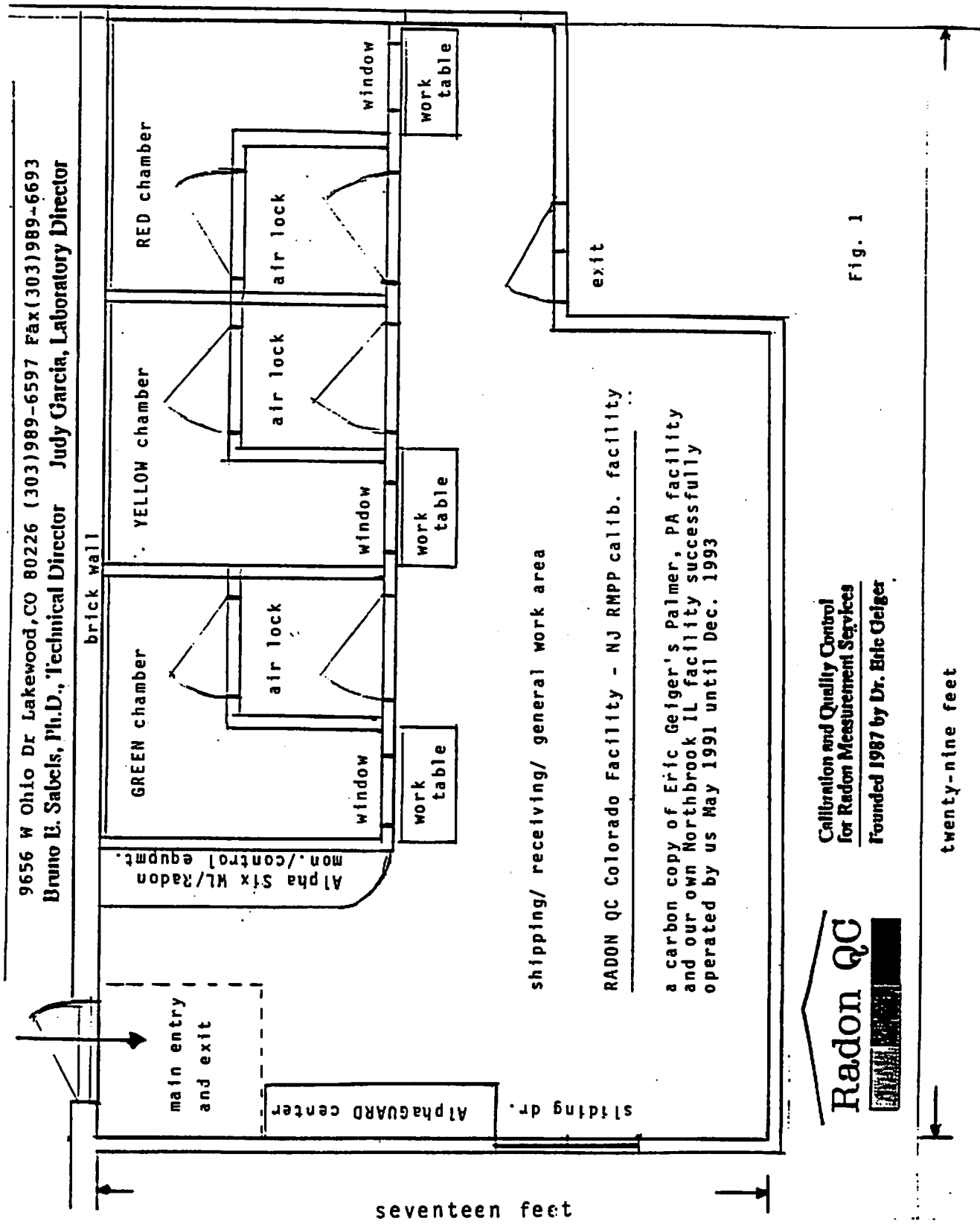


Fig. 1

**Radon QC**  
 Calibration and Quality Control  
 for Radon Measurement Services  
 Founded 1987 by Dr. Eric Geiger

RADON QC Colorado Facility - NJ RMPP calib. facility  
 a carbon copy of Eric Geiger's Palmer, PA facility  
 and our own Northbrook IL facility successfully  
 operated by us May 1991 until Dec. 1993