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MULTIPARAMETER RADON MONITORING AND INTERACTIVE COMPUTER EVALUATION AND DOCUMENTATION

by Volker Genrich and Bruno Sabels,
AlphaGUARD Inc., Northbrook IL.

Abstract

Several technologies of different sophistication have evolved over the years, in order to come up with the best possible estimate of the "average annual radon level" in a given location at the shortest possible measurement interval.

The DOE-EML radon chamber and other government chambers have shown in numerous reports that the precision and accuracy of different methods is not necessarily improved by sophistication and cost of technology. This may have to do with the great variability of radon concentrations, which react to many environmental variables.

Once it is realized that the value of a radon measurement per se may be limited, it becomes important to measure and understand the dominating parameters that contribute to the all-important radon concentration.

Passive radon detectors cannot respond to environmental parameters, except for humidity indication by some charcoal devices. Active continuous radon monitors have the capability to print out hourly measurements of radon and, in some cases, of air pressure, temperature, humidity, and motion sensing. But thermally printed records allow only limited evaluation, and the supporting data is generally accepted to be of tamper-inhibiting value only.

The Genitron Company has recognized that high-precision measurement of the major parameters that influence radon emanation may be as important to understand radon readings as the radon levels themselves. Through high-powered software, computerized data is stored and manipulated so as to understand the forces that move radon gas.

A number of case histories are presented that help understand radon levels and what makes them change. It is believed that a new era is about to dawn in radon work - the era of the computer-driven CRM.

Introduction

It appears inevitable that sooner or later computers would invade the radon field and perhaps help the industry in coping with a problem that is hard to pin down by limited concentration measurements alone.

The radon chambers of Radon QC have been operating for over two years now in Illinois, and the radon levels in the chambers have been fluctuating, without apparent control, dominated by meteorological parameters such as wind and barometric pressure. But it was believed that high pressure would keep the radon level down, whereas low barometric pressure would bring out more radon and make levels rise. This "working hypothesis" corresponds to the situation in the typical basement of a home.

But the multi-parameter data acquisition by AlphaGUARD has changed our understanding. We now know that radon levels rise in the chambers with high pressure, as the air pump moves less air out into the atmosphere, and the source keeps adding to increasing levels. Conversely, in bad weather, our air pump sends out more air and dilutes the concentrations. We can counteract by slowing the air flow down.

The point is - despite having had hundreds of instruments and detectors in the chambers, we had to wait for a modern, computer-interactive instrument to tell what runs chamber radon concentration. Our situation does not correspond to the situation in a home basement over the slab. Our situation corresponds to the situation <u>below</u> the slab. It is below the basement slab where radon gets slowed up and concentrated in high pressure times, when it shows depletion in the house. And it is in low pressure regimes when radon flows through cracks and drains more freely into basement and living areas, thus depleting its reservoir below the slab.

<u>Fig. 1</u> shows a 6-day chamber exposure of AlphaGUARD, two days each in the low, middle and high radon chamber.

<u>Fig. 2</u> shows the barometric air pressure recording of the instrument for the same time. The variations of the pressure are reflected, especially in the middle and high radon chamber records.

<u>Fig. 3</u> is an enlargement of the high radon record, and

<u>Fig. 4</u> shows the corresponding air pressure record.

Clearly, the relationship of pressure and radon in the chamber is not inverse, it is directly proportional.

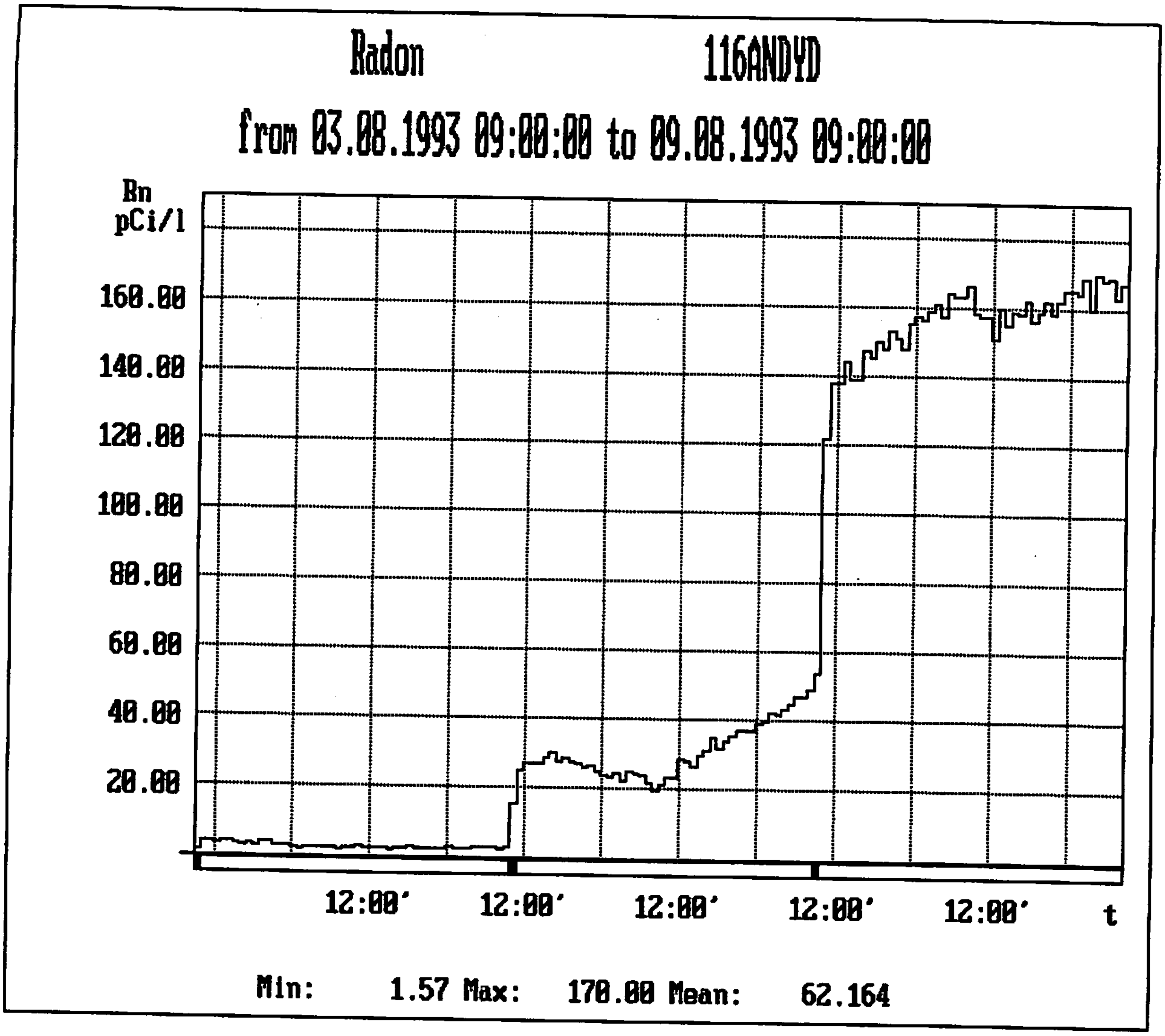


Fig. 1 AlphaGUARD exposure in three Radon QC chambers August 3 to August 9, 1993

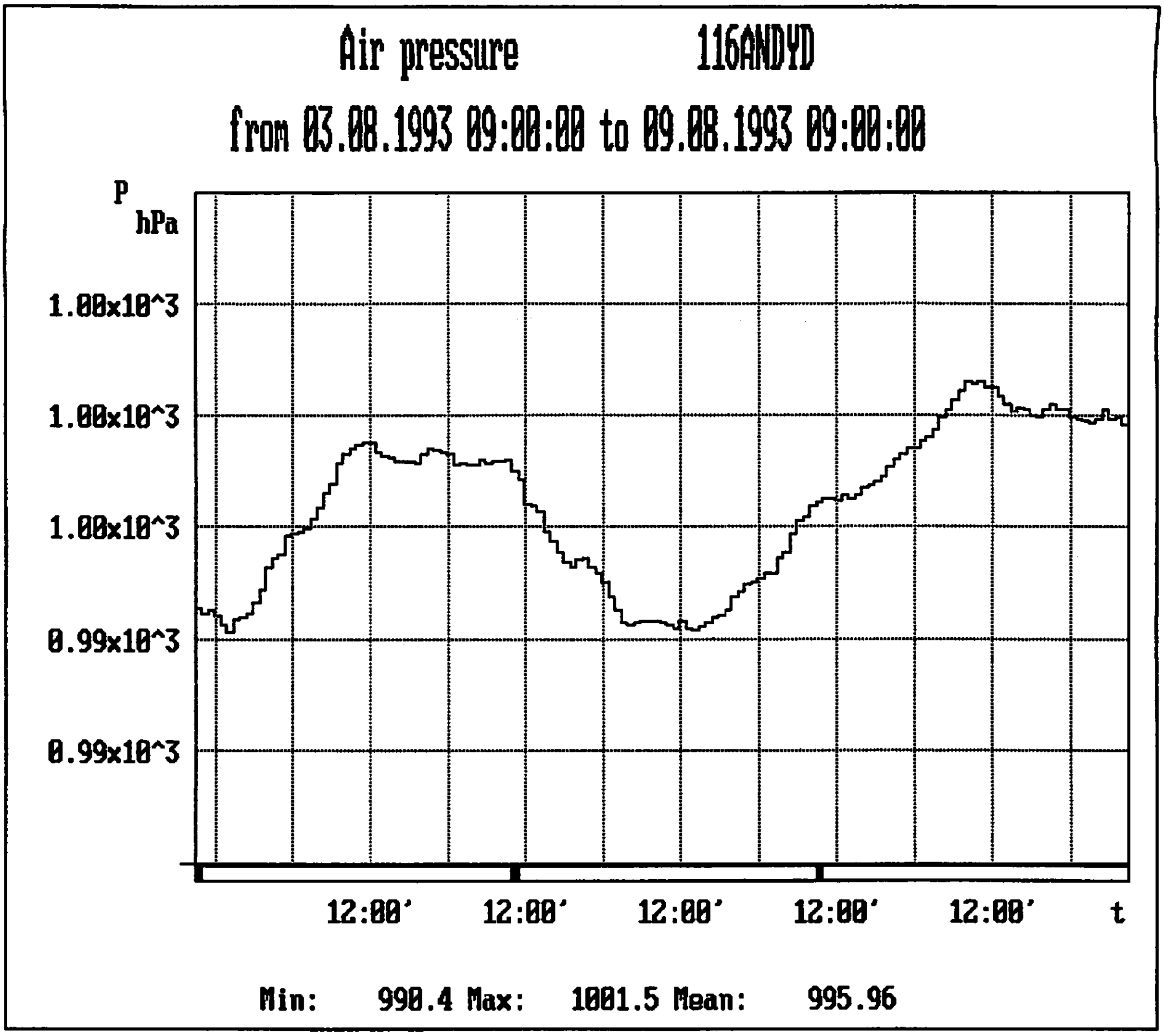


Fig. 2 Barometric pressure recording by AlphaGUARD during the exposure August 3 to August 9, 1993

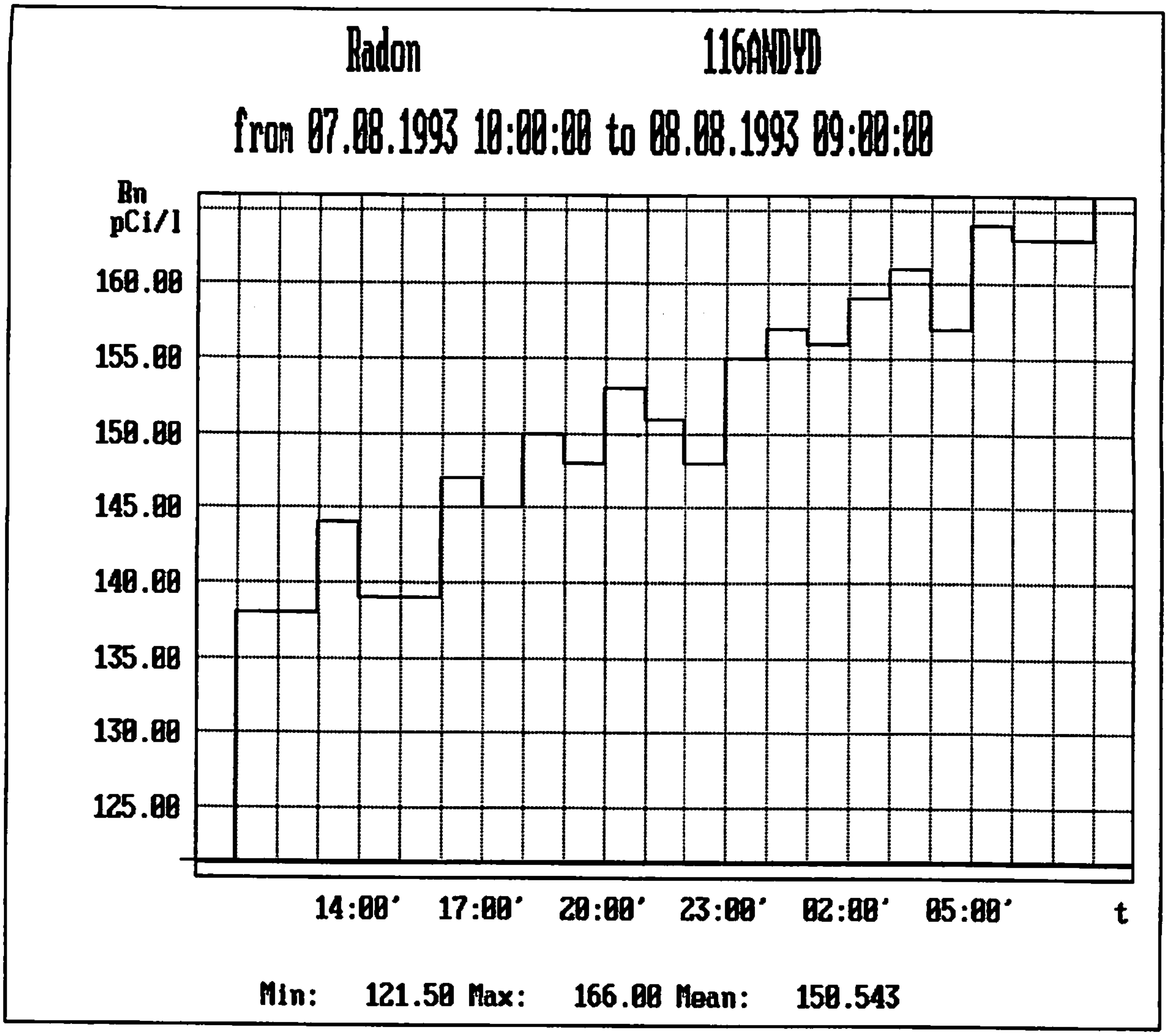


Figure 3 High chamber record only

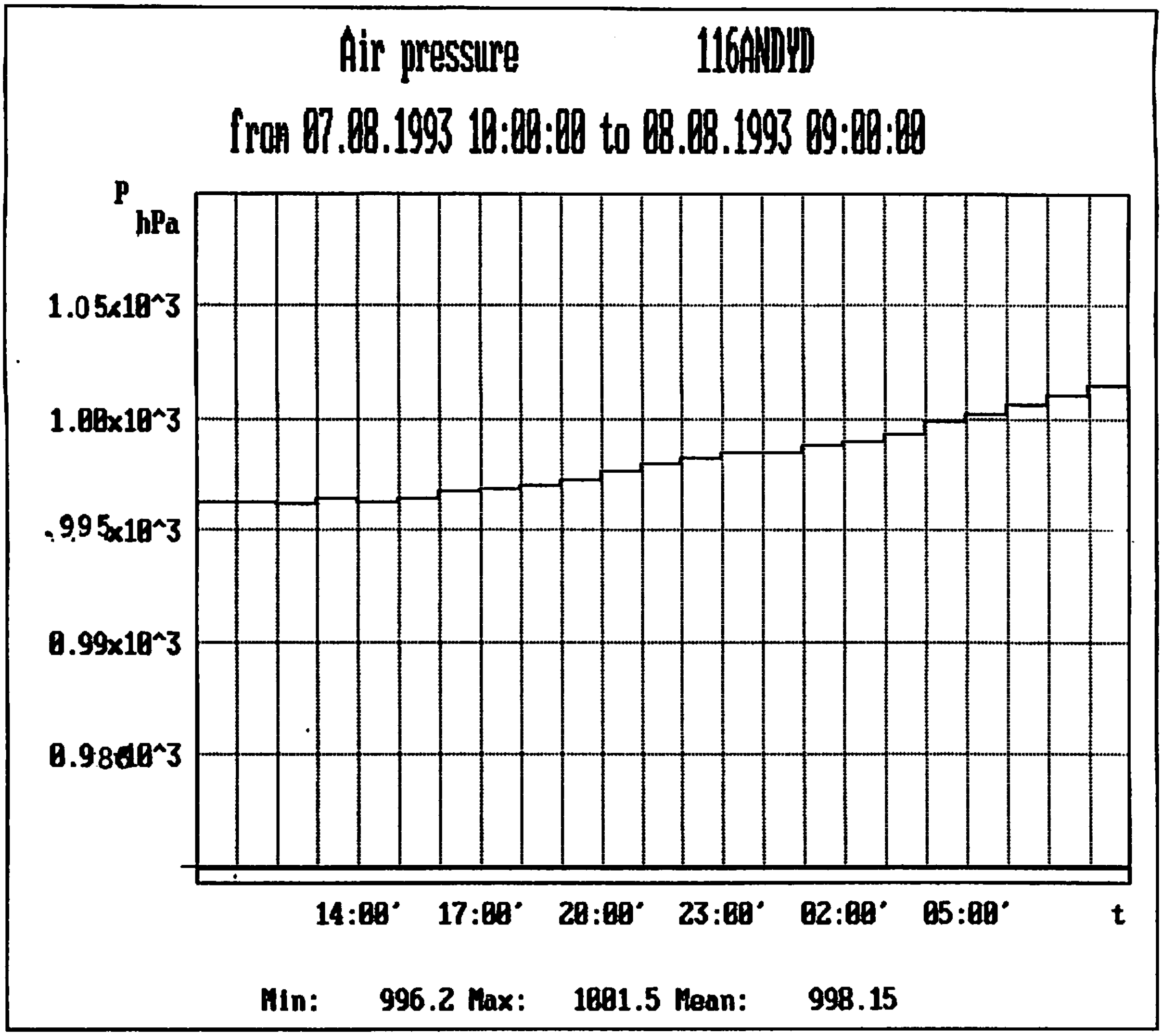


Fig. 4 Barometric pressure during high chamber reading

Taking the Multiparameter Monitor On The Road

In a recent automobile trip from Idaho Falls, ID to Waukeegan, IL, the MC-50 AlphaGUARD was left in "on" position and placed in the trunk of the car.

Fig. 5 demonstrates the sensitivity of the monitor in a low-radon (ambient)environment. The air-conditioned ground-floor hotel meeting room had a higher radon level than the Idaho outdoors, about 0.6 pCi/l vs. 0.35. But in Montana and North Dakota, during an evening and night drive, average levels of 0.5 pCi/l were encountered This would not be very significant in itself, would the levels not have dropped to an average 0.25 pCi/l in continuation of the journey through Minnesota and Wisconsin.

During the stop in Wisconsin, levels rose a hint between 0.25 and 0.4 pCi/l, and fell again as the trip was continued the next day. But in the garage in Illinois, the level quickly rose up to and beyond 1.2 pCi/l.

The pressure record in Fig. 5 bears out the elevation drop from the Yellowstone region to the Midwest, and passage through a thunderstorm still in Idaho. Otherwise, the barometer was quiet, as the weather was good.

Fig.6 shows a lively thermometer, saw-toothing up and down after the air-conditioned hotel was left. Also, the humidity documents the departure and passage through the potato belt. Every early morning, dropping temperatures promote increased moisture, though dew-point conditions were never reached here.

The motion sensor looks like a trucker's driving record. Thus, the AlphaGUARD provided a unique documentation of the journey, in demonstrating how easily it negotiates low radon activity levels. Part of this facility comes from the electronic suppression of the second radon daughter's activity, Bi-214. The halflife would interfere with the rapid cycle time of 10 minutes.

Which reminds us to point out that the present Idaho record was made with a 60 min. cycle time.

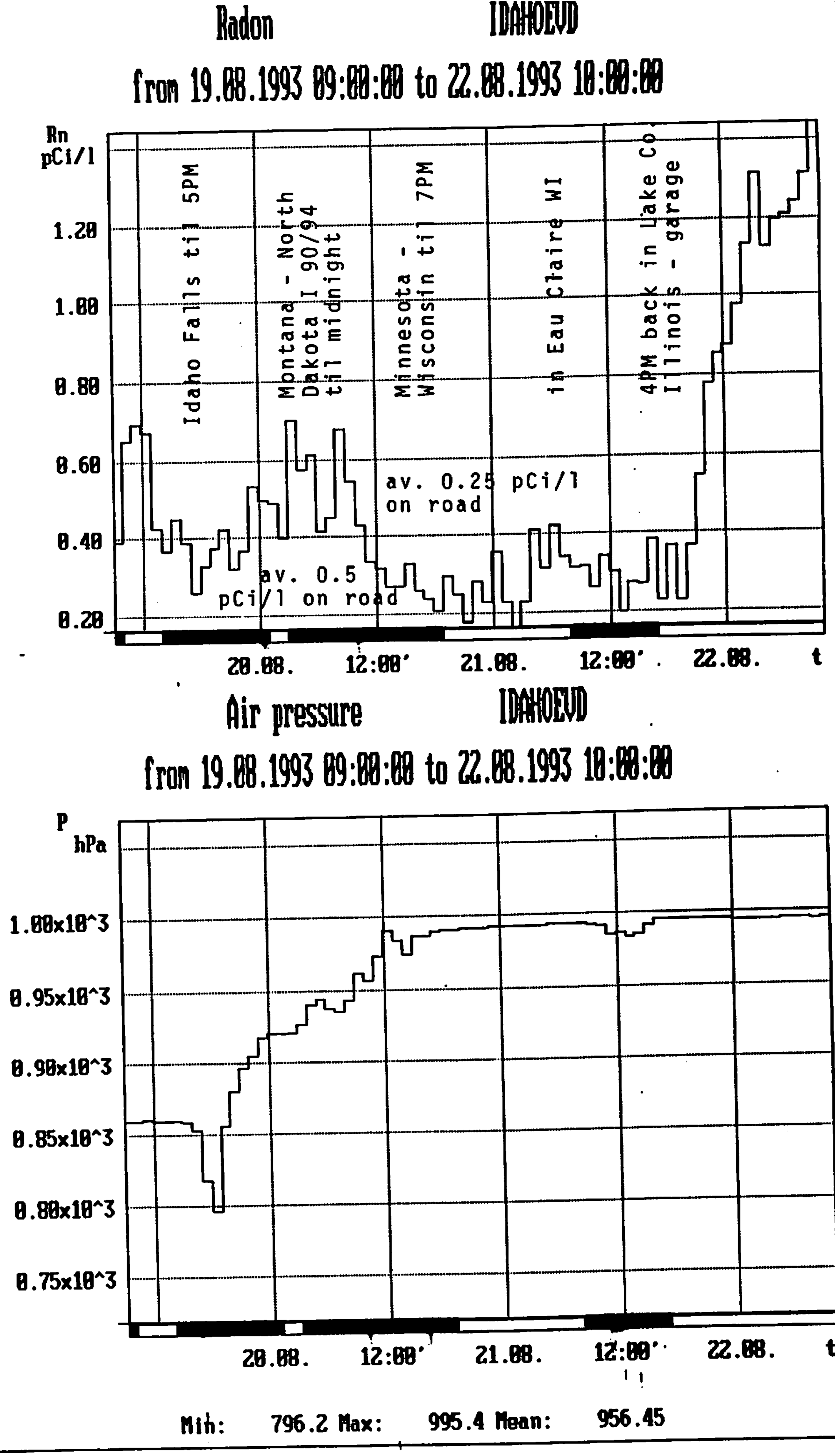
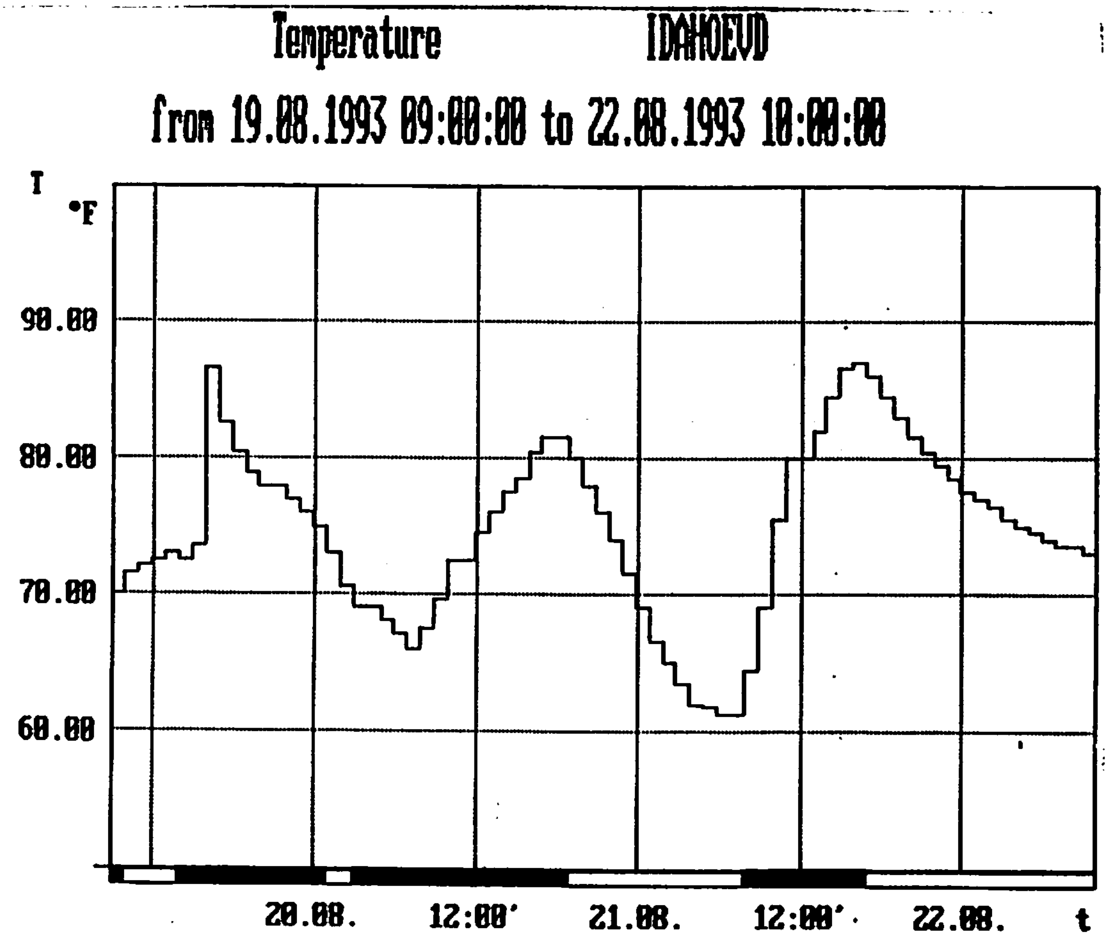


Fig. 5 Radon monitoring on the road from Idaho Falls ID to Waukeegan IL



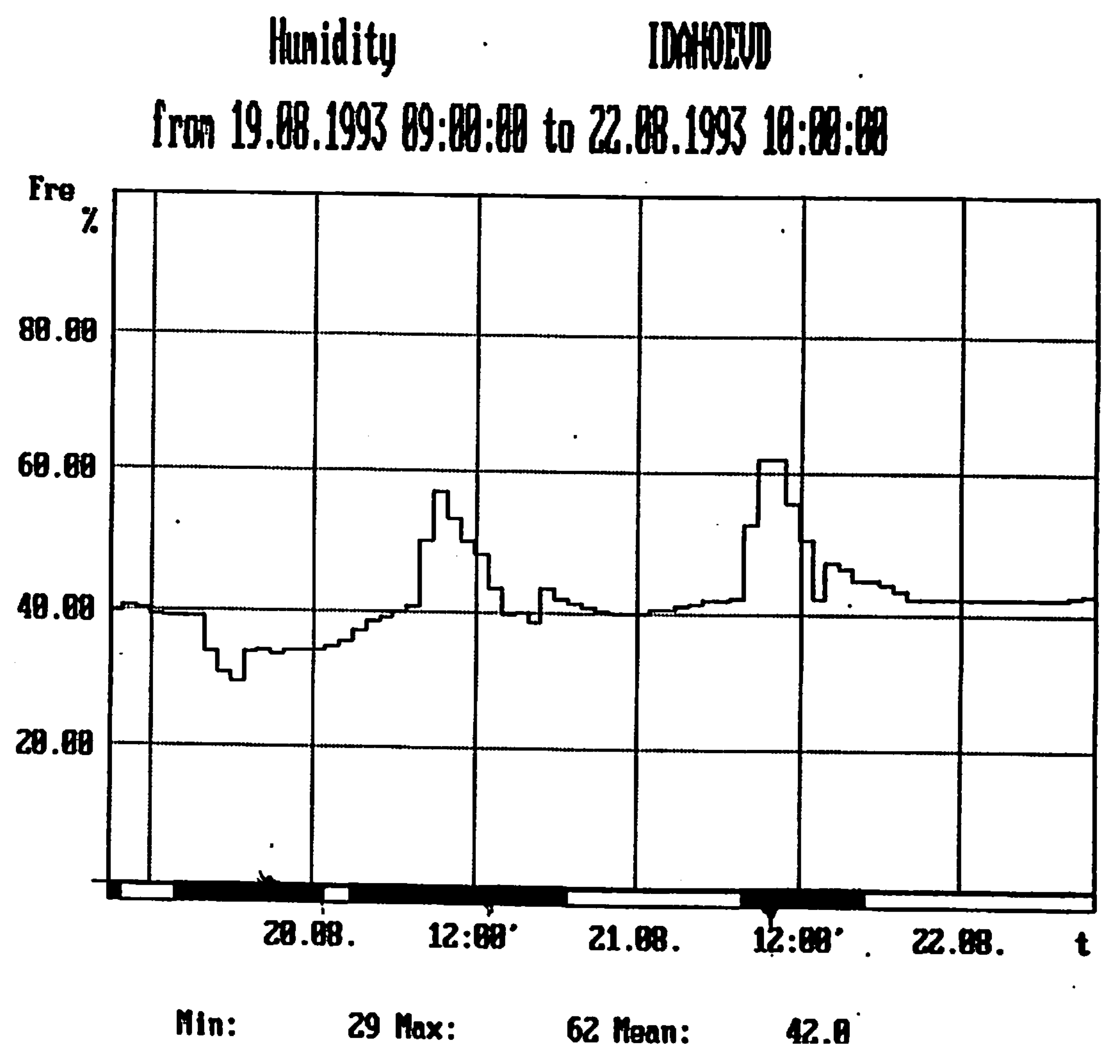


Fig. 6 Temperature and humidity during the Idaho - Illinois trip

Taking The Multiparameter Monitor Into A Deep Mine

Recently, an opportunity was available to test the dynamic range of the monitor, which claims to have a linear response from 0.05 to 50,000 pCi/l or 2 to 2 million Bq/m^3.

The mine offered only a four order of magnit.. range. This comes out nicely in the logarithmic display option which is available. Pressures seem to drop and humidity seems to rise where radon levels go up, and temperatures appear to indicate that radon increase was achieved through horizontal "depth" rather than vertical descend.

Fig. 7 shows the logarithmic record, as well as the composite of radon gas, humidity, temperature and air pressure from this visit.

Multiparameter Applications of a Research Nature

The above given print-outs cannot do justice to the multi-color demonstration and utilization of a high-powered monitor. In conjunction with the mouse and the key board, the AlphaVIEW and AlphaEXPERT software enable even the unexperienced operator to work out relationships in the data that were previously unnoticed.

Recording Indoor Air and Soil Gas with Two AlphaGUARD simultaneously

The 10-min. cycling time was used to record radon levels in the basement of a house for eight days. Radon ranged between 8 pCi/l and 81 pCi/l (see Fig. 8)

Just three feet away at two feet depth, soil radon was measured, using an AlphaPUMP auxiliary unit with a flow of 2 l/h. Though AlphaGUARD is a passive monitor, there is an external port that can accommodate a pump for special applications. The records of the two instruments were linked by a software command (see Fig.8, lower part).

It is concluded that the levels as well as the dynamics in both records look very similar. This is not usually expected, as soil gas should have a higher level and a gradient toward the house. This basement has a perfect linkage with the soil.

Using Built-In Sensors For Multiparameter Analysis

This time, basement radon and outdoor, ambient radon were correlated, and supporting parameters evaluated (Fig. 9)

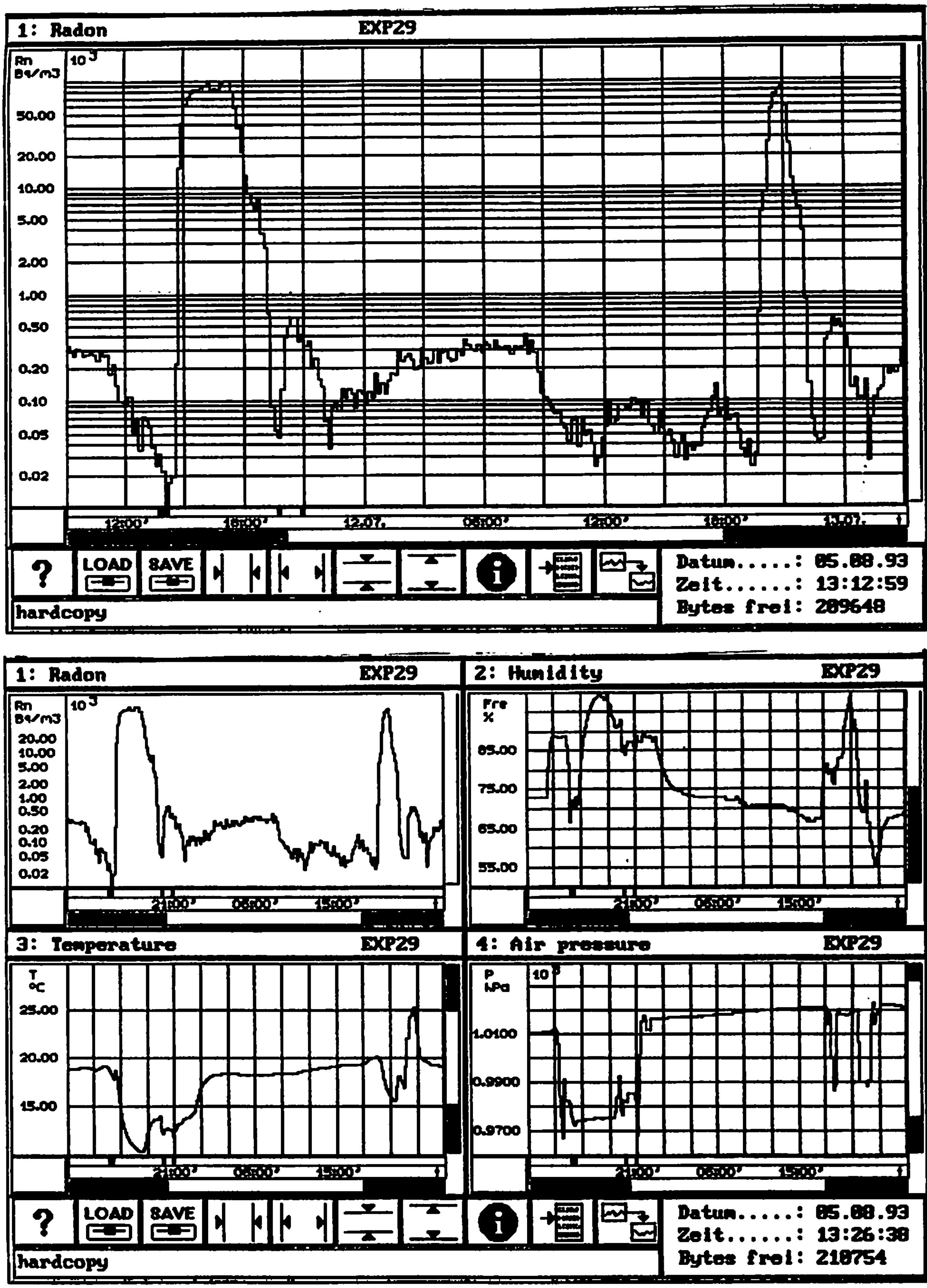


Fig. 7 Radon and multiparameter records from a deep mine

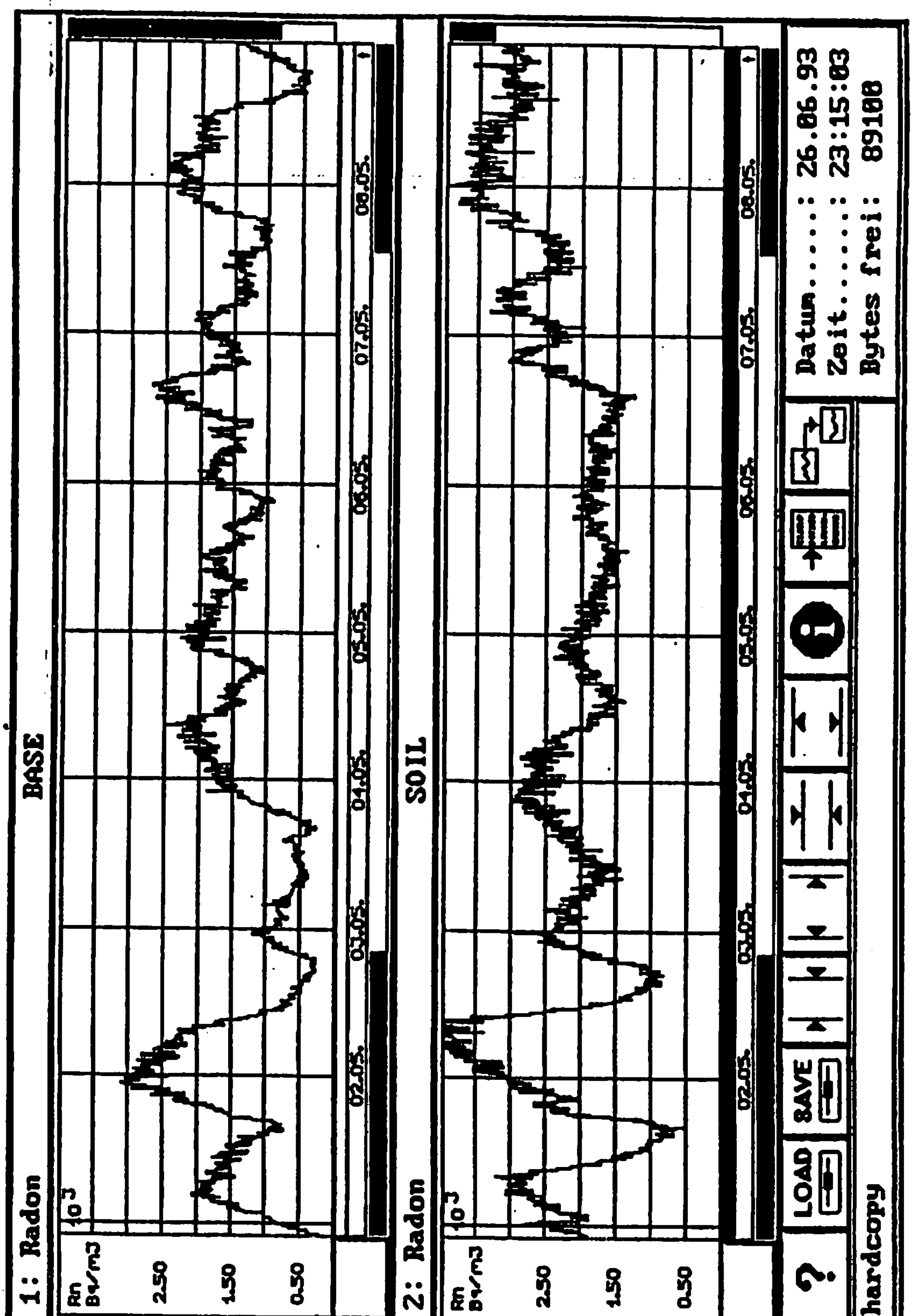


Fig. 8 Indoor (basement) and soil radon measurement

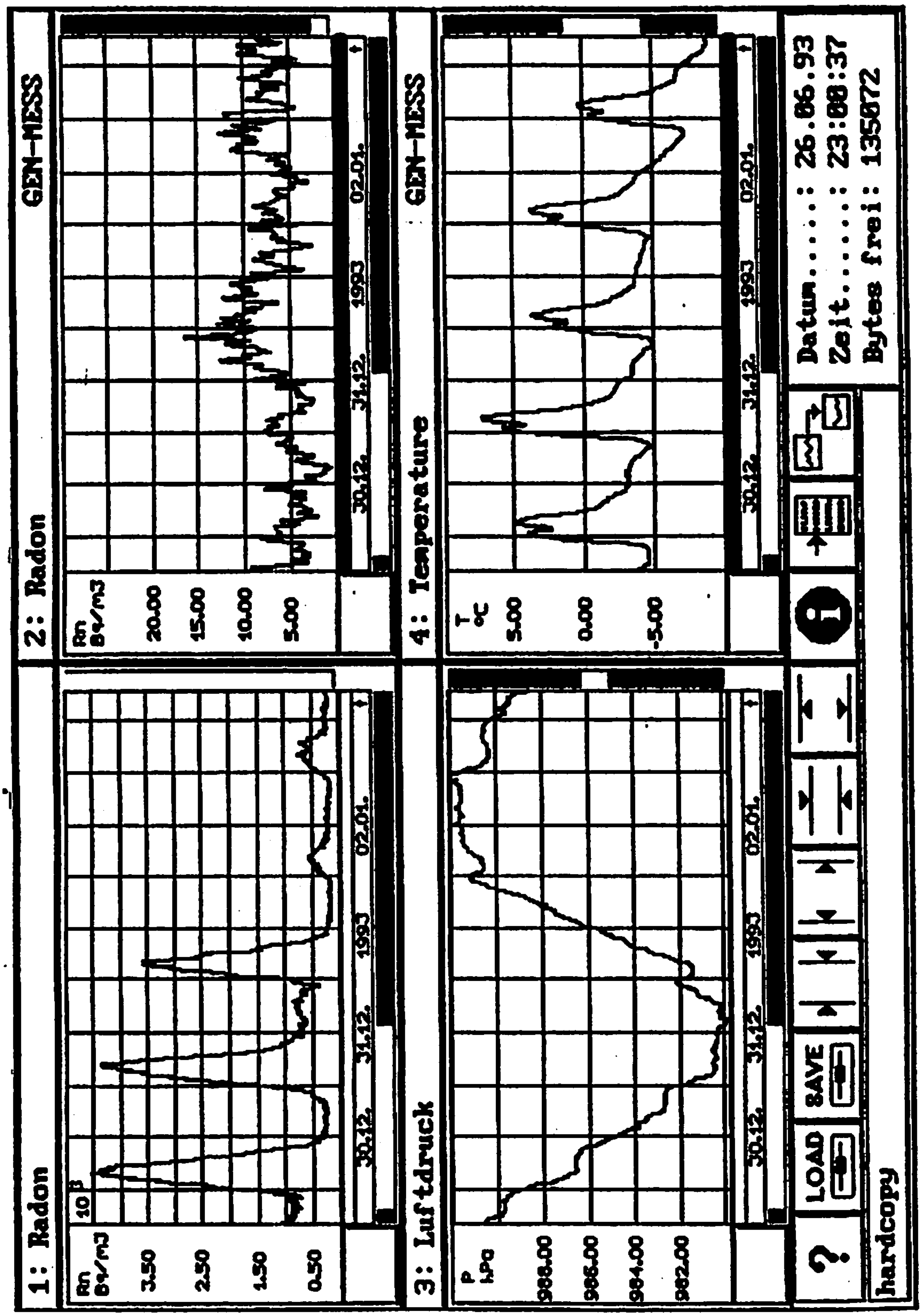


Fig. 9 Indoor (basement) and outdoor (ambient) air radon

The upper left diagram shows radon ranging from 5 to 122 pCi/l in this basement. During the first three days of the five day test, heavy fluctuations occur, which lateron subside. These may be in part pressure driven (diagram 3), as the barometric pressure shows a recessive trend.

The corresponding outdoor levels range from 0.03 to 0.5 pCi/l. A smoothing function SMQ 6 was applied to the data, providing a moving average of 1 h width. But there appears no direct correlation between indoor and outdoor radon.

The outdoor temperature, showing diurnal cycles, features an interesting dip near the peak close to the maximum reading. This is due to the shading of the instrument by a tree for half an hour every day.

The pressure record should be addressed, as the highest radon readings are associated with falling pressure (0.25 hPa/h = 0.25 mbar/h). The extremely high resolution and absence of "noise" in the pressure record are noteworthy.

It is believed that good pressure data are an important prerequisite to understanding radon movement. In differential calculus, the first derivative of pressure usually is an important driving force for radon movement, as well as for radon control or mitigation.

It is concluded from this experiment that atmospheric pressure, modulated by solar energy, could be used to explain the main factors that make the pulsing entry of radon into a house so evident.

Other papers to be presented in this symposium have come to similar conclusions. It is hoped that further work will employ the technology here presented to bring more understanding to our work.

Conclusions

The above paper is attempting to demonstrate the enormous capability of a new tool and a new technology. It may be emphasized that the graphs are only sheet music - to truly appreciate the power of the display one needs to unleash the data and the program on a color monitor, just as the power of an orchestra cannot be transferred to a printed page.

Dozens, if not hundreds of experiments and case histories have been recorded by AlphaGUARD. Only few optional, external monitors have been connected for wind velocity measurements. More are to follow.

It is hoped that the new technology will influence our approach to dealing with radon, in that more, if not equal emphasis will be placed on accompanying parameters. The intensity of the data taking will allow for shorter sampling periods with sophisticated equipment, such as already permitted in the State of New Jersey (24 h instead of 48 h).

AlphaGUARD is a precise radon monitor. It's original calibration, which was based on the Swedish standard, has been adjusted to the American standard, which is slightly higher. AlphaGUARD will be used by its manufacturers to intercalibrate all the major radon chambers in the world, which is a very worthwhile undertaking. Thus, no longer will the instruments from around the world need to come to a chamber - now the instrument will go and visit all the chambers.

But precision in measurement is only a prerequisite to what AlphaGUARD is attempting to do. Coupled with precisely measured multiparameters, it will open new doors to radon understanding.