RADON TESTING WITH DATA LOGGERS

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ABSTRACT

Many available, continuous radon monitors lack the ability to capture environmental data such as temperature, relative humidity, ambient light, and barometric pressure. This is crucial in verifying a valid radon measurement and supplementing device tampering. Some continuous radon monitors also lack a "real time clock" and are totally dependant on a tester's input to synchronize timing. By adding data loggers to many of the current radon continuous monitors, suppliers can deliver the cost reduced options back into the equation. Reputable data logger companies, such as Onset Computer Corporation, MadgeTech, and Lucid Technologies, for example, offer price-competitive alternatives for adding the deleted environmental data and a real time base back into the test.

This paper discusses the various advantages of using an environmental data logger in conjunction with a radon monitor, and the advantages and disadvantages each logger can supply relative to its base configuration, size, and software compatibilities.

ENVIRONMENTAL DATA

Some continuous radon monitors (CRM) collect environmental data, some do not. Does that make one CRM better than the other, or does it just give the radon professional a better idea of why the hourly data is what is reported? Based on regulatory organizations, active and passive radon measurement devices have the same accuracy range. However, active devices have the advantage of hourly data collection. It is in this area that data loggers can add value. There is no reason to believe the collection of environmental data can not be easily added with the use of available inexpensive data collection technology without having to replace existing functional CRMs that lack the built in environmental collection features. It is well known that several meteorological factors such as temperature, humidity and barometric pressure (changes and differences) affect radon levels, so why not capture that data. As an additional feature, captured environmental data can be used for identifying device tampering depending on the period of measurement, variations and obvious differences between the test location and outdoor conditions. Many industries have used simple data loggers to monitor shipments of various

products to detect high/low temperatures and humidity. Current trends have seen their use in everyday life to better monitor energy usage in working environments.

TODAY'S LOGGERS

Current data logger technology and accompanying software provides the ability to setup, start, read capture and graph selected incremental environmental changes from seconds to hours. Portability has been increased by physical size reduction - in many cases to sizes smaller than a standard tape measure. Battery life can last several days to several years eliminating the need for an additional AC power source. This is a dramatic change from the wall-mounted, continuous pen plotters of the past. Software programs allow users to program the loggers and generate various plots of collected data to a file or hard copy printout. Although loggers have evolved to lightweight and portable devices, the technology to communicate with many newer laptops and desktops has been more limited. Most loggers communicate via the serial port – the once universal standard of communication of many devices. Our continually-evolving computer technology has phased out the slower limited serial standard for a faster, less restrictive, more user friendly replacement, the Universal Serial Bus (USB). The USB is the main peripheral interface used in new printers, external hard drives, CD ROM, DVDs, digital cameras, memory devices, and scanners. There are easily obtainable inexpensive devices that make the serial to USB conversion, so we can still use the once popular serial communication with our newer technology computers and USB serial ports. On the downside, some of the serial-to-USB and serial conversions have limitations which will be discussed later.

This paper deals with several manufacturers of data loggers that also sell their own loggers. There may be other logger manufacturers and probably many resellers which are not mentioned – the ones identified in this paper were selected due to the ease of finding them on internet searches, range of technology, portability and familiarity. The selected manufacturers will be used as examples for desired user features since they represent a varied spectrum for you to consider if you decide to pursue data logger adoption.   This paper is not intended to be an endorsement of any one manufacturer, but rather, to give you insight into features that may best fit your needs.

What can data loggers collect? The answer is almost anything.   The determining factor is the cost of the desired parameter and its integration into the device.   From a meteorological direction, considering cost and availability, temperature is probably the least expensive environmental parameter to produce, followed by humidity, which requires the temperature. The cost seems to increase greatly when barometric pressure is added to the equation. Looking purely at available meteorological environmental data - temperature, humidity and barometric pressure seem to be areas of desire with CRMs. Differences between interior and exterior temperatures can influence pressure variations and affect the radon concentrations inside a home.

Humidity has been associated with radon levels, but more to certain activated carbon absorption passive devices. CRMs are less susceptible to humidity, but having a record of multiple readings will verify the CRM was in an acceptable range. Barometric pressure changes could indicate severe weather conditions which could impact a two-day radon test. The important thing to highlight is the precision of the loggers rather than their absolute accuracy. Hourly meteorological data, if collected, can be evaluated and related to trends in the radon readings, to either support the readings, or identify potential device tampering if large variations of radon are not consistent with the collected data.

Data loggers can also give us physical information such as the level of light and notification of movement (shock) which would be further helpful in determining evidence of device tampering. Some loggers also have external inputs to allow us to sense additional areas such as current, voltage, events, temperature, CO_2, CO and many other parameters. However, many available external logger options cost several times the price of the basic logger it connects to. External options generally require additional supporting circuitry and cabling making them laboratory suitable but impractical for standard radon measurement use. This paper will only address loggers configured as a deliverable operational item and leave external input features to your creative imagination. Onset Computer Corporation, Lucid Technology, and Madge Tech are all manufacturers and suppliers of loggers and have been selected for this exercise based on reasons explained earlier – their features, options and advantages will be discussed. Please refer to the last section for company contact information and websites.

For simple comparison the following charts will show some of the key features and model numbers of available data loggers. Many other variations exist that may better suit your needs based on cost, functionality, and size. Although additional models are shown in Tables 1 & 2, for price/feature comparison, only the models that are in bold will be discussed in further detail.

Company	Model	Temp	Relative Humidity	Barometric Pressure	Light	External Input
Onset Computer Corporation	**U12-012**	X	X		X	X
	U10-003	X	X			
MadgeTech	**PRHT TEMP101**	X	X	X		
	TransiTemp RH	X	X			
Lucid Technologies	**ELOG1**	X	X	X	X	X

Table 1

A comparison of additional features - physical size, battery life, and communications to a laptop or desktop computer using a Windows based operating system are identified in Table 2.

Company	Model	Approx Size in inches	Battery Life	Comm	Cost*	S/W*
Onset Computer Corporation	**U12-012**	2.3 x 2.9 x 0.85	1 Year	USB	$119	$95
	U12-012	2.4x 1.9 x 0.8	1 Year	USB	$69	
MadgeTech	**PRHT TEMP101**	1.6 x2.3x0.9	1 Year	SERIAL RS232 COM 1-8	$229	$99 Cable S/W Free
	TransiTemp RH	1.9x3.6x0.7	90-120 Days	SERIAL RS232 COM 1-8	$39 in 20 Qty	
Lucid Technologies	**ELOG1**	5 x5.25 x1.5	30 Days	SERIAL RS232 COM 1&2	$126	Free

Table 2
* Please note: catalog cost only - no shipping/handling and applicable tax included.

Software and its relationship with loggers should be discussed briefly to eliminate any confusion, since "software" is a general term that can be broken down into three serviceable areas. First, there is the operating system or the running environment of the computer such as Windows – Windows XP Home as a specific example. Secondly, it can be used as an application or the package that works with the operating system and a particular logger to setup, read and manipulate (plot, analyze …) data captured by the logger. This software is provided by the manufacturer of the logger. Finally there is internal embedded instruction or firmware that allows the logger to function (measure, record and store data) as a stand alone device when not connected to a computer. This paper addresses the application software when dealing with logger manufacturers and implies a Windows based operating environment.

A detailed discussion of each manufacturer's bold model beginning with Onset Computer Corporation's product will follow. Please note again this is not an endorsement of Onset Computer Corporation or Sun Nuclear Corporation products. The HOBO® & Sun Nuclear products are being featured because they have been used by the author over a period of time and information is readily available for example purposes. Each sub section will be followed by generalized advantages and disadvantages which can be used to identify criteria that can determine the best features or key selection factor in data logger acquisition.

The HOBO® U12
The U12 lacks the ability to log barometric pressure, based on a company decision not to pursue that feature due to battery life and cost. The unit does, however, have several other advantages including the ability to utilize the faster commonly used USB connection for direct

communications with a PC. It has the ability to be programmed for a predetermined start time, like the other two units to be discussed, but also can be activated by a push button start allowing the start to be in synchronization with a CRM start. The ability to sense light gives additional tamper detection ability with reaction to normal daylight, house light, and expected dark conditions. An external input is also available for additional sensing if required. The combination of the U12-012 with a Sun Nuclear Model 1027 is shown in Figure 1.

Figure 1

Note the physical size of the data logger which is attached to the CRM by Velcro. Tampering with the logger would activate the internal disturbance detector of the Sun Nuclear CRM which is very sensitive to movement. Since the Sun Nuclear CRM does not have a real time clock (has an internal hourly clock grouped in 12 hour sections), pushing the available external start button of the U12 utilizes the loggers date and exact start time giving a real time stamp to the measurement. Setting the logger to gather data at a 30 minute sample rate allows two times the data points of the CRM. This particular logger can sample from a programmable range of 1 second to 18 hours in 12 bit resolution. The logger has the ability to store 43,000 12-bit data measurements. Short of the inability to monitor barometric pressure, this combination works well collecting temperature, RH and available light levels. This particular CRM still uses an RS232 serial port (DB-9) and requires a USB converter to communicate with newer laptops that are not equipped with RS232 ports.

The application software used by this logger is HOBOware™ for Windows which supports all of the Onset U-Series Loggers. This software requires Windows XP or Windows 2000 to function. As with most logger software, device setup, start time, graphics, analysis and export are many of the standard features available to display and manipulate the collected data. As mentioned before, this logger can be programmed to start by a button push.   The standard mini-USB cable comes with the software. The following picture (Figure 2) shows a plot of collected data. A
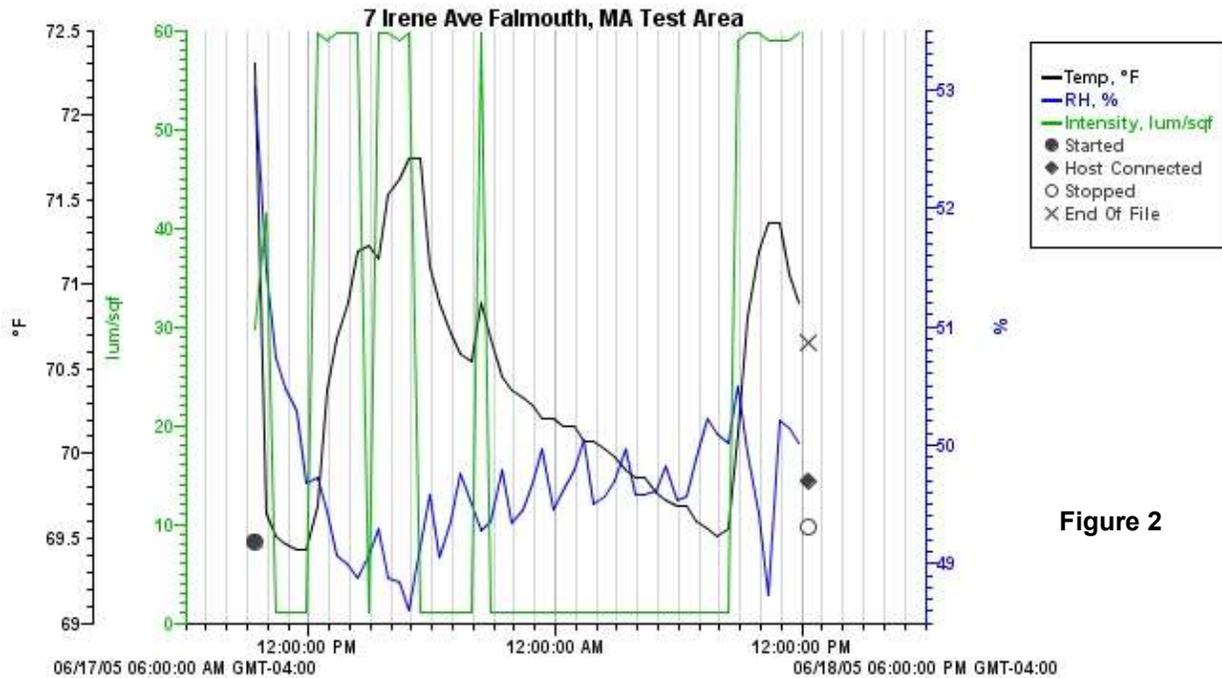

Figure 2

color printer should be used to emphasis the difference in the items graphed when multiple parameters as plotted for ease of reading. This setup had a 30-minute sample rate over a 24-hour period which yielded adequate data and is not too busy. Note that the logging must be stopped by a physical connection to a computer and a software command to stop.   Otherwise, it will continue logging until the internal memory is full, collecting additional data that may not be relevant to the placement.

Advantage - Faster USB support, push button start, size, light sense
Disadvantage – No built in barometric pressure ability, additional software cost

The MadgeTech PRHTemp101
This particular logger collects temperature, relative humidity and barometric pressure and is slightly smaller than the Onset product. It can be programmed to take readings from a range of 2 seconds to 12 hour intervals and can collect up to 13,107 readings per channel. MadgeTech products require a proprietary cable – a stereo jack to the logger and a DB-9 serial connector for the PC connection. The cable contains circuitry between the two ends to allow for the proper communication of data and unit functionality. Use of a non-authorized cable without the proper

circuitry will damage the logger.   The cable cost is $99. MadgeTech has a new proprietary cable under development that would provide a true USB connection to their existing loggers. The cable availability date and cost are not known at this time.   If only temperature and relative humidity were desired, a slightly larger package device (Table 2) with the advantage of a programmable push button start can be obtained for $39.   The same proprietary cable and software would be required for communications.

The software from MadgeTech is free. A manual and demo software can be downloaded from their web site for evaluation. This gives the potential user the ability to look before they buy to make sure their needs are covered, or just look at the functionality. The software runs with Windows 95/98/2000/XP/NT with a Pentium or higher processor. One software feature has a direct to Excel data export button on the application tool bar.

Advantage - All three meteorological variables captured, size, free software
Disadvantage – Proprietary cable

Lucid Technologies ELOG1
This logger collects temperature, relative humidity, barometric pressure, and light levels. It is much larger in physical size than the previously mentioned loggers. It is powered by 2 AA or rechargeable AA batteries (not included) with an option to add an AC adapter (purchased separately).   In any case, the battery life would surpass the typical 2-3 day requirement for a short-term radon test. Data sampling time can vary from 4 seconds to 1 hour intervals at 10 bit resolution.

The Logger Data Exchange (LDX) Software is very basic and free with the logger. It works under DOS and Windows. The application software is used to configure each test session and export the stored data in Comma Separated Values (CSV) format via a serial port (COM 1 or 2) to another program such as a spreadsheet for analyzing and graphing purposes when the test is over.

Advantage - All three meteorological variables captured, cost, light sense
Disadvantage – Size, limited software features, limited COM ports

SERIAL-TO-USB ADAPTER ISSUES

As identified early in this paper there can be some issues when trying to connect loggers with serial (DB-9) ports to Laptops or PCs without them. The Serial to USB adapter generally works but there are some concerns you should eliminate before you purchase an adapter. The adapter must come with drivers suitable for the operating system of your computer. The serial logger's

software must support enough serial ports in case there is a conflict with available serial ports on the PC to be connected to. For example, the Lucid Technologies' logger presently supports COM 1&2 and if after connecting a Serial to USB adapter COM 1&2 were not available on the PC due to other devices using those ports there would be a conflict. Communications can not take place until the conflict is resolved. It is always best to purchase a Serial-to-USB adapter from your logger's company to eliminate configuration and driver issues.

SUMMARY

Hopefully this paper has sparked some interest in considering the collection of additional parameters whether it is the capture of real time, temperature, RH, barometric pressure, etc. or any combination using data loggers with radon measurements to fill that void. Although the focus has been on the advantage of using loggers with CRMs there are cost effective solutions (Temp & RH) that would also work with passive radon measurement devices.   Before you add data logging to supplement meteorological and/or physical data collection, look at all the factors outlined earlier – desired variables to capture, physical size of logger, communication interface, software reporting needs, and your PC operating system. Review all of the offerings of the data logger manufacturers at their web sites to determine the best combination of logger attributes and functionality. Determine the cost of the overhead items, whether it is software, cables or some other combination that only works with that logger manufacturer. You are now in a position to make an informed decision on your purchase and the value it will return to your data collection needs.

LOGGER COMPANY CONTACT INFORMATION

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