AWARE Electronics

RM-60 MICRO-ROENTGEN RADIATION MONITOR COMPUTER INTERFACE USER MANUAL

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RADIATION MONITOR
COMPUTER INTERFACE MANUAL

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OVERVIEW

The RM-60 Micro-Roentgen Radiation Monitor, in conjunction with a PC computer, is a highly sensitive, feature packed, easy to use geiger counter. The software included with the system allows a user to scan, quickly and conveniently, days, weeks or months of stored radiation data for any unusual surges or trends in radiation level.

With the RM-60, the user can continuously record natural background radiation, as well as low levels of radiation from bricks and other building materials, rocks, soil, water, etc. The RM-60 also can measure small amounts of radioactivity in contaminated foods, beverages, chemicals, atmosphere, etc.

The RM-60 can detect and continuously monitor for extremely low levels of radon gas by measuring radioactive buildup on an air filter, such as found in a heating system, air conditioner or portable filter. This technique also will alert you to the presence of rare but highly dangerous airborne radioactive particles.

The RM-60 detects all three types of radiation emitted by radioactive elements, namely, alpha, beta, and gamma radiation, as well as X-ray radiation.

Sophisticated software allows the RM-60 to detect and accurately display levels of radiation one thousand times less than standard milliroentgen survey geiger counters. The system can detect and display dosage levels as low as one microroentgen/hr. to as high as 30,000 microroentgens/hr.

QUICK INSTRUCTIONS

Note: For Aw-Radw Windows software instructions, refer to Aw-Radw Help. To install on hard drive, make a new sub-directory on it (MD C:\AWARE) and copy all the files from the floppy to the new sub-directory (COPY A:*.* C:\AWARE). Note: AW-SRAD.EXE and AW-MRAD.COM are the only files needed to run the program. Make a backup copy of the floppy. Plug the RM-60 into a COM port or LPT printer port by following the instructions below under "JACK ADAPTER". **DO NOT ALLOW ANY OBJECTS TO PROJECT THROUGH THE RM-60'S ALPHA WINDOW (TOP GRID).** Never touch the RM-60 to an active radioactive substance; you may contaminate it.

Go to AWARE dir (CD C:\AWARE). Load the program AW-SRAD.EXE (type AW-SRAD enter), or AW-SRAD -M to force monochrome (black and white) mode. Select the input port the RM-60 is plugged into by using the program's Setup selection. After selecting the input port, you can observe radiation levels by selecting the program's "Capture" option, sub-option "Display Current Input". The computer's speaker will click with every detection of radiation. Every minute (default) the program will display the radiation dosage rate impinging on the RM-60, by scrolling a bar chart across the screen. If this dosage rate exceeds 27 microroentgens/hr. (default), an alarm will sound. Pressing the F1 key will provide a help window.

CONNECTING THE RM-60 TO A PC COMPUTER

JACK ADAPTER:

Plug the special adapter into the computer port. A com port adapter is a 25 or 9 position D-sub Female adapter. A LPT printer port adapter is a 25 position D-Sub Male adapter. The RM-60 has a 6 foot modular phone cord with a modular phone plug. Insert the phone plug into the D-Sub adapter jack. The cord can be extended several hundred feet with standard RJ11 modular phone extension cord. Use a com port when extending the cord for better noise rejection. (Also see "Selecting Input Port" below)

MONITORING EXTERNAL DEVICES:

The software will gather and store radiation data from the RM-60, as well as simultaneously monitor the operating status of an external device such as a fan, vent, switch, etc. If you want to monitor an external device, read this section, otherwise skip this section.

To monitor the operating status of an external device, you need to gain access to the DS (Device Status) wire (Data Set Ready pin of the serial port (pin 6) or the BUSY pin of the printer port (pin 11)).

The status of the external device will be recorded as active by connecting the DS wire to:

Serial port: DTR
(25 pin D-Shell: pin 20, 9 pin D-Shell: pin 4)

LPT port: Ground (pin 18 to 25)

The status of the external device will be recorded as inactive (default) by connecting the DS wire to:

Serial port: Signal ground
(25 pin D-Shell: pin 7, 9 pin D-Shell: pin 5)
or negative lead
(25 pin D-Shell: pin 4, 9 pin D-Shell: pin 7)

LPT port: pin 3

(Note: Often the colors of wires through a modular connector, such as found inside the adapter, are reversing). Modular and D-Shell plugs, cords, jacks, etc., are readily available from stores such as Radio Shack.

For example, to monitor the activation of a fan, connect the DS wire to the pole of a SPDT relay. Connect the NC (normally closed) and the NO (normally open) connections from the relay to the proper pins as explained above. Connect the coil of the relay to the fan supply leads. (Note: relay coil voltage should match fan supply voltage). Every time the fan is activated, the coil of the relay will energize, connecting DS to the appropriate pin.
Once every TBU (Time Base Unit, see below) the status of the DS lead is checked. With the DS lead activated, the software records the radiation data with a device active bit set. When displaying the radiation data, the software draws a scrolling bar chart, representing the radiation level. If the device active bit is set for any point, the software will use a special color or shade and special character to draw the bar, thereby informing the user that the device was active at the time the radiation level was recorded.

Note: Pull-up or pull-down current can be limited by inserting a 2.2K ohm resistor in-line with the DS lead. If you do extend the DS lead out of the computer, you should avoid letting it float.

RUNNING THE SOFTWARE

The main software program included with the package is AW-SRAD.EXE (AWare_Show_RADiation). It will monitor any standard LPT (printer) port or COM (communication) port for data from an RM-60. As mentioned, it will simultaneously monitor an external device, such as the operating status of a fan, vent, etc. It will capture raw data to a file, format raw data from a file, display raw data in strip chart and scrolling bar chart format, and print formatted data to a line printer, file or DOS device. The code also will sound an alarm if the average radiation level exceeds a preset level.

Aw-srad should be used with DOS 2.0 or higher. After plugging the RM-60 into the computer (see "Quick Instructions" above) type "AW-SRAD" at the DOS prompt. Run through the Setup selection, leaving the default values if you wish. The only selection you must accurately make is the "Input Port" selection. If you have trouble with this selection, try trial and error and\or read the section below on ports "Selecting Input Port".

After running through Setup, you can save your selections to disk by selecting the "Disk Write All Settings" option under the Setup Menu or Misc. menu. This allows the program to remember your settings so that next time you use the program, it will initialize all the variables the way you want them.

CAPTURING RAW DATA:

Aw-srad captures raw data from an RM-60 and an external device in one of two ways:

1. Capture raw radiation data to a file and at the same time, display the data in scrolling strip chart and\or bar chart format. This method displays the radiation level, accumulated and averaged over any period desired. Also displayed is the operating status (on or off) of the external device. This method also will save the raw radiation data to a file for later formatting, averaging and viewing.

2. Install TSR (terminate but stay resident) code to capture raw data to a file, while the computer is busy performing other tasks. This method uses code (AW-MRAD.COM) that runs in the background and allows the computer to run other programs. See TSR section below for more information on running the TSR code.

SETUP:

The Setup feature of Aw-srad allows changing strip chart/bar chart parameters, printer parameters and input port. It offers choices for the character(s) to use for drawing the bars and points, during the activation and non-activation of the external device. You can tell Aw-srad to use bios video writes with snow checking when scrolling, for old noisy or snowy CRT display cards. All parameters can be saved to disk.

You can elect to use a special display character string that uses the actual microroentgens/hr. average for each point, (num) during the activation of the external device (fan, vent, switch, etc. on) and <num> during the non-activation of the external device (fan, vent, switch, etc. off), for example (14) or <14>. (14) would indicate an average rate of 14 microroentgens/hr. for the point while the ( ) characters would indicate activation of the external device, whereas <14> would also indicate an average rate of 14 microroentgens/hr. while the < > characters would indicate a non-active external device.

In addition, you can choose a unique color for the points and bars to indicate the activation or non-activation of an external device (monochrome displays use shades).

The Setup menus are straightforward. Only a few additional points will be covered in the following descriptions.

SELECTING INPUT PORT:

When selecting the input port from the Setup option, the program displays a list of standard port choices that include a name, address and interrupt number for each choice.

If you are not sure which selection is correct, select the AUTO-FIND selection from the menu. The program will then try to identify the port that the RM-60 is plugged into.

Another method of identifying the port includes trial and error as follows: Select a port, then go to the "Capture" option, sub-option "Display Current Input", and wait about 30 seconds or so. If you have selected the correct port, you should hear the computer's speaker click or beep each time the RM-60 detects ionizing radiation. This should occur randomly about 12 times a minute. If you do not hear the beep, try another port selection.

Following is a further discussion of LPT ports.

LPT 1 port is usually the printer port found on the computer's display adapter card. Its address is normally 3bc (hex) and its interrupt request number is normally IRQ 7.

Some display adapter cards do not have a printer port. Rather, the printer port is found on a separate card. In this case, the printer port card normally allows the user to choose an address and interrupt number by way of dip switches or jumpers. In such a case LPT 1 normally has an address of 378 (hex) and uses interrupt request IRQ 7. A second LPT port normally uses the address 278 (hex) and interrupt request IRQ 5.

Each port has the possibility of using one of two interrupts, depending on how the port card dip switches are set. If your port selection does not operate, try the other interrupt number for the port address, or check the port adapter card to make sure that the proper address and interrupt number have been enabled.

As stated above, the standard port choices are displayed by Setup's "Input Port" option. If you are working with a non-standard port address, there is included a choice that allows the use of any port address desired with any IRQ # between 2 and 15. A pop-up window will display a list of IRQ numbers currently masked off. (IRQ 2 is used by many serial mouse cards. IRQ 2 is often masked on and therefore will not show up in the pop-up window, even without a mouse installed, but the default interrupt routine might contain nothing but an IRET, in which case it would be OK to go ahead and use IRQ #2 if your card can make use of it, unless you're using AT IRQs 8 to 15).

When using either the LPT port or the COM port, the program checks the port once per Time Base Unit (see below) to see if the external device is active (for example fan activated, etc.) by testing the appropriate port connections (see "Monitoring External Devices" above). The device must be activated at the end of each Time Base Unit for the program to record the device as active during that particular TBU.

SCROLLING BAR CHART / STRIP CHART FEATURES:

Raw radiation data from a previously saved radiation data file can be extracted and displayed for easy viewing of radiation levels and to spot radiation peaks, trends, etc. The data is displayed in scrolling strip chart format and/or bar chart format.

DEMO FILE:

A raw radiation data file ("RAWDATA.RAD") is included on the disk as a demo. RAWDATA.RAD contains background radiation data gathered in southeastern Pennsylvania using an RM-60.

A few descriptions of program operation follow. By loading Aw-srad with the demo file, you can try out the descriptions. The demo file can be loaded by typing "AW-SRAD RAWDATA.RAD" at the DOS command prompt.

Aw-srad will scan through the file and then display a list of summary data, including the date and time of the last occurrence of the highest and lowest radiation level, any messages contained in the header of the file, period of the file, etc. To aid in keeping a record of summaries, you can append the summary data to a text file of your choice. There is also a selection to edit the text file (or any other file) using your favorite text editor. The rawdata file is held open by Aw-srad for your return from the editor. If you "Disk Write All Settings" from the Misc. or Setup menu, after you enter the name of the text file and the path of your favorite text editor, the program will save the names and offer them as defaults next time.

Place the bar on the selection "Strip/Bar Chart" and press <Enter>. By pushing the left arrow key, the data is scrolled in from right to left. Every bar/point that appears is accompanied by a listing of its microroentgens/hr. rate in the right hand column.

The date and time of the point appear at the top right of the screen. The raw data file name appears top left. At the bottom right appears the average value of all the points displayed so far and also the total number of points displayed and averaged so far. The average of every 60 points appears lower left and that point is drawn in white on red (or a different shade on monochrome displays).

The seconds of data averaged per point (time resolution) appears bottom center. This value is selected by running the Setup portion of the program. Maximum time resolution is the average of the data gathered during one TBU (Time Base Unit). You can change this from one TBU to 9,999 TBUs of data averaged per point. For example, if the program is in the 60 sec./TBU mode and you use Setup to assign a 60 TBU time resolution, the strip/bar chart code will average 1 hr. of data per point. Each point will then be the average microroentgen/hr. radiation rate for the last hour. A good all-round choice for time resolution is 5 or 10 minutes.

If the external device were active for any of the averaged periods, the point will display in the external device active format (for example (num) instead of <num>) and in the external device active color previously selected in Setup.

If the next point to be displayed is above the screen or below the screen, the entire screen will automatically scroll down or up, so that the next point will be shown. If the program finds it necessary to scroll the screen more than one screen depth, to display the next point, it will blank the screen, move to the new point, and then redraw the screen. Otherwise the program could take an inordinate amount of time scrolling to a point way out of range.

The up and down arrow keys scroll the screen down and up, revealing any points off screen. (This feature also works

when the program is drawing real time data to the screen from the Capture menu). If you are displaying wildly varying radiation levels, so that the screen auto scrolls up and down with every few points, you can use Setup to reduce the vertical resolution so that every row equates to a change of as many microroentgens/hr. as you want, or you can average more minutes of data per point by increasing the time resolution, or if you have an EGA or VGA you can set the program to operate in 43 or 50 line mode.

You can leave Strip/Bar Chart by hitting the escape key. The raw data file will be held open. You can select the "Change Setup" item in the Display menu, to change operating parameters, and then return to Strip/Bar Chart to review the data using the new parameters, without having to reload the raw data file. For example, you might want to leave Strip/Bar Chart to change the Time Resolution in Setup, and then return to Strip/Bar Chart. If you leave the Display Menu by hitting the escape key again, the raw data file will close and you will be prompted to load another file if you try to select Strip/Bar Chart again.

As explained earlier, Setup allows you to use any character(s) you want for the point, for example * or ## or &&& etc. (Note: To enter non-ascii IBM characters, hold down the <ALT> key then enter the IBM character code into the keypad of your keyboard. For example to enter the IBM square character #254 hold down the <ALT> key and key in 254 on the keypad then release the <ALT> key).

Alternatively you can use the string <num> for each point where num is the average microroentgens/hr. for the point. For example <14> would mean the data averaged for the point equals 14 microroentgens/hr.

You can specify the number of columns used for each bar/point, for example, a display string of ### would need three columns per point, <14> would need four columns per point, etc. By specifying more columns than needed, each bar/point will be separated.

You also can choose bar colors and characters. To deactivate bar chart mode see Strip/Bar Chart's help screen.

Strip/Bar Chart has a repeat command feature. Enter any number, then a command and Strip/Bar Chart will repeat that command by the number. For example, to move quickly 5 screens down the file, enter 5<PGDN KEY>, or to move 60 points down enter 60<LEFT ARROW>. The fastest way to move around in a file is by using the repeat PGDN KEY or repeat PGUP KEY because the program skips drawing intervening screens and draws only the last screen of data.

Strip/Bar Chart also will auto scroll through a file, and you can set the scroll speed or change it on the fly.

Strip/Bar Chart's help screen is activated by the <F1> key.

ALARM FEATURES:

Both Aw-srad and the TSR code (Aw-mrad) have an alarm feature. When running Aw-srad's "Display Current Input" mode with the alarm activated, if the average for any point displayed is greater than the alarm level, an alarm will sound from the computer's speaker. For example, if you run Setup so that each point displayed is the average of the last ten minutes of data, and a ten minute average exceeds the alarm level chosen with Setup, the alarm will sound until a point is displayed below the alarm level. You can activate/deactivate the alarm during the "Display Current Input" mode. Just press F1 for commands.

The TSR code also has an alarm feature. (See TSR CODE section below). Since the TSR code always stores averaged raw data gathered each TBU (Time Base Unit), either to its buffer or disk, the TSR code has a special running average for the alarm. You can select the length of the running average while activating the TSR code, or from the TSR's pop-up window. For example, if you select 600 sec. for the running average length, the TSR code will calculate the average radiation level every TBU, using the data gathered over the previous 10 minutes. If the running average is equal or above the alarm trigger level, the alarm will sound until the running average drops below the alarm trigger level or the alarm is shut off from the pop-up window.

The TSR code and Aw-srad always round up a fractional part equal to or above 0.5 and round down any fractional part below 0.5.

PRINTER FEATURES:

You can print to any DOS device or file including a LPT, COM, AUX, or CON device or a disk file. DOS's "Mode" program can set baud rates, etc. for serial printers.

By printing to the CON device, you can see exactly what will be sent to your line printer. Use ctrl s or ctrl c as you would with the DOS "Type" command.

By printing to a disk file, you can use a text editor to edit the file and then use your DOS "Print" program ("print filename"), DOS "Copy" ("copy filename PRN"), or DOS "redirect" ("type filename > PRN") to print the file.

Printer formatting is controlled both by Setup's "Printer" and Setup's "Strip/Bar Chart" selections.

You can enter an initialization string that the program will send to your printer before any data. To enter any non-ascii character in the initialization string, hold down the ALT key and then key in the code on the keypad, then release the ALT key. For example, if you need to enter the escape character in the initialization string, hold down the ALT key and key in 27 then release the ALT key. 27 is the base 10 code for the escape character. All non-ascii codes will display as the equivalent IBM character. For example code 27 will display as the IBM character left arrow. (You can view all the IBM characters from Setup's "Chart Character" option)

Also, Aw-srad includes a selection that prints any Strip/Bar Chart screen to a DOS device or file. (First use Setup to select a printable bar drawing character).

ASCII / SPREADSHEET OUTPUT:

To accommodate easy transfer of radiation data to a spreadsheet or database, AW-SRAD'S "Display" menu in-

cludes a selection that will print data from a raw radiation data file to an ascii file. The ascii file created will consist of a column of numbers representing the average radiation level per data point. The ascii file will be much the same as a file created by printing to a file with zero left printer margin and zero print columns. The Time Base Units of data averaged per point is determined by the value entered from the "Strip/Bar Chart Settings" or the "Printer Settings" under Aw-srad's Setup menu.

Optionally each number can be followed by a comma and a data\time code, for use by the spreadsheet or database. Also optionally, the ascii file can begin with a data bar (a couple of lines of summarizing data). The ascii file generated can be loaded into a text editor program for any minor changes or viewing.

Beautiful multi-series graphs, including log graphs, can be produced and printed effortlessly with spreadsheet programs such as Quattro-Pro.

SELECTING FILES:

Aw-srad will display a directory listing from which you can select a radiation data file to load into the program for viewing. Alternatively, Aw-srad will load a file typed on the DOS command line. (See Command Line Args below). Any file loaded must of course be raw data files generated by Aw-srad or the TSR code (Aw-mrad.com).

While selecting a file, change directory listings by placing the cursor bar on a "DIR" listing and pressing <ENTER>. The "DIR .." listing is Dos's notation for the parent directory, so to change to the parent dir from a sub dir, place the cursor bar on the "DIR .." entry and press <ENTER>.

The "DIR ." listing is Dos's notation for the current dir. One use for this listing is if you are running the TSR code and you save the memory buffer to disk by hitting the appropriate hot key, and then you wish to update the dir listing, to reflect the data file's new size, do so by selecting the "DIR ." and pressing <ENTER>.

By pressing the <F5> key you can change drives and display directories and files for selection, by using a path name and filename with wild cards as needed.

The <F7> <F8> keys toggle the sort method between name sort and date/time sort. The selected sort method is highlighted.

TSR CODE:

The TSR code (Aw-mrad.com) gathers raw radiation data from a preselected port and stores the data in a buffer. It automatically saves the buffer to a disk file when the buffer is full. It also maintains a running average of the radiation level and sounds an alarm if the average exceeds a preselected value.

The TSR code runs in the background, allowing the computer to carry out other tasks. A pop-up command window can be accessed by a pre-defined Hot-Key Combo.

The TSR code is loaded by the user from the main program AW-SRAD.EXE. The TSR code can be automatically loaded by AW-AUTO.COM or AW-AUTOT.COM every time the computer is turned on (See AUTOEXEC.BAT below).

The TSR code activates a pre-defined Hot-Key Combo, which creates a pop-up window from any non-graphics program. This pop-up window allows the user to control the TSR code while it is running in the background.

The TSR Hot-Key Combo is a two keystroke combination. The default Hot-Key Combo combination is the left ctrl key - F1, so to bring up the TSR code's pop-up command window, hold the left ctrl key down and press the F1 key. *(Note: On older, slow computers, the pop-up window might not be fully active before you release the Hot-Key Combo, in which case, when leaving the pop-up window, the computer bios might not know you released the command key i.e. the CTRL, ALT or SHIFT key. If this is the case on your computer, just tap the CTRL, ALT, or SHIFT key a second time.*

The TSR code's pop-up command window displays the MicroR\hr. level averaged from the TBUs of data specified by the running average length. For example if you choose 600 sec. for the running average, the pop-up window will show the MicroR radiation level average from the data gathered over the last 10 minutes. You can change the running average length at will from the pop-up window. As you change the running average length, the average MicroR level displayed will change accordingly.

The TSR program's pop-up command window selections include:
<W> The TSR code sets up a small capture buffer in memory in which it stores the raw data from the port. By hitting the W key from the pop-up window, the TSR code writes (saves) its memory buffer to disk. Otherwise the TSR code will save its buffer to disk automatically according to your "Save Buffer Cycle" selection in Aw-srad's Setup.

<U> will save the buffer to disk and then un-install the TSR code from memory.

<B> will toggle the operation of the beeper, either activating it or deactivating it. With the beeper activated, the computer's speaker will beep or click every time the RM-60's geiger tube is triggered by ionizing radiation.

<A> will toggle the operation of the alarm system. As mentioned previously, the TSR code saves raw data to memory and disk, and simultaneously calculates a running average of the radiation level. If the running average exceeds the trigger level, an alarm sound is continuously emitted from the computer's speaker. The alarm trigger level and the seconds of data used for calculating the running average can be selected in Aw-srad's Setup selections or from the pop-up command window.

<F5 - F6> increases or decreases the duration of the beep or click emitted from the computer speaker, with each detection of radiation.

<F7 - F8> increases or decreases the alarm set point.

<F9 - F10> increases or decreases the number of seconds of

data averaged for the alarm as well as for the pop-up window's "Current MicroR Average" display.

While the TSR code is running, you can save the TSR buffer to disk and then view the data gathered up to that point with the program Aw-srad.

The TSR's pop-up window contains the name of the disk data file in which the program is storing the data.

The TSR code will not allow more than one copy of itself with the same IRQ # to be installed. If you install another TSR program on top of Aw-srad's TSR code, you should un-install it before un-installing Aw-srad's TSR code, otherwise your other TSR program may fail to work until you re-boot. Before un-installing itself, the TSR code will warn you if any interrupt vectors have been changed by another program.

AUTOEXEC.BAT OPERATION (AW-AUTO.COM):

A program is included, AW-AUTO.COM, which allows automatic operation of the TSR code from a power down condition. (Also see README about AW-AUTOT.COM which is just like AW-AUTO.COM but uses PC date-time to generate file names).

With the help of a text editor, by making the dir path and name "AW-AUTO.COM" the last line of the file "AUTOEXEC.BAT" found in your root directory, Aw-auto.com will create a new unique raw data file in the directory where it resides, every time the computer is turned on or re-booted. It will then invoke the TSR code (Aw--mrad.com) using all the parameters you previously specified from Aw-srad's Misc. menu option "Configure AW--AUTO.COM".

This automatic creation of a unique raw data file and automatic boot of the TSR code allows a computer to monitor the radiation level continually, with no intervention necessary. This is handy if the user wants to monitor the radiation rate automatically, every time he\she turns the computer on, or to monitor radiation rates with an unattended computer. Even if the power fails for a period, when the power is restored, several automatic steps will follow.

1. The computer will re-boot.

2. During the process of booting, MSDOS always looks in the root directory for the file "AUTOEXEC.BAT", and runs any programs listed in the file.

3. MSDOS will see the path and program name "AW-AUTO.COM" previously placed in the autoexec.bat file by the user.

4. MSDOS will load AW-AUTO.COM.

5. AW-AUTO.COM will search the file names in the directory in which it resides, and create a new sequentially numbered unique raw data file name using the file extension name previously specified with AW-SRAD.EXE.

6. AW-AUTO.COM will next load the TSR code using all the parameters previously specified with AW-SRAD.EXE.

7. The TSR code will terminate but stay resident, and MSDOS will display the command line prompt.

8. The TSR code will continue to gather data to its buffer and disk file, and optionally monitor the alarm and click the speaker, as well as watch for the Hot-Key combo, which would activate the pop-up window.

For remote operation, there is no need for a CRT display monitor or keyboard.

Setting the stage for automatic operation involves the following steps:

Step 1: Use the program AW-SRAD.EXE to establish user defined parameters for the TSR code. Do so by selecting AW-SRAD'S Misc. menu option "Configure AW-AUTO.-COM". You will choose all the parameters needed by the TSR code. These parameters will be saved into AW-AUT-O.COM.

The "Configure AW-AUTO.COM" operation will present various options including:

The "Save Buffer Cycle" selection tells the TSR code how often to save its buffer to disk. For example, by choosing 10, the TSR code will save its memory buffer to disk every 10 Time Base Units. By choosing a low number, a power outage or re-boot will only lose the small amount of data in memory. By choosing a larger number, disk accesses will be minimized.

The "File Extension" selection tells the TSR code to use a unique file name using the file extension specified. For example, if you choose "RAD" for the file extension, the first file name created will be "AW-1.RAD. The second will be "AW-2.RAD" then "AW-3.RAD", ... "AW-65000.RAD", etc. By looking at the dates of each file, you can tell each occurrence of a re-boot due to power outage or other reason.

Step 2: Create or choose a directory that will be used to hold the raw data files. Place in this directory AW-MRAD.COM (the TSR code), and AW-AUTO.COM (the load program). When activated, the TSR code will automatically use a unique file created in this directory.

Step 3: Using your favorite text editor, create or edit the file "AUTOEXEC.BAT" in the computer's root directory. Add a line of text to this file that contains the path and name of the load program AW-AUTO.COM. For example, if the directory created in step 2 was C:\RAD\DATA, place as the last line in the autoexec.bat file: "C:\RAD\DATA\AW-AUTO.COM".

TELECOMMUNICATIONS:

If a communication program, such as Aware's AW-FETCH, is loaded with Aw-mrad, from an Autoexec.bat command, data files can be auto downloaded over the phone lines. If you would like more information about this type of operation, write Aware Electronics.

MULTIPLE RM-60s per P.C.:

Aw-srad.exe, Aw-mrad.com, and Aw-auto.com are configured

so that up to eight RM-60s can be plugged into one PC for the simultaneous monitoring of eight locations.

Aw-mrad (the TSR program) will allow more than one copy of itself to be loaded into memory, as long as no two copies are configured to use the same IRQ number. The IRQ number is selected from Aw-srad's "Setup" menu, sub selection "Input Port". For more information about multiple RM-60s per P.C., read the text file "MULTI-RM.TXT" on the disk.

CLOCK:

Both the TSR code and AW-SRAD keep track of the time and date by way of the computer's clock. Check the computer's time/date before gathering data, to insure the data file is stamped with an accurate time and date. You can set the time by typing "TIME" at the DOS prompt. The date can be set by typing "DATE" at the DOS prompt. Real time clocks automatically set the date and time every time the computer is turned on. They can be inexpensively added and quickly reveal their value.

COMMAND LINE ARGUMENTS (SWITCHES):

Aw-srad recognizes six command line arguments, namely -B -M -D -S -C -U and -T. You can use more than one switch.

The -B switch will force bios video mode, for example: "AW-SRAD -B". -M will force monochrome colors.

The -D -S or -U switch loads a previously generated radiation data file then (D)isplays info or (S)hows chart. -U is like -S but enters auto update mode. The -D -S or -U switch must be followed by a file name, for example:
"AW-SRAD -DMYFILE.RAD" would tell Aw-srad to load the file MYFILE.RAD and display data about it.

The -C switch tells Aw-srad to enter Capture-Display-File mode wherein Aw-srad will gather radiation data, display it and file it. If the -C switch is followed by a filename, Aw-srad will place the radiation data in the file. For example "AW-SRAD -CMYFILE.RAD" will tell Aw-srad to start gathering radiation data and place it in a file named MYFILE.RAD. If the -C switch is not followed by a filename (with or without a path), as in "AW-SRAD -C", Aw-srad will make up a new, unique file name for you with a name format of UNQXXXXXX.RAD, wherein the XXXXXXX is a number, for example UNQ1.RAD.

The -T switch is just like the -C switch but unique filenames are generated from the PC's system date-time. See the README.TXT file on disk for info. about additional args.

MICROSOFT WINDOWS

Win 95, works well with Aware Programs. Create a shortcut to AW-SRAD.PIF file and AW-GRAPH.PIF file. For highest performance, disable Win 95's COM port manager as follows: "Control Panel"; "System"; "Device Manager"; "COM port" (the one the RM-60 is plugged into); "Properties"; "Disable in this hardware Profile", or uncheck "Dock & Undock". *WARNING: It is best not to start Windows with Aware's TSR program running. It is fine however to use Aw-srad in a Window. When Windows begins to load, it first switches your display into graphics mode, then issues a global interrupt to tell any loaded programs that Windows is starting. At this point, if a program does not want Windows to install, it can answer the interrupt telling Windows not to install. This is what Aware's TSR code does. Windows will not install but will return to the dos prompt. The TSR program will make an error sound. In such a case, Windows doesn't bother returning your video monitor to text mode, so even though you are back at the DOS prompt, you can't see the prompt. Type MODE CO80(enter) to restore your video to text mode.*

To load Aw-srad.exe into a window, use Window FILE MANGER to click on the supplied Aw-srad.pif file or if Windows is not running, at the dos prompt type: "WIN AW-SRAD.PIF". This will load Aw-srad into a window, at which point you can run the program as you normally would. Much more information about Windows is contained in the "Readme.txt" file on disk. You can read it with your text editor or with DOS by typing "edit readme.txt" or "type readme.txt | more" or by typing it on your printer ("copy readme prn") or clicking on it. Be sure to read it, particularly if you plan on using the programs with MS Windows.

UNITS OF RADIOACTIVITY

The RM-60 is calibrated in microroentgens/hr. You may want to know more about roentgens and about other units of radiation. If so, a brief explanation follows.

ROENTGEN:

One roentgen is that quantity of X-rays or gamma rays that produce 1.61 x 10^{12} ion pairs per gram of air, which corresponds to the absorption of 83.8 ergs of energy per gram of air, or ions carrying one electrostatic unit of either sign per cubic centimeter of air.

The roentgen is a unit of the total quantity of ionization produced by gamma or x-rays. Dosage rates are therefore expressed in terms of roentgens per unit time (like miles per hour, roentgens per hour expresses a rate).

One roentgen equals one thousand milliroentgens (1R = 1000mR), and one milliroentgen equals one thousand microroentgens (1mR = 1000uR).

One curie of radium (approx. one gram) with decay products, produces .97 roentgens/hr. at one meter.

RAD:

The rad (Radiation Absorbed Dose) is a unit for measuring absorbed doses of radiation equal to 100 ergs of energy per gram of exposed biological tissue.

REM:

The rem (Roentgen Equivalent Man) is a measure of ionizing radiation of the type that produces the same damage to human beings as one roentgen of X-rays. The rem takes into effect the greater damaging effects of alpha radiation, beta radiation, protons, fast neutrons and thermal neutrons. Protons and neutrons are normally only emitted from nuclear reactors or accelerators.

(When dealing with X-rays and gamma rays, a rough equivalency exists between roentgen, rad and rem:

1 roentgen approx. equals 1 rad approx. equals 1 rem.)

CURIE:

The curie is a unit of radioactivity of a material. Radioactivity is measured in terms of nuclear disintegrations per unit time. One curie is the rate of nuclear disintegration of a quantity of radioactive material that undergoes 3.7×10^{10} nuclear disintegrations per second. One curie of radon is approx. the quantity of radon in equilibrium with one gram of radium. One curie of radium is approx. equal to one gram of radium. One curie equals 1000 millicurie, which equals 1,000,000 microcurie, which equals 1,000,000,000,000 picocurie (10^{12} picocurie).

BECQUEREL:

Like the curie, the becquerel is a unit of radioactivity. One becquerel is equal to one nuclear disintegration per second. One becquerel equals 27 picocurie.

GRAY:

Symbol: Gy. The Gy is a SI unit. 1 Gy is equivalent to 100 rads.

SIEVERT:

Symbol: Sv. The Sv is a SI unit. 1 Sv is equivalent to 100 rems. (1 micro Sv = 100 micro rems). Many users desire readout in µSv instead of µR. Since one µSv equals 100 µR (standardized to Cesium 137), the program reads out in 1/100ths of a µSv. You could change the program's Global Caption and Y-axis caption to reflect this (Menu SETUP, STRIP/BAR, GLOBAL CAPTION). Change µR/hr to µSv/C/hr. (C for 1/100th). *To enter non-ascii IBM characters, hold down the <ALT> key then enter the IBM character code into the keypad of your keyboard. For example to enter µ, hold down ALT key and key in 230 on keypad. To see all the IBM characters with corresponding numbers, view menu SETUP, CHART CHARACTER.*

MEASURING RADIOACTIVE SUBSTANCES

Always be very careful not to contaminate yourself when dealing with a suspected radioactive substance. Utmost precaution should be exercised. Approach a radioactive substance slowly and carefully. Never touch your RM-60 to an active radioactive substance; you may contaminate it. Avoid drawing incorrect or misleading conclusions by knowing all the facts involving a given situation.

The radiation emitted by a radioactive substance can be any combination of three types of radiation, namely alpha particles, beta particles or gamma rays. A predominant alpha emitter or beta emitter usually also emits gamma rays. Likewise a predominant gamma emitter usually also emits some beta and/or alpha particles. When you have come across a radioactive substance, you should try to determine which types of radiation are being emitted.

ALPHA PARTICLES:

Alpha particles are positively charged particles (helium nuclei) emitted at high speeds, from the nucleus of radioactive elements. Due to their large mass and positive charge, alpha particles usually are stopped by a sheet of paper or by about an inch of air. In the process of being stopped, they produce considerable ionization, over a relatively short distance. Therefore, alpha emitters are especially dangerous when ingested or inhaled.

To determine whether or not a substance is emitting alpha particles, position the alpha window about 1/4" from the substance. Next, place a piece of paper between the substance and the alpha window. If the indication of radiation stops, the substance is emitting alpha particles.

BETA PARTICLES:

Beta particles are negatively charged particles (nuclear electrons) emitted, at very high speeds, from the nucleus of radioactive elements. They have much less mass than alpha particles, and therefore can penetrate material to greater depths. Due to their smaller mass, beta particles have less ionizing power than do alpha particles, although some beta particles, travelling close to the speed of light, possess energies and ionizing powers approaching those of alpha particles. Normally, a few millimeters of aluminum will stop beta particles.

To determine whether or not a substance is emitting beta particles, point the alpha window at the substance, and apply the paper test for alpha particles. Next place a 1/16" thick piece of aluminum between the alpha window and substance. If the indication of radiation stops, the substance is probably emitting beta particles.

HIGH ENERGY BETA PARTICLES:

High energy beta particles will be able to penetrate the side of the stainless steel geiger tube, and thereby produce a detection, but will not be able to penetrate a 1/16" thick piece of aluminum. To distinguish high energy beta particles, see GAMMA RAYS below.

GAMMA RAYS:

Gamma rays are pulses of high energy electromagnetic radiation (photons), much like very high energy X-rays, but emitted from the nucleus of radioactive elements. They have exceptional penetrating powers, travelling to much greater depths than alpha or beta particles. They, like alpha and beta particles, produce damaging ionization along their path, but the ionization is more spread out. The emission of gamma rays usually accompanies the emission of alpha and beta particles.

To determine whether or not a substance is emitting gamma rays, hold the back of the RM-60 over the substance. Next place a 1/16" piece of aluminum between the substance and the back of the RM-60. If the indication of radiation stops, the substance is probably emitting HIGH ENERGY BETA PARTICLES. If the indication of radiation does not cease, the substance is emitting gamma rays.

X-RAYS AND LOW ENERGY GAMMA RAYS:

X-rays are electromagnetic radiation (photons) emitted when a high speed stream of electrons hits a metal obstruction, as

occurs in X-ray tubes and in high voltage tubes in some TV power supplies. They are just like low energy gamma rays, except that gamma rays originate from the nucleus of radioactive atoms, whereas X-rays originate from interactions involving orbital electrons.

To distinguish X-rays and low level gamma rays, hold the back of the RM-60 toward the source. X-rays and low energy gamma rays will not be able to penetrate the side of the stainless steel geiger tube, with enough energy to produce a detection.

Next point the alpha window towards the source. X-rays and low energy gamma rays will penetrate the alpha window, thereby producing a detection.

Next place a 1/16" piece of aluminum between the source and alpha window. Unlike alpha particles or beta particles, X-rays and low energy gamma rays will be able to penetrate the aluminum, therefore a detection of radiation indicates X-rays or low level gamma rays.

RADON and THORON GAS

THORON GAS:

Many building materials contain small quantities of thorium. Thorium-232 is a radioactive element that heads a series of radioactive elements, just as uranium-238 heads a series of radioactive elements. Thorium is far more abundant in nature than is scarce uranium. Thorium is almost as abundant as lead.

Thorium decomposes into thoron gas, an isotope of radon. Thoron gas has a halflife of only 55 seconds (half of a given quantity of thoron decomposes into radioactive solids every 55 seconds). Because of the short halflife, most sub-surface (underground) thoron gas decomposes into radioactive solids before it has a chance to escape into the atmosphere or seep into a house.

Thoron gas released from building materials can immediately enter the living space atmosphere, without first having to seep up through many feet of sub-surface soil.

When thoron gas decomposes in a living space atmosphere, it releases solid charged radioactive products of decomposition (daughter products). These daughter products cling to floating dust particles, and if inhaled, can lodge in the body and induce cancers.

The RM-60 can detect these dangerous radioactive daughter products of thoron by measuring the buildup of radioactivity on an air filter. An air filter will become radioactive as it catches thoron daughter products clinging to dust particles. (see RADON GAS);

RADON GAS:

PAST EXPERIENCE:

Over the years, many users of the RM-60 system have sent to Aware, graphs and letters, showing the great value the system provides for watching real time radon levels. Experience has indicated one can expect an increase over and above normal background reading of perhaps 3 micro roentgen per hour per pico curie radon per liter air. In other words, if your background reading outdoors or upstairs, where there is no radon, is 10 microR/hr., but you measure a background reading of 13 micro/R/hr. in the basement, this perhaps indicates approx. 1 pico curie radon per liter air. A reading of 16 micro/R/hr. would indicate 2 pico curies radon per liter air, etc.

By placing the RM-60 window within perhaps 0.3 inch from the filter of a small fan-filter combination, the increase in readings due to the presence of radon will perhaps more than double, that is approx. 7 microR/hr. increase per pico curie radon per liter air. A buildup of radioactivity on an air filter is a very strong indication of the presence of radon.
Some users have indicated a large buildup of radioactivity in the bathroom, when running the shower. For example, one user measured approx. 15 microR/hr. in the bathroom, but after running the shower, the reading increased to approx. 200 microR/hr., as radon and daughters were released into the air from the water.

As indicated above, with the help of an air filter, your RM-60 can detect very low levels of radon gas. This same test procedure also will alert you to the presence of rare but highly dangerous airborne radioactive particles.

QUICK RADON TEST:

Hold a coffee filter over the inlet of a vacuum cleaner for 2 mins., then place the filter on top of the RM window, or run a fan forced air filter for 1/2 to one hour then pull the filter out of the plenum, as though you were going to clean or replace it, and place the RM-60 right on top of the filter. If you have even the smallest buildup of radon gas in your house, you should notice an increase in the reading. Also, see DECAY CURVES. By performing this test several times a year, you will be alerted to any buildup of radon.

Suitable filter systems include good quality filters in a heating or air conditioning system, charcoal filters such as those mounted above a stove, or portable filters. Sears sells a line of inexpensive portable electrostatic filters.

RM-60 users who have contacted Aware Electronics and who have an enclosure containing radon, such as a basement, have noticed an increase in the background radiation level when placing the RM-60 in the enclosure, without the use of an air filter. By moving the RM-60 around from location to location, they are able to ascertain likely areas of radon ingress. Puffs or spurts of high activity are often observed in a particular location, for example next to a particular wall.

RM-60 users who have had radon remedy work, use the RM-60 to check for the return of any radioactive build-up.

RADON DISCUSSION:

Radon gas is released by radium, found in association with uranium, primarily in soil and rock. If radon decomposes in the atmosphere, the radioactive daughter products cling to dust particles.

Since radon has a halflife of 3.8 days, most radon that forms underground decomposes back into a solid, before it has a chance to seep up out of the ground.

Radon can seep into your house through cracks and openings in your basement or foundation, and can collect to dangerous levels. The danger is due to the decomposition products released by radon. These decomposition products are charged solids, and cling to dust particles. They are highly radioactive, and can lodge inside your body, when you inhale the contaminated dust. Once lodged inside your body, they can remain there for extended periods of time, subjecting the cells surrounding the particles to a continuous bombardment of ionizing radiation. This destroys and damages tissue, triggering cancers.

These same dust particles will collect on an air filter. By running a fan forced air filter for half an hour or more, and then placing your RM-60 as close as you can to the filter, you can detect levels of radon gas as low as 1 picocurie per liter. After two hours or so, the filter will reach equilibrium, that is radon daughter products will collect as fast as they disintegrate, and the radiation level you detect with the RM-60 will flatten out. From then on the radiation level will rise and fall with the level of radon gas. You may notice the level increase at night and decrease during windy weather.

The exact increase in reading due to a certain level of radon gas depends upon the air flow rate, the efficiency of the air filter in catching dust particles and the distance the RM-60 is from the air filter. For example, a typical house might have about 500,000 liters of air. If the air is contaminated with 2 picocurie of radon gas per liter, the build up of radiation on a 99% efficient air filter, with an air flow of 1000 cubic feet per minute, might produce an increase in reading of approximately 13 microroentgens/hr. on your RM-60, when the average distance between the RM-60 and the filter is 1/4 meter or 52 microroentgens/hr. at 1/8 meter. Eight picocuries of radon per liter of air might produce an increase four times higher, or 52 or 208 microroentgens/hr. respectively. A 40% efficient air filter could produce a reading approximately 60% less than a 99% efficient filter. In the above example, a 40% efficient filter might produce an increase in reading of 5.2 and 20.8 microroentgens/hr. respectively, when the air is contaminated with two picocurie of radon gas per liter of air. An 8 picocurie per liter air contamination could produce an increase of approximately 21 and 84 microroentgens/hr. respectively. Likewise a 20% efficient filter might produce an increase in reading of 2.6 and 10.4 microroentgens/hr. respectively at two picocurie of radon per liter and 10.5 and 42 microroentgens-/hr. respectively at eight picocuries per liter. *The above assumes detection of gamma only. If beta and alpha are detected as well, the increase in readings will be much higher.*

EPA RECOMMENDED ACTIONS:

(Note: EPA's action levels equate 1 picocurie Radon / liter air with 0.005 Working Level (WL)).

The EPA recommends the following actions, when the following various levels of radon gas contamination are found:

200 Pc/l: Take action to reduce levels, within several weeks. If this is not possible, consult state or local health officials about the appropriateness of relocating until the levels are reduced.

20 to 200 Pc/l: Take action to reduce levels to below 4 Pc/l. within several months.

4 to 20 Pc/l: Take action to reduce levels to below 4 Pc/l. within a few years.

Less than about 4 Pc/l: Although exposure in this range does represent some risk, reductions at these low levels are sometimes difficult to achieve.

Because of the many variables involved in detecting radon gas, Aware Electronics suggests that if you detect any increase in radiation when placing your RM-60 next to an air filter, call your state or local health agency.

REDUCING RADON:

You can reduce a buildup of radon in your house by venting. The most immediate method of doing this is to open basement windows. RM-60 users have reported that background readings have dropped to near normal after only several hours of opened basement windows.

You should seal all cracks and openings, for example, around pipes and wires that enter your basement, with a good caulk. Urethane caulk is reported to form a good gas barrier. Latex paint applied to cinder block or cement walls might help form a good radon gas barrier. Floor drains and sumps are often sources of radon. Never overlook good professional remedy work.

CONTINUOUS RADON MONITORING:

You can continuously monitor for the return of any radon gas by mounting the RM-60 next to the air filter in the heating or air conditioning system or portable filter system. Use modular telephone extension cord to extend the RM-60's cord if need be. Set the operating parameters of the program to average about 10 minutes per point. Set the alarm level several microroentgens above the highest background level you observe. For example, if the normal background level swings between 15 and 18 microroentgens/hr, set the alarm level to 23 microroentgens/hr. Thereafter, if radon gas begins to build up in the house, soon after the fan in the heating, air conditioning or portable filter system switches on, the radioactive dust will build up on the filter, and trigger the alarm.

Portable air filter systems are available with an electrostatic filter, charcoal filter, or good quality fiberglass filter. Place the portable air filter, with fan in a lower part of the house, for example in the basement. Mount the RM-60 as close as you can to the filter. Although detection of beta emission from radon daughters provides the highest sensitivity, the gamma rays can be detected as well. This allows mounting the RM-60 on the outside of the filter chamber if need be (gamma penetrates metal).

If you foresee leaving the RM-60 in a dusty environment for an extended period, consider placing a piece of tape over the alpha window grid to exclude the accumulation of dust from inside the RM-60.

RADON IN WATER:

If you find that you do have a build up of radon gas in your house, and you suspect one source may be your water, you can test for radon in water by buying an inexpensive activated charcoal filter for your tap. After mounting the filter, run your water at a medium rate for half an hour or so, while holding the back of the RM-60 against the charcoal filter. Be careful not to get the RM-60 wet. Any radon and radon decomposition products should collect in the filter, causing it to become radioactive. Any increase in your monitor's reading would indicate the presence of radon, or other radioactive material, in your water, in which case you should call your state or local health agency.

CHARCOAL CANISTERS:

A charcoal canister or alpha track test is a valuable addition to your radon testing program, and it is a good idea to have at least one charcoal canister test. The charcoal canister or alpha track tests are calibrated to measure for radon gas in picocuries radon per liter of air, whereas the RM-60 is calibrated to measure the level of ionizing radiation.

Your RM-60 does many things for you that a charcoal canister test cannot do. For example, in combination with an air filter, the RM-60 rapidly samples a large quantity of air for the highly radioactive decomposition products (daughter products) of radon. Even without the assistance of a fan forced air filter system, a room with significant levels of radon will immediately produce higher background readings on the computer, from the RM-60, over-and-above a room without radon.

Also the RM-60 can continuously check for the presence of radon gas as well as many other radioactive contaminations, year around, and immediately warn you of a potential problem.

Never-the-less, you should not overlook the benefits of a charcoal canister or alpha track test.

An interesting experiment might be to measure the level of radiation from a charcoal canister with your RM-60 before sending the canister back to have it tested.

A charcoal canister will become radioactive when sitting in a radon infested area. The level of the ionizing radiation from the canister is an indication of the quantity of radon the canister was exposed to, just as the level of ionizing radiation from an air filter is an indication of the quantity of radon present.

You can use a charcoal canister test to calibrate an RM-60\fan forced air filter combination, empirically, to picocuries radon per liter of air, if you so desire, as follows:

1. Set up your fan forced air filter\RM-60 system and run the fan for about two hours, until you reach equilibrium. Equilibrium is evident when the radioactive build-up on the filter levels out. This occurs when enough daughter products are collected on the filter such that the collected daughter products are decomposing at the same rate as they are being collected.

2. Keep the fan running and periodically measure the radiation level with your computer. At the same time, run a charcoal canister test. The increase in radiation from the filter system, above normal background, should correlate with the level of radon per liter reported by the charcoal canister test. A doubling of your reading from the filter would indicate a doubling of the quantity of radon present.

RADON INDUCED RADIOACTIVITY OF AN AIR FILTER:

A detailed evaluation of a reading expected from a buildup of radioactivity on an air filter, from decomposition of radon gas, follows. An typical house might contain 20,000 cu. ft. of air which equals 500,000 liters. At two picocuries of radon per liter, this would equal one microcurie of radon in the house. To maintain this level, there must be a continuous inward flow of radon into the house of one microcurie/hr., given an air exchange rate of one exchange/hr., to the absolute least radon inflow of 0.25 microcurie/hr. in only the most super insulated houses. The daughter products of radon gas should produce a reading of 0.85 microroentgen/hr./microcurie, at one meter, due to gamma flux from radium B (Pb., At. Wt. 214, halflife, 26.8 minutes), radium C (Bi., At. Wt. 214, halflife, 19.7 minutes), radium C' (Po., At. Wt. 214, halflife 1.5 x 10^{-4} seconds) radium D (Pb., At. Wt. 210, halflife 22 years) and radium E (Bi., At. Wt. 210, halflife 5.0 days). Essentially all the gamma flux from radium is due to these daughter products of radon. The intensity of radiation flux decreases by the inverse of the square of the distance between source and measuring point, therefore a reading of 0.85 microroentgens/hr. at one meter should produce a reading of 3.4 microroentgens per hr. at 0.5 meters, 13.6 microroentgens per hr. at 0.25 meters and 54.4 microroentgens per hr. at 0.125 meters. At 4 picocuries per liter concentration, a 100% efficient filter would produce an increase in reading of 26.6 microroentgens/hr. at 0.25 meters and 106.8 microroentgens/hr. at 0.125 meters, while a 35% efficient filter would produce an increase in reading of 9.3 and 37.25 microroentgens/hr. respectively. Even higher readings could be expected, as the radon daughter products reach equilibrium on the filter (radium B, halflife 26.8 minutes), due to the continuous source of fresh radon that must be entering the house to maintain the picocurie per liter level. If a smaller, portable fan/air filter combination were used, it would be placed in the basement, the area with highest radon concentration.

Although there are many variables involved in the detection of radon, the above illustrates that the RM-60, in combination with an air filter, can detect the presence of very small levels of radon gas.

As indicated above, past experience indicates that a RM-60 placed in the middle of a basement with about 2 picocuries radon per liter air might display a background reading perhaps 5 to 10 MicroRs higher than normal, with puffs or spurts to higher levels. Such an increase would not necessarily be expected from an even distribution of the radon. A reservoir of beta emitting daughter products in the form of radioactive dust may explain the increase.

To double-check your conclusions about the presence of radon, run at least one charcoal canister or alpha track test. The small cost of a canister test as well as the benefits of the RM-60 are well worth the cost and effort.

DECAY CURVES

For complete and easy evaluation of Radon-Thoron decay curves, purchase MAKDECAY (see price list). It includes many additional features and info.

If you observe the decay curve of Radon Daughters collected with an Aware Fan-Filter, after turning off the fan, using AW-GRAPH (or a spreadsheet program), you will notice what appears to be a curve with a halflife of approx. 40 minutes. This is due to the following:

The two materials generating a flux from the filter are Radium B (halflife 26.8 minutes) and Radium C+C' (halflife 19.9 minutes), both beta emitters (C' alpha emmitter). Radium B decays into Radium C, resulting in a curve with an apparent halflife of approx. 40 minutes.

You can verify this by using a spread sheet program to plot the decay curve of Radium B and Radium C as follows.

Given a certain quantity of radioactive material, if you know the halflife, you can calculate the remaining quantity of the material after an elapsed amount of time using the following formula:

$E=E_o * 2.71828^{-(\text{DecayConstant} * t)}$

Where E is the remaining material,
E_o is the initial quantity,
DecayConstant = 1/(halflife * 1.443),
t = elapsed time expressed in units the same as the halflife.

Fill four columns in the spreadsheet as follows. Fill column 1 with time numbers (for example 0 1 2 3 4 5 6 etc.) for the x-axis.

Fill column two with the remaining quantity of Radium B using the corresponding time number in column 1 and the Decay Constant of Radium B, by applying the above formula. Start with an arbitrary amount of Radium B, say 1000 units.

Fill column three with the remaining quantity of Radium C as above, starting with an arbitrary amount of Radium C, say 700 units, but for every row, add to the starting amount, the quantity of Radium B lost in the corresponding row of column 2.

Fill column 4 with the sum of column 2 and 3.

Now generate a graph by assigning column 1 to the x-axis and column four to the y-axis. You should get a curve with an apparent decay very similar to that which you observe with real data when plotting Radon daughter decay. For an exact match, use MAKDECAY program (see price list).

It is likely the Fan-Filter is collecting a little Thorium daughter as well. This would be Pb-212. You can add a col. 5, col. 6 and col. 7. to the spreadsheet. Fill col. 5 with decay info for Pb-212 (halflife: 10.64 hours), using the above formula and the time info in Col. 1. Pb-212 is a daughter of Rn-220 (gaseous Radon isotope from Thorium, with halflife of 55.6 secs.). Fill col. 6 with the sum of col. 4 and 5. and add col. 6 to a y-axis graph series. Import into col. 7 actual data collected from the fan-filter, and add this to a y-axis graph series as well. Make sure the time increment in col. 1 equals the time increment of the imported data in col. 7. Now observe the graph then adjust the starting quantity of Ra B&C and Pb-212 so that col. 6 curve matches col. 7 curve. This will reveal the percentage of Pb-212 collecting on the filter.

X-RAYS FROM T.V.s and COMPUTER MONITORS

Computer monitors, as well as TVs, operate with a high voltage power supply generating voltages as high as perhaps 20,000 to 40,000 volts. This voltage has the potential of generating X-Rays and Beta rays with electron volts as high as the power supply voltage. The RM-60 is equipped with a mica window (density 1.5 mg/sq. cm.). It can detect X-rays with energies below 10,000 electron volts.

U.S. Department of H.E.W 21 CFR 1029.10 requires "Radiation exposure rates produced by a television receiver shall not exceed 0.5 milliroentgen per hour (500 microroentgens per hour) at a distance of five (5) centimeters (1.97 inches) from any point on the external surface of the receiver, as measured in accordance with this section".

Normal background radiation levels average between 9 and 25 microroentgens per hour, depending on your location and altitude. 500 microroentgens per hour is about 50 times higher than background.

With the RM-60, a background radiation level of 10 microroentgens per hour will generate an average of approx. 10 clicks per minute. A radiation level of 500 microroentgens per hour will generate an average of approx. 500 clicks per minute. It is evident that any radiation level approaching the 500 microroentgens per hour figure will be immediately and obviously apparent given the large increase in click rate. Therefore, one method of scanning a TV receiver (or computer monitor) for excess radiation is to merely start the AW-SRAD.EXE software collecting data in the ten second mode, then slowly scan the surface of the receiver with the RM-60 holding it about two inches from the surface. If any increase in click rate is observed, carry out a more detailed test to determine the exact increase.

To run a more detailed check of a TV (or computer monitor) for excess X-Ray generation, first place the RM-60 5 cm. from the surface of the TV at the location that gave the highest click rate observed as above, with the RM-60 window pointing towards the TV. Start the radiation software and gather radiation data for several TBU (ten second) periods. Observe the average radiation level. Subtract the average background radiation level for the site.

To eliminate alpha and beta emission from the test, place an aluminum shield over the RM-60 window. A 5 mils thick aluminum shield has a density of 35 mg./sq. cm. It will shield all alpha emission and just about all beta emission with energies less than 300,000 electron volts.

It would probably be a prudent decision to flag any TV (or computer monitor) generating levels approaching 100 micro roentgens per hour for a checkup by a technician who can investigate the high voltage power supply, shielding, etc., of the TV in question.

If you directed AW-SRAD to save the data to a file, you can always reload the data and re-calculate the averages at your leisure.

X-rays and gamma rays are composed of photons. They differ only in their source. X-rays are generated from electron beams hitting a metal obstruction whereas gamma rays are emitted from radioactive materials. As stated above, the RM-60 can detect X-rays (and gamma rays) with energies less than 10,000 electron volts. The RM-60 system is calibrated

in microroentgen per hour, standardized to gamma rays from cesium 137 +- 5%. Cesium 137 has an average gamma ray energy level of 661 KEV (661,000 electron volts).

From 8 KEV up to 166 KEV, the RM-60 has a sensitivity to X-rays as much as or more than the sensitivity to cesium 137 gamma rays, therefore, from 8 KEV to 166 KEV, the RM-60 will always provide you with, at least, the minimum microroentgen per hour level.
At 8000 electron volts, the sensitivity is the same as the sensitivity to cesium 137. The X-Ray sensitivity of the RM-60 increases from approximately 8 KEV to 60 KEV in relation to cesium 137 sensitivity. From 60 KEV on up, the sensitivity drops back down to cesium 137 sensitivity. If you discover any TV or computer monitor which generates a significate increase in reading (very unlikely with anything but old tube TVs), please phone us. Although it is always prudent to error on the safe side, you may want to derate the reading observed due to the increase in RM-60 sensitivity centered at 60 KEV. This involves measuring the TV's power supply voltage level, multiplying by 0.666 then applying a correction factor. If you have any questions or comments, please don't hesitate to write or phone us.

TIME BASE UNIT

A Time Base Unit (TBU) option from the Setup menu allows the selection of a TBU of either 10 sec. or 60 sec. With a 10 sec. TBU, Aw-srad and the TSR program will display and save data every 10 sec. Likewise, with a 60 sec. TBU, the programs will display and save data every 60 sec. The data saved is the average radiation level for a TBU period (10 sec. or 60 sec.). Each of the two TBU modes of operation uses a unique calibration factor (see below) so that the raw data saved (either every 10 sec. or 60 sec) is displayed in microroentgen/hr. The program will automatically choose the correct calibration factor for you. When loading a previously gathered raw data file for viewing, the program automatically detects the TBU used when the file was generated, and sets the calibration accordingly. You should only use the 10 second TBU mode for plotting higher levels of radiation because the files generated are six times larger. Also, 10 second averages at lower levels of radiation will swing over a large range.

CALIBRATION FACTOR

As stated in the brochure, the RM-60's tube is calibrated to cesium 137, +/- 5%. Aw-srad includes a calibration factor option from the program's Setup menu for both the 10 second Time Base Unit mode and the 60 second Time Base Unit mode. The software stores data in the form of counts per unit time (10 secs. or 60 secs.). When applying the calibration factor for display, to avoid floating point arithmetic, the program multiplies the count by 100 then divides by the factor. The factor allows calibration to other sources, for critical scientific work. To calibrate readings to a known radioactive source:

Step 1: Gather raw radiation data to a disk file while subjecting the RM-60 to a known ionizing flux level from the source for 10 minutes to an hour or longer.

Step 2: Next display the file's summary from the Display menu. Observe summary's "Average MicroR/hr" value.

Step 3: If the average doesn't precisely match the calibrated source flux level, select "Change settings" from the Display menu, then select "Factor RAD calibration", and adjust the factor accordingly.

Step 4: Next hit escape to return to the Display menu and choose "Display Summary" again to observe the new "Average Micro/hr".

If need be, repeat Step 3.

Calibration factors can be saved to disk by activating the "Disk Write Settings" selection from the Setup or Misc. menu.

The calibration factors have no effect on the gathering of the raw radiation data. The factors are only utilized when the program interprets the raw data while displaying to the screen or DOS device.

CRITICAL APPLICATIONS - PROBLEMS

If you expect very high radiation levels (0.1 to 10 R per hr.) add an external power supply as per the diagram at the end of the manual. (See README, "EDIT README.TXT"). Also, for very critical applications, perhaps it is best not to load other TSR programs into computer memory, besides programs from Aware. Since none of the Aware programs use extended-expanded memory, you can also remove all lines from the config.sys file that load extended-expanded memory managers, many of which will switch the computer into virtual mode. (You could make a BOOT floppy). The standard 640K DOS memory is plenty to run all Aware programs, load DOS, and most standard DOS programs. We mention this because on rare occasion we noticed some complicated memory managers (i.e. QEMM with "Stealth", etc.) can, after running certain combinations of complicated programs (not Aware programs), switch into a mode that interferes slightly with the timer routines used in the Aware programs.

For very critical monitoring, perhaps an autonomous computer ($300 to $400) is advisable. Any AT should be more than sufficient. Also, to allow maximum CPU freedom, reduce the beep length to one or turn the beep off.

Running a disk compression program on a slow computer can cause problems with a small "Write Buffer Cycle" (see README file "EDIT README.TXT").

RM-60 TREATMENT

In general treat your RM-60 no worse than you would treat a portable computer. Do not place your RM-60 in water or leave it in the rain. Do not place your RM-60 in a microwave oven. The case is made of ABS which is very shock resistance but somewhat soft. To avoid scratches when transporting, keep unit in the heavy walled plastic bag. Wipe clean with a soft cloth moistened with water or rubbing alcohol. Avoid all other solvents.

If you plan to mount your RM-60 outside, you must prevent

water from entering the case, and you also must prevent water from condensing inside the RM-60. You could place it in a sealed container along with a silica dehumidifying packet. You can first dry the silica by placing it in an oven.

CIRCUIT DESCRIPTION

A regulated high voltage power supply draws minute power from the computer and supplies the stainless steel Geiger-Mueller tube with voltage. The Geiger-Mueller tube is filled with a harmless inert gas and has a mica end window (alpha window). When ionizing radiation enters the tube, the gas ionizes, causing an avalanche of current. As the positive ions migrate toward the cathode (stainless steel body) they are quenched by a halogen quenching agent, otherwise they would emit secondary electrons when striking the cathode, causing a second avalanche.

SENSOR SPECIFICATIONS

Type 712 tube used in the RM-60

Window: Areal Density: 1.5 to 2.0 mg/cm^2, Eff. Diameter: 0.360", Area: 0.102 Sq. In., Material: Mica

Wall: Thickness: 0.012", Eff. Length: 1.5", Eff. Diameter: 0.566", Material: 446 SS

Max. Diameter	.....	0.59 inches.
Max. length	.....	2.125 inches.
Dead time	.....	90 microseconds.
Alpha sensitivity	.....	2.5 Mev, 80% at 3.6 Mev.
Beta sensitivity	.....	35% at 50 Kev. 95% at 300 Kev.
Gamma & X-ray sensitivity		10 Kev. through end window, 40 Kev. through case.

Nominal cpm/mR/hr for Cs-137: 1050

The RM-60/RM-70 and software are digitally locked to the tube. Each tube has passed all examinations, inspections, tests and calibrations of the LND Quality Assurance Procedures including DCAS MIL-Q985A, MIL-E-I and appendix B of 10CFR50. Calibration is accomplished in accordance with MIL-STD-45662. Sources for calibration and/or dose rates have calibration traceable to National Bureau of Standards.

The open area of the RM-60's stainless steel mesh is 72%. The tube is constructed of stainless steel, ceramic and mica. It is fused shut with molten glass by heating in a furnace. (See response graphs at end of manual).

LIMITED WARRANTY

Aware Electronics warrants the RM-60 to be free of defects in material and workmanship for a period of five years from the date of purchase provided the RM-60 has been handled with care (as one would handle a camera). (Note: The geiger-mueller tube sensor is warranted separately by the manufacturer for a period of six months.)

The remedy for breach of this warranty shall be limited to repair or replacement and shall not encompass any other damages, including but not limited to loss of profit, health, special, incidental, consequential, or other similar claims.

Aware Electronics Corp. specifically disclaims all other warranties, expressed or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose.

PLEASE NOTE: ***Except for the graphs on the last page, the remainder of the manual is included for the benefit of laymen users of the RM-60.***

COMMON SOURCES OF RADIATION

In addition to building materials and rocks, other, more radioactive sources commonly exist around the house. For example:

LANTERN MANTLES:

Lantern mantles from Army-Navy stores with Made in India on the bag, are made from silk impregnated with thorium salts. Thorium, a naturally occurring radioactive element, primarily emits alpha particles, although many of its daughter products emit high energy beta particles and gamma rays. It is a dangerous material and we suggest that you handle lantern mantles very carefully, particularly the ash, disposing of it in a manner that will prevent inhalation by you and others.

SMOKE DETECTORS:

Many smoke detectors contain Americium 241 in their sensing chambers. Americium 241 is a highly radioactive alpha emitter, normally made in nuclear reactors by bombarding plutonium with neutrons. Although smoke detectors are useful devices, Americium 241 is extremely dangerous. Therefore, do not dig out, prod, or otherwise disturb the ionizing chamber of a smoke detector.

CLOCKS AND WATCHES:

Old radium watch faces have numbers and hands painted with a radium salt/fluorescent mixture. Radium, and its daughter products are vigorous alpha, beta and gamma emitters. The alpha radiation from the radium causes the fluorescent material to glow-in-the-dark. This should not be confused with glow in the dark fluorescent mixtures that are activated after exposure to light. Radium watch faces are no longer manufactured. Although the quantity of radium in the paint is extremely small, radium, and its daughter products, are extremely dangerous, therefore handle any old radium watches with extreme care.

Newer, glow-in-the-dark watches, use tritium as a source of radiation. Tritium is a byproduct of nuclear reactors, produced when the hydrogen in the reactor's cooling water is bombarded by neutrons. Tritium has several industrial and military uses. It is a weak beta emitter, barely detectable with the RM-60. The weak beta particles cannot penetrate the face of the timepiece.

STATIC ELIMINATORS:

Some static eliminators, used to dissipate static electricity on plastic films and records, contain small amounts of radioactive polonium, a highly dangerous and vigorous alpha emitter.

The ionized molecules produced by the alpha bombardment, neutralize the static electricity. Polonium's halflife is 140 days, (half of its atoms decompose in 140 days). It is a daughter product of radium D (halflife, 22 years) both of which belong to the uranium 238 radioactive series.

GOLD JEWELRY:

Radium and radon are used to irradiate cancerous tissues in the medical profession. Gold is sometimes used to encapsulate these highly radioactive materials. Some improperly decontaminated gold has reentered the market in the form of jewelry.

GLAZING COMPOUNDS:

Uranium oxide is sometimes used as a glazing material for pottery and some types of jewelry.

GEMS:

Some gems have been treated in nuclear reactors, to enhance their color. The neutron flux transmuted elements in some gems, producing dangerous radioisotopes.

ANTIQUE COLORING:

Yellow uranium oxide was commonly used as a coloring agent in old glass articles and pottery.

BACKGROUND RADIATION:

Background radiation is the normal radiation we are exposed to 24 hours a day. An analogy of measuring background radiation is measuring a light rainfall with a rain gauge in which many drops add up to an accurate reading. Sources include cosmic rays from outer space and very small amounts of radioactive elements in building materials, soil, rocks, etc. The level of background radiation will swing over a certain range, over an hour's time. For example, if the average background level in your area is 12 microroentgens/hr., you will notice that for the majority of time your RM-60 will display an average reading of 12, but occasionally the average will rise about 3 to 5 microroentgens per hour, and at other times it will fall about 3 to 5 microroentgen/hr.

Average background radiation levels range from about 5 microroentgens/hr. to about 25 microroentgens/hr., depending upon the location and altitude. In a jet at 30,000 ft., background levels might reach about 300 microroentgens/hr. The average American is exposed to 100 to 200 milliroentgens per year.

A background level of 5 microroentgens/hr. X 24 hours per day X 365 days per year would yield a yearly average of 43,800 microroentgens per year (43.8 milliroentgens per year).

A background level of 25 microroentgens/hr. would produce a yearly average of 219,000 microroentgens per year (219 milliroentgens per year).

A typical chest X-ray might expose one to about 10 millirems (10 millirem approx. equals 10 milliroentgen), therefore, average background levels, over a year's period, expose one to a quantity of radiation equal to about 10 to 20 chest X-rays a year.

ELEVATED BACKGROUND RADIATION:

If you notice an unusual increase of background radiation in your area, the first thing to do is make sure the increase is not due to gamma rays from something that has been brought into the immediate vicinity of the RM-60, for example a large quantity of bricks used in an addition to your house, or a new concrete, tile or rock floor, etc. Place the back of the RM-60 flat against any such new potential source of radiation. If any happens to be radioactive, the monitor's reading will increase to a greater extent, the closer it is moved to the radioactive source.

After having ruled out any sources of radiation brought into the immediate vicinity of the RM-60, to account for the increase in reading, make sure the increase is not due to radon gas. Radon gas is very heavy, and would tend to collect in the lower areas of your house. The highly radioactive decomposition products of radon gas are solids and collect on dust particles. The dust particles collect on any air filter, therefore if you have any radon gas in your house, any air filters, such as furnace air filters, air conditioning filters, or air filters mounted over your stove, will become radioactive as air with radon gas passes through the filter (See "RADON GAS").

If the RM-60 cord is long enough, place the RM-60 outside through a window or door. If you still have an increase in radiation above your normal background radiation level, it is likely not due to radon gas collecting in your house. Barring a malfunction, an explanation for the increase in radiation could be contaminated atmosphere in which case you might want to call your local state agency such as your state emergency management agency, state department of natural resources, the NRC regional office, etc. Check your telephone book for emergency information.

RADIOACTIVITY IN BUILDING MATERIALS:

Many bricks, tiles, rocks, etc. are very slightly radioactive due to very slight quantities of uranium or thorium and their decomposition products (daughter products). Uranium and thorium release gamma rays as they decompose.

Slight radiation from bricks, rocks, tiles, etc. is not as dangerous as radioactive dust, in that while radioactive building materials expose you to gamma rays, floating radioactive dust can lodge or adhere to inner body parts (although see THORON GAS).

A house built of radioactive bricks, rocks, etc. can have elevated levels of radiation inside the house. The more radioactive brick, tile, rock, etc. used in the construction of the house, the more radioactive the house will be. The increased level can easily be detected with your RM-60. A house made of brick or rock can have radiation levels two, or three times higher than normal background radiation, which is equivalent to receiving an additional quantity of radiation per year of exposure, equal to perhaps 14 to 40 extra chest X-rays. Children are somewhat more susceptible to the damaging effects of radiation than adults.

RADIOACTIVITY IN FOODS, BEVERAGES AND OTHER ITEMS:

Levels of contamination generating an increase of perhaps 20 or so µR per hour will be immediately evident by way of higher readings next to food.

To check food or other items for lower levels of contamination, simply compare background reading to reading with item next to RM-60. For example, start PC collecting radiation data (Menu: "Capture" sub-menu "Display Current Input"). After several minutes, note average background reading at bottom right of screen. Next place RM-60 on-in box of fish, etc. and zero out (reset) average at bottom right of screen (Press F1 then Z). Wait a few minutes then note any increase in average as compared to background average. (Make sure when moving RM-60 to food, you are not also moving it closer to a radioactive item like a brick floor or wall).

There are many ways you could use the programs to detect very tiny levels of contamination (2 or so µR/hr.). One method is as follows. Place RM-60 on table. Start radiation file with added message "BACKGROUND". Run for 20 minutes or so then close file. Don't move RM-60. Place item to check on-around RM-60. Start new radiation file with message "WITH ITEM". Close this file after approx. 20 minutes. Repeat "BACKGROUND" and then "WITH ITEM" process several times, each time with a new unique file name. Now look at a summary of each file (Menu: Display/Edit/Clear Summary) and compare average radiation level of the BACKGROUND files to the WITH ITEM files.

To thoroughly analyze food or beverages for extremely low levels of contamination would take a lab full of very complex equipment. Nevertheless, your RM-60 can warn you of very low levels of radiation.

If you desire to measure even lower levels of radiation from substances such as edible items, you can increase your ability to distinguish a very small increase in reading from your RM-60, over and above fluctuating background radiation, by placing your RM-60 in a lead brick enclosure. The lead will block out all but the more energetic cosmic rays, cutting your background reading by about 50%. By placing the sample next to the back of the RM-60, within the lead shield, you will be able to distinguish very low levels of radiation. 4" x 8" lead bricks cost about $30 each. If you desire some lead bricks, contact Aware Electronics for current prices.

EFFECTS OF IONIZING RADIATION

Unlike radio waves, microwaves, infrared rays, and visible light, radiation from radioactive substances ionize materials they pass through, that is, radiation from radioactive substances split the molecules of materials they pass through, into charged particles. Ionizing radiation can cause the formation of free radicals. In addition, disruption of molecules by recoiling atoms, as happens with alpha bombardment, is also a factor.

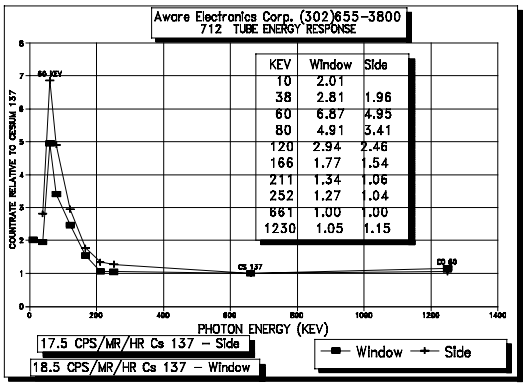
Radiation sickness results from extremely high doses of ionizing radiation, and is usually characterized by internal bleeding and various changes in tissue structure.

NOTE: Additional information is contained in the "readme" file. Read it with your text editor or with DOS by typing "TYPE README.TXT | MORE" or by typing it on your printer ("COPY README.TXT PRN"). Be sure to read it.

TEST OF RM-60 RAD. MONITOR TUBE

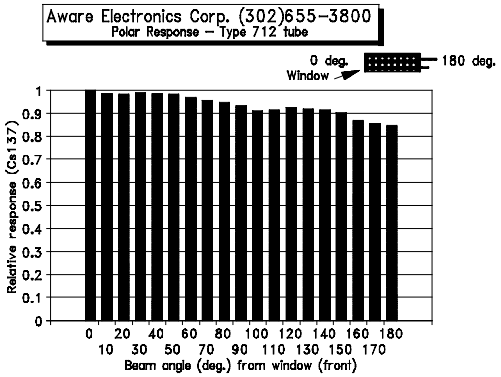
Tube Data: Type LND 712
Window: Areal Density: 1.5 to 2.0 mg/cm^2, Eff. Diameter: 0.360", Area: 0.102 Sq. In., Material: Mica

Wall: Thickness: 0.012", Eff. Length: 1.5", Eff. Diameter: 0.566", Material: 446 SS



Neutron Sensitivity With Pu-Be inclusive of Gamma Emission @ the given neutron flux:

Tube type 712:
0.7 CPS/Neutron/CM^2/SEC (Window)
1.0 CPS/Neutron/CM^2/SEC (Side)



The RM-60 and software are digitally locked to the tube. No analog adjustments are necessary. Each tube has passed all examinations, inspections,

tests and calibrations of the Quality Assurance Procedures including DCAS MIL-Q985A, MIL-E-I and appendix B of 10CFR50. Calibration is accomplished in accordance with MIL-STD-45662. Sources for calibration and/or dose rates have calibration traceable to National Bureau of Standards.

Tube calibrated to Cesium 137 +/- 5%.
ABS case material has flame retardant and threaded brass inserts. Size: 4.4" x 2.44" x 1.06"

TIME CODES and SPREADSHEETS ADDENDUM

Lets say you wanted to generate a spreadsheet using Aware Electronics data and a spreadsheet program, such as Lotus 123 (or Quattro-Pro, etc.).

First convert your Aware data file to an ASCII file and include the date-time code of "Seconds Since 1/1/70".

Next import this ASCII data file into Lotus (Tools, Import ASCII File, Comma Delimited).

The seconds since 1/1/70 00:00:00 is based on east coast time. For example a data-time of July 14, 1994 11:31:26 is equal to 774203486. To convert this number into Lotus-Quattro-Pro time-date serial number, subtract 18000 then divide by 86400 then add 25569.

You can perform the above arithmetic using Lotus 123. Lets say you imported a file into Lotus, as above, with three data points, each one minute apart. If the first point's date-time was July 14, 1994 11:31:26, the imported file would appear in the spreadsheet as follows:

	A	B	C
1	15	774203486	
2	18	774203546	
3	22	774203606	

Cell A1 contains the value of the first data point and cell B1 contains the time code. If you wanted to generate a Lotus style Date-Time serial number in cell C1, you could place the following code in cell C1:

```
((B1-18000)/86400)+25569
```

You could then copy C1 to the block of cells C2-C3. When you do this, Lotus will automatically increment the B1 cell reference. The result would look like this:

	A	B	C
1	15	774203486	34529.480162037
2	18	774203546	34529.480856481
3	22	774203606	34529.481550926

Now you could change the Numeric Format of the C column to a Date format and/or a Time format. You could then assign the C column to the X-axis in a graph (with the A column assigned to the Y-axis).

(Note: To save memory in your spreadsheet, you could convert the formulas in the C column block to their resulting values, or write a macro that would do all of the above, one row at a time).

(Also Note: When making graphs with a spreadsheet program, you may want to change the font size of the x-axis tick labels, and/or instruct the spreadsheet to use minor x-axis tick labels in conjunction with major tick labels, thereby providing more room for the x-axis date labels)

(Also Note: The Aware programs are written in Borland's Turbo C. Turbo C functions default to EST time zone (18000 seconds behind GMT). Turbo C library routines cancel out the time zone parameter, so all Date-Time representations within the Aware programs will display Dates and Times based on the time set in the computer, without regard to time zone or DST, but this is the reason why we subtract 18000, in the above formula, from the time code, for use within the spreadsheet).

ADDENDUM

Below is a wiring diagram showing a remote RM-60 connected to computer's serial port by way of 5000 feet of cable using only two leads. Since we have plenty of power from external power supply, we added a 1.2K ohm pull-up resistor. The pull-up resistor in RM-60 is 4.7K ohm, limited by the small amount of power available from computer's serial port. The additional pull-up resistor will add to the extreme noise resistance. A hefty silicon transistor inside the RM-60 (KN3904) pulls the signal line to negative with each count. It can dissipate 400 mw.

As regards the power supply, a good +9VDC, -9VDC power supply will work. These cost about $45. If you locate the power supply by the computer, and run an additional two wires out to the RM unit(s) to carry the +9VDC -9VDC, or if you use a lower quality power supply, you should add power supply filter caps. out by the RM unit(s). Two filter caps should be added, one between +9 and ground and one between -9 and ground. Use a cap. with good high frequency response for good slew rate, for example, 25 volt, 10 mfd. tantalum caps, or a combination of a smaller mfd. tantalum cap. and a 10 to 100 mfd electrolytic cap.

Current draw by each RM unit will be perhaps 2 ma, but with extremely high radiation levels, this could reach perhaps 10 to 20 ma. Instead of a power supply, you could use two 9 volt batteries to supply the power, along with the filter caps. as described above.

As regards cabling locations with multiple RM-60s,70s,80s,etc., you could connect all signal ground leads from multiple ports together so that each RM-monitor shares the same signal ground lead, allowing the use of only one additional wire for signal per RM-monitor so that, for example, 4 monitors would need a cable with 5 leads, namely four signal leads and one signal ground.

The serial ports meet RS-232 specs. so have built in safeguards. You could add a 26 volt MOV surge protector between signal ground and each lead from port. You might want to add a "TrippLite" "ISOBAR" surge suppressor, with 21 active electronic filtering components ($49.90) or a "TrippLite" battery backup system which includes the filtering components ($250), to your computer's power line. IF YOU HAVE ANY QUESTIONS, PHONE US.