SabreBPM Operations Manual

bladewerx™
Cutting-Edge Technology for Instruments and Measurement Applications

BLADEWERX

SabreBPM Operations Manual

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SECTION

1

Getting Started

The Parts of the SabreBPM

The SabreBPM consists of a fiberglass NEMA enclosure containing the SabreMCA™ electronics, battery and pump assemblies. A detector head, mounted to the right side of the case, contains the detector, preamp, and a filter holder. A foldable light stack containing an alarm beacon and red light is mounted to the left side of the case.

The enclosure is dust-tight and sheds water. Two plastic screws hold the front cover on. Opening the cover to should only be done by personnel in trained in hardware repair of the SabreBPM.

The front of the SabreBPM contains a touch-screen active-matrix QVGA display. The display should be operated using a stylus. A stylus holder and stylus are located on the left side of the unit behind the folding alarm stack.

There are three buttons located below the touch-screen display which allow the user to toggle displayed units and isotope channel, as well as an alarm acknowledge. There is a power switch on the right side below the detector head. The switch button is colored red to distinguish it from the other buttons found on the unit.

In addition to the SabreBPM itself, the package contains an AC Adapter for the SabreBPM, a flow calibration fixture (the mating half to the filter holder), and a software CD.

Charging the Batteries

Before the SabreBPM may be operated, the Lithium-Ion battery must be fully charged. The battery can be charged by plugging the AC Adapter into a wall socket (115 VAC only) and plugging the power into the connector at the lower right side of the case (seen in Figure

1). A Red/Green LED next to the connector indicates the charging state. When the LED is Red, the battery is being charged. When the LED is Green, the battery is charged and the charger may be removed. The charging time is approximately 3 hours.

NOTE: Two charge cycles may be required for completely discharged batteries. Simply unplug and re-plug the DC power plug to start a new charge cycle.

Important Notice Concerning Battery Charging

The SabreBPM has persistent registry settings that are saved in non-volatile flash memory thus keeping your program configuration settings intact if the battery is fully discharged. Also the SabreBPM program will be stored on a non-volatile SD memory card and will be restored and run once the power is restored to the unit. So after the battery is fully discharged all that is needed to restore the instrument to an operational condition is to reconnect the unit to AC power and allow the battery to charge again.

Turning the Unit On

With the battery fully charged, you are now ready to turn the SabreBPM on. A red switch located on side of unit below the detector head turns on the power to the SabreBPM.

After pressing the switch the battery will charge if it is not full and the SabreBPM program will execute.

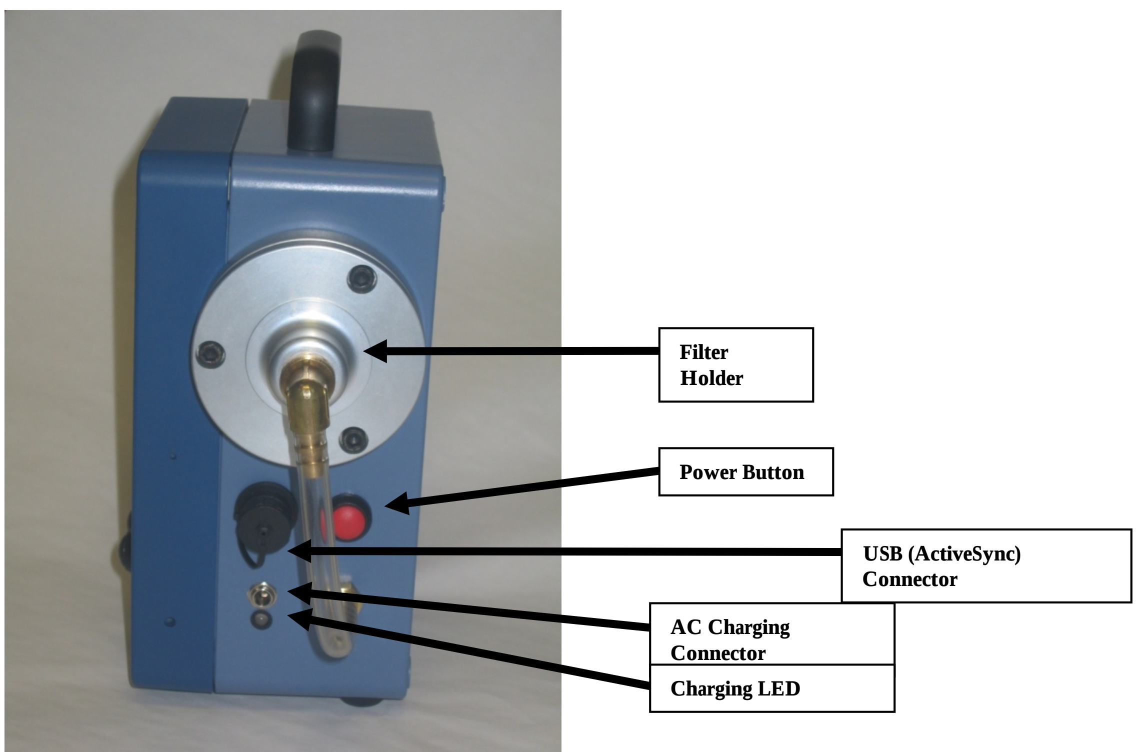

Figure 1

Setting up the Light Stack

The SabreBPM includes a retractable light stack to be used when radiological alarms have been enabled. The light stack is mounted on an elbow joint so that it can be elevated above the top of the unit and be visible from all angles. The Figures 2 and 3 show the direction that the elbow joint folds.

Figure 3

Figure 2

Adjusting the Sonalert Volume

The Sonalert, located at the base of the light stack, has an adjustable volume setting. To adjust the volume of the sonalert, twist the screen at the base of the light stack (shown in Figure 4), mechanically limiting its sound. After you swing the light stack up, as shown in the previous section, you twist the tabbed plastic screen on the stack base. To make the sonalert louder twist the screen counter-

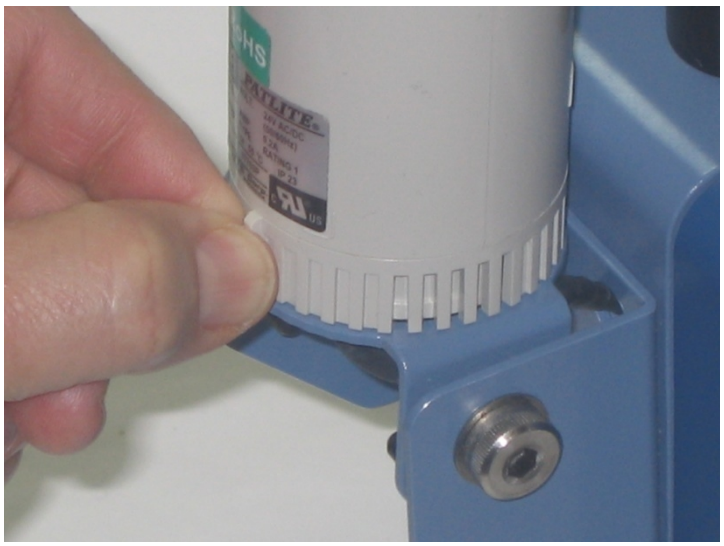

Figure 4

clockwise, allowing more sound from the horn. To make the sonalert softer, twist the screen clockwise.

Starting the SabreBPM Program

Under normal circumstances, the SabreBPM program will start automatically when the instrument is turned on, and remain in the program when the instrument is put to sleep and resumed. If there is a need to exit the program, it can be restarted from the desktop screen.

To start the SabreBPM program, remove the stylus from stylus holder on the side of the unit below the light stack and double tap the shortcut to the SabreBPM icon shown highlighted in Figure 5.

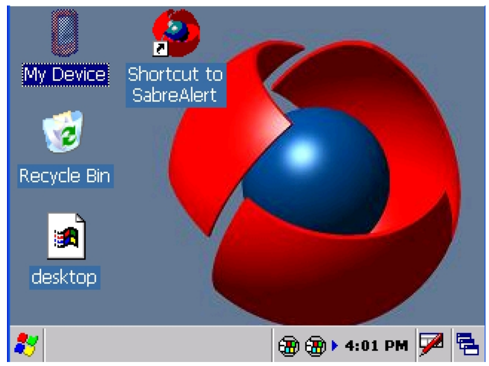

Figure 5

NOTE: Once the SabreBPM program is running, you will not be able to perform any other Windows CE operations like running other applications or changing display or network settings. To change any settings or run other applications, close the SabreBPM program first.

A fully-charged SabreBPM battery can power the unit for more than eight hours.

SabreBPM Clock

The SabreBPM is configured with a real-time clock which can be manually set or set automatically when connected via the USB port to a PC during ActiveSync data synchronization. Whenever the battery and external power are disconnected from the main processor board during maintenance or repair, the clock will be reset to a default date. The SabreBPM program will sense this condition and allow the operator to manually set the clock during startup as shown in Figure 6.

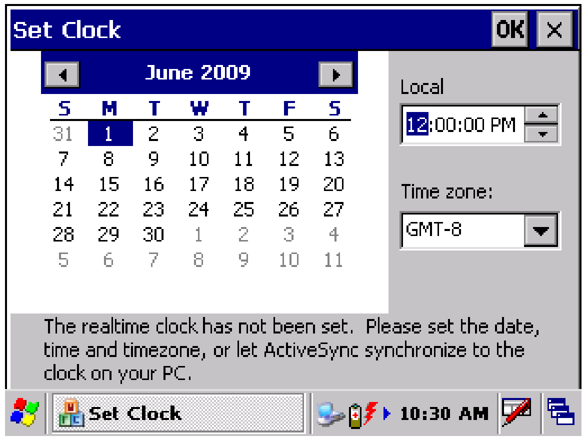

Figure 6

Password Authorization

The SabreBPM supports password security to prevent unauthorized users from changing the instrument calibration or configuration. By default, password security is turned off and all menus and functions are accessible by the user.

Password security may be enabled by the user. If enabled, none of the functions below will be accessible until the user is logged in from the *File—Login…* menu.

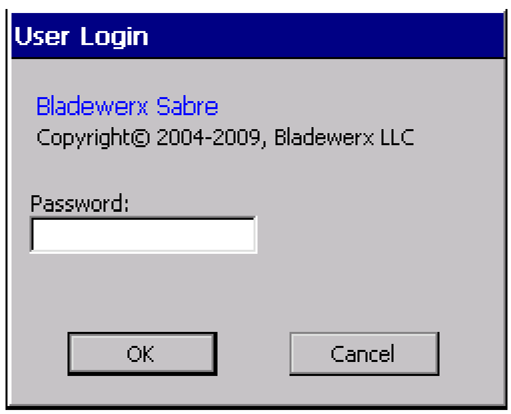

Figure 7

Note: The default passwords are **calib** for full access to the menus, and **config** for access to all but the calibration features.

Once logged in, the user will be able to change the password(s) through the *File—Security Options…* dialog. Be sure to record the new passwords in a safe place.

Response Check

The Response Check dialog (show in Figure 8) is the first screen to be displayed after starting the SabreBPM program. The Response Check function will be covered later in this manual. For now, and until the SabreBPM is fully calibrated, tap the Skip

button to skip the Response Check or wait for 60 seconds for it to time out and then automatically continue.

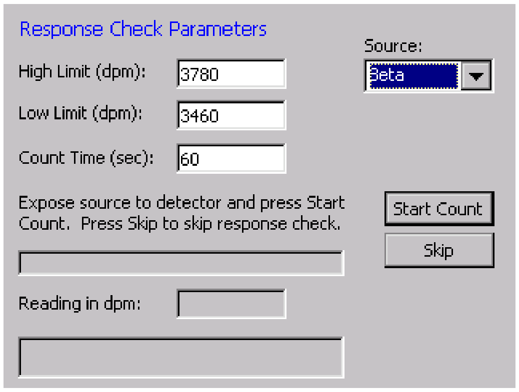

Figure 8

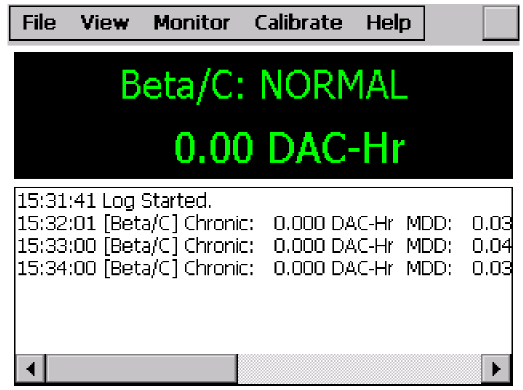

Figure 9

Figure 9 shows the basic display for the SabreBPM. It includes a digital meter display in the upper half of the screen and a log entry display in the lower half. The digital meter displays the current data and status of the selected channel. In Beta-Only mode, only the beta and flow channels are displayed. In Alpha-Beta mode, the alpha isotopes monitored by the SabreBPM are short-lived radon daughters: Po-212, Po-214 and Po-218; and up to two additional isotopes of interest. A suffix character is appended to the channel name to denote the detail of the reading: Acute (/A) or Chronic (/C).

Toggle the current channel displayed press the Channel button on the front of the unit. Hitting the Channel button will first toggle to active or chronic channel information then repeated presses will cycle through the channels (switching between acute and chronic info before cycling to the next channel or flow) starting with the chronic beta channel first.

Switching units displayed is done by hitting the Units switch this will toggle through units of activity and concentration (e.g. pCi, cps, DAC-Hr, DAC).

The log entry display in the lower half of the screen shows the list of Chronic readings for the beta channel, logged once a minute. Using the stylus you can use the scroll bars to move the list up and down, and also sideways to display additional information like the peak acute readings and minimum-detectable levels. Battery charge level is included at the end of the line in the log (e.g. "Batt.: 86%").

In addition to the log entry display, the user can also view the spectrum in the lower portion of the screen as in Figure 10 (under the View menu item).

A menu bar across the top left-hand portion of the screen provides access to the various configuration settings and other information. The menus will appear differently depending on whether the password security feature is enabled. These menu items will be covered in detail later in this manual.

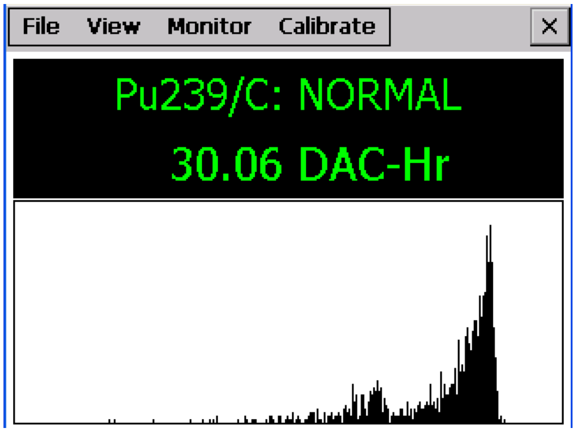

Figure 10

SECTION
2

Calibration

To maintain accurate measurements of beta dose and concentration, the SabreBPM must be calibrated periodically. There are both beta and alpha calibration steps. The purpose of alpha calibration is to insure that the peak-fitting algorithm knows where in the spectrum to expect the isotope peaks so that proper radon background subtraction of the beta channel is performed. The peak-fitting algorithm will fail (causing a POOR FIT status) and the instrument will fail to alarm properly if the radon peaks appear too far from the expected locations.

The calibration functions are accessed from the Calibration item on the SabreBPM menu. There are two types of alpha calibrations that can be performed on the SabreBPM. The first is called the "Automatic Alpha" calibration or the source calibration. The other type of calibration (Advanced) requires separate Alpha Energy, Alpha Efficiency and Beta Efficiency calibrations. The first step in the Automatic Alpha calibration is entering in the calibration source information. The source type and activity are entered in the Calibration Isotope Parameters dialog show in Figure 11.

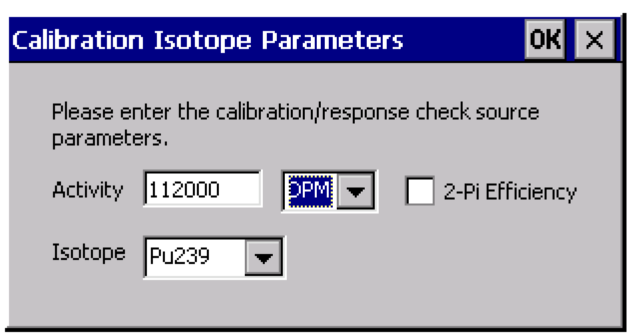

Figure 11

NOTE: The automatic alpha calibration routine calibrates from the isotope set in the Set Alpha Source dialog.

Entering the calibration isotope parameters separately enables the user to use a source isotope for the automatic alpha calibration and response check.

Typically the user will receive the instrument from the factory already calibrated to the conditions at the factory. Performing an "automatic" alpha energy calibration (with the calibration source isotope that was defined previously) will line up the energy channels based on the altitude, temperature and humidity of the local environment. In special applications a user may want to customize all of the energy calibration parameters. These applications will require the user to perform manual energy/efficiency calibrations and flow calibration from the advanced menu.

Automatic Alpha Energy Calibration

The automatic alpha energy calibration is designed to make on-site alpha energy calibration quick, easy, and accurate. This calibration mode will adjust the offset parameter in the MCA and the energy channels of the radon isotopes to compensate for a shift of the spectrum due to local temperature and pressure—keeping the spectrum in approximately the same position as the factory calibration. To start the Automatic calibration tap *Calibration – Automatic Alpha…* **on the menu. Then the dialog show in Figure 12 will be displayed.**

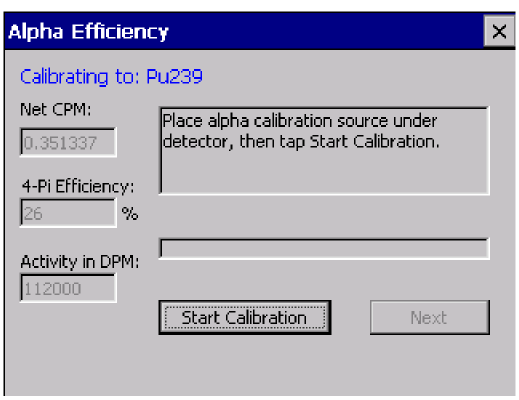

Figure 12

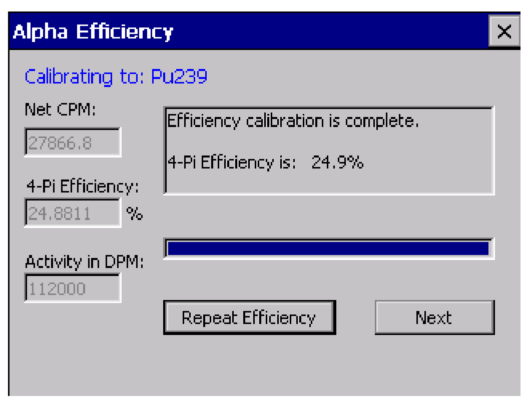

Figure 13

Insert the source defined as the Alpha Source and tap *Start Calibration*. **The calibration routine will calculate the alpha efficiency and display the efficiency results as in Figure 13. Then hit** *Next* **to go to the Calibrate Energy step shown in Figure 14.**

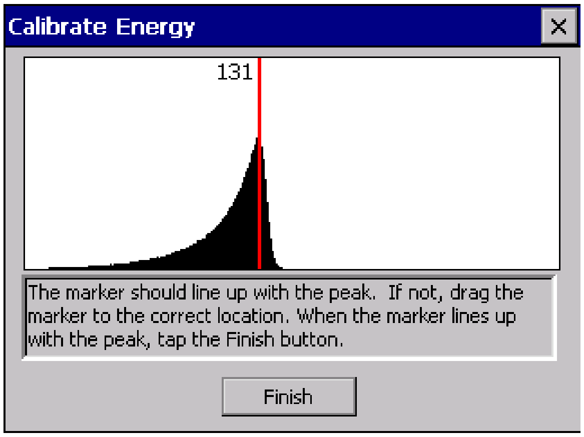

Figure 14

After the peak fitting lines up a peak channel to the selected source isotope the spectrum and peak channel information will be displayed in the dialog in Figure 14. Your job is to make sure that the fitted channel lines up to the peak displayed by the spectrum. If the peak channel does not line up then drag the red marker over the actual peak channel. Once the peak channel is lined up select *Finish* if you wish to save the offset and peak channels from the calibration you just performed. If you select to save the new settings, the offset and peak channels will be adjusted to compensate for the new attenuation at your location.

For most users this will be sufficient to calibrate the instrument to your location. But if you need access to all of the calibration parameters select the Advanced—Alpha Energy… menu item shown in Figure 14.

Manual Energy/Efficiency Calibration

NOTE: When performing a manual calibration, the Pu-239 energy calibration step should always be performed before doing the alpha or beta efficiency calibrations.

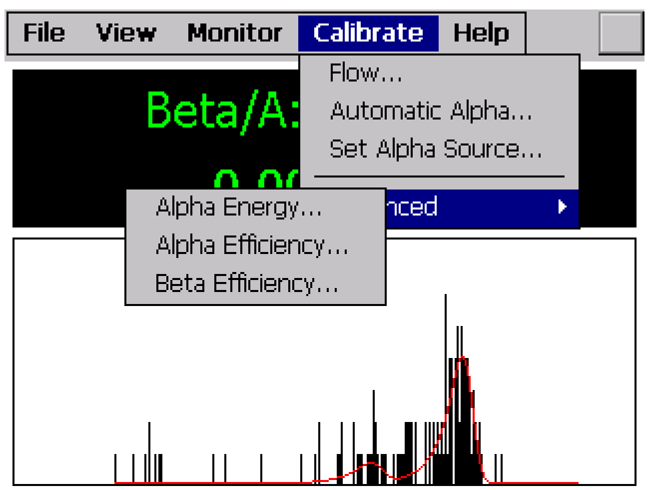

Figure 15

Advanced Alpha Energy/Efficiency calibration consists of:

- **Setting the position of the Pu-239 peak with a calibration source. This typically requires adjusting only the offset and the peak locator. The threshold, gain, and scale do not normally require adjustment.**

- § **Adjusting the position of the Po-212, Po-214 and Po-218 radon daughter peak locators.**
- § **Determining the counting efficiency to an alpha calibration source.**
- § **Running the SabreBPM with filter in place for four to eight hours so that a radon daughter spectrum is accumulated in order to confirm the radon daughter peak locator positions.**

To begin the alpha energy/efficiency calibration, tap *Calibrate – Advanced – Alpha Energy…* **on the menu. The Alpha Energy Calibration dialog in Figure 16 will be displayed showing the alpha energy calibration settings and a window of the spectrum.**

Internally, the SabreMCA utilizes a 1024-Channel discriminator, whose output can be translated to the 256-channel MCA output through four configuration settings. The four fields at the top of the screen, Gain, Thresh, Offset and Scale, control the translation of the SabreMCA discriminator output and affect the location, width, spacing and offset of isotope peaks on the 256-channel spectrum. These values are stored permanently on the SabreMCA board and in most cases do not need to be changed from the factory settings. Changing any of the four values will result in new values being permanently stored on the board.

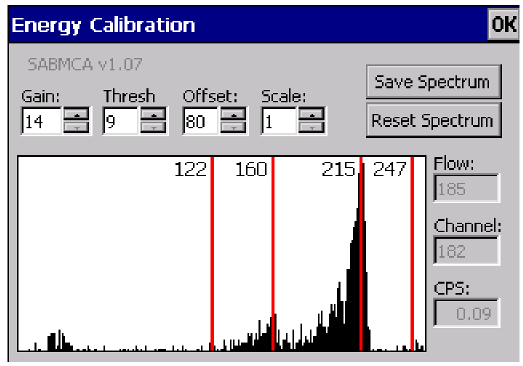

Figure 16

Gain—(Range 1 to 31) This value controls the amplitude of pulses coming from the detector. Increasing the gain broadens isotope peaks, shifts them to the right, and spreads individual peaks further apart. As the Gain is increased, the peak(s) can be shifted completely off the right end of the spectrum display. Shifting to the next Scale will bring the peaks back into view on the spectrum. ***Default Gain is 14 and should not normally be changed.***

Thresh—(Range 1 to 31) This value controls the amplitude threshold that pulses must exceed to be measured. It should be set just above the level where the amplifier noise is first observed. ***Default Threshold is 9.***

NOTE: As Gain is increased, the noise amplitude will increase proportionally, requiring a compensating increase in Threshold level.

Scale—(Range 0 to 2) This value controls the binning or compression of the 1024-channel discriminator output into the 256-channel spectrum value. A value of zero results in no compression. A value of one does 2::1 compression, binning 512 channels of the discriminator output into 256 spectrum channels. A value of two does 4::1 compression, binning all 1024 channels of the discriminator output into 256 spectrum channels. ***Default Scale is 1 and should not normally be changed.***

Offset—(Range 0 to 255, Resolution 8 channels) This value shifts the 256-channel spectrum the defined number of channels to the left. It is related to the Scale setting by controlling the 256-channel window on the scaled discriminator output. If the Scale is zero, the Offset will allow the output of any consecutive 256 channels, from discriminator channel 1 to channel 512. If the Scale is one, Offset will allow the display of any 512-channels over the 1024-channel discriminator range (binned down to 256 spectrum channels). If the Scale is two, the Offset has no effect and the entire 1024-channel discriminator output is compressed 4::1 to the 256-channel spectrum. *Default Offset is 80.*

Alpha Spectrum Display

The lower half of the display shows the current alpha spectrum from channel 0 through channel 255. The vertical scale adjusts automatically to display the highest peak.

The red lines identify the locations of the fitted isotopes. Depending on the operating configuration of the SabreBPM, up to five lines may be visible. Typically there are zero, one or two isotopes-of-interest, and the Po-218, Po-214 and Po-212 radon-daughter peaks. In radon mode, a peak marker for Po-210 will also appear. The numbers at the top of each red line correspond to the channel number that the line identifies as the peak location. It is necessary to know the alpha energy of each peak to be able to associate each peak marker.

NOTE: In the Advanced Alpha Energy Calibration dialog, when configured for Alpha-Beta mode, the lowest marker(s) are associated with the isotope(s)-of-interest. There will be no marker associated with the selected calibration source unless that source isotope matches one of the isotopes-of-interest.

SabreMCA Calibration

Begin the alpha energy calibration by removing the filter holder and placing a Pu-239 source in front of the detector so that the peak builds up just below mid scale. If an adjustment is necessary, you may reset the spectrum by tapping the *Reset* button so that changes to the Offset or Gain may be observed more accurately. The Gain, Threshold, Offset and Scale settings interact such that the Pu-239 peak is below mid-scale and the Po-212 peak (8.78 MeV) is fully visible just below max scale. In most cases, the default values for Gain, Threshold, and Scale should not be changed from the defaults listed previously.

Peak Location Adjustment

Adjust the offset setting so that the Po-218 peak is as close as possible to channel 156. Note that the offset setting can only be adjusted to multiples of eight (e.g. 72, 80, 88, etc.).

Peak location is performed by adjusting the red lines on the spectrum display to coincide with the actual peak locations. Move the lines by tap-and-holding the stylus on the line until a circle of red dots appear, then dragging the line to the new location. If operating in Alph-Beta mode, set the lower reference line(s) on the spectrum to coincide with the isotope(s)-of-interest. Set the upper three reference lines to coincide with the Po-214, Po-218 and Po-212 peaks mathematically as the Pu-239 peak location plus 38 and plus 100.

Typical values are Pu-239 in channel 130, Po-218 in channel 160, Po-214 in channel 226, and Po-212 in channel 248. In radon mode, Po-210 will fall approximately in channel 140.

When the red peak locating lines have been set, tap the *Ok* button to exit the alpha energy calibration dialog. A prompt will require confirmation of the changes at which time the peak locations for peak-fitting are saved on the SabreBPM and the MCA configuration settings are saved on the SabreMCA.

Tapping the *Save Spectrum* button will save the spectrum in the \My Documents\ folder under the name "EnergyCalSpectrum.csv".

Alpha Efficiency Calibration

To begin the efficiency calibration, tap *Calibrate – Advanced Alpha* -- *Efficiency…* on the menu. The Alpha Efficiency Calibration dialog will be displayed showing the current efficiency.

To perform the efficiency calibration, a stainless steel alpha source of active diameter of 1.00 inch should be used (the same as the filter collection area diameter that is provided by the filter mask). A source of at least 10,000 dpm should be used for the calibration. The isotope should match the Alpha Source.

Enter the source activity in dpm into the *Activity in DPM* edit field.

Now, place the source in front of the detector, maintaining its distance from the detector the same as the distance of the filter from the detector. The filter mask and source should be centered on the detector.

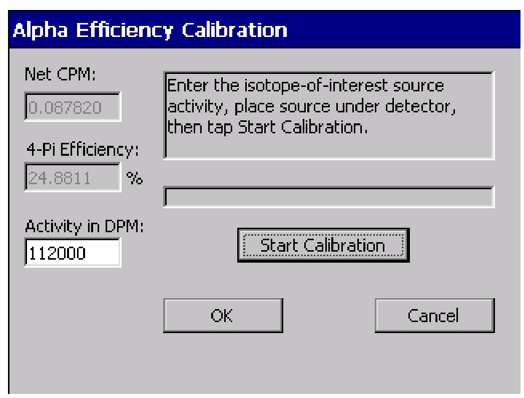

Figure 17

Tap the *Start Calibration* button to start the measurement. The routine will perform a count, peak-fitting just the counts under the isotope-of-interest peak (if Pu239 is the calibration source of interest Am-241 in-growth is ignored), and display the Net CPM and calculated 4-Pi Efficiency. When the count completes, the final calculated efficiency will be displayed. Depending on the source quality and active area, an alpha efficiency between 22 and 30% should be expected.

Repeat the calibration if desired or remove the source and tap *Ok* to close the Efficiency Calibration dialog, responding to the confirmation prompt to save the new setting.

Confirm Radon Peak Locations

Remove the source, replace the filter holder (with a filter in place) and let the SabreBPM accumulate a radon spectrum so that the Po-218, Po-214 and Po-212 peaks are easily identifiable.

To confirm the radon peak locations (which were set previously mathematically relative to the Pu-239 peak location), reset the spectrum and start a four- to eight-hour radon spectrum accumulation.

Note: It is very important to reset the spectrum prior to starting the new four-to-eight hour radon spectrum accumulation. This will allow the best viewing of new radon daughter counts.

The entire Po-212 peak should be visible and appear just below the upper end of the spectrum. Adjust Po-218, Po-214 and Po-212 peak locators to match the actual peak locations.

Beta Threshold Settings

The SabreBPM has three settings that control the beta detection hardware sensitivity; they are controlled by three manually adjustable potentiometers. These internal hardware adjustments must be made before performing the beta efficiency calibration. See Figures 18 & 19.

The first potentiometer (R15) controls the lower threshold for the beta channel. This setting defines the threshold between noise and the beta pulses and should be set to maximize the figure-of-merit value so as to optimize the beta signal-to-noise ratio.

The next setting (R11) controls the maximum threshold for the beta channel. This setting defines the threshold between beta pulses and the larger alpha pulses. Any pulse above this threshold *will not* be counted as a beta pulse.

The third setting (R18) controls the high voltage used to bias the beta-sensitive detector. It allows the bias voltage to be adjusted between zero and 120 volts DC.

The beta and alpha thresholds are easily reachable by removing the two retaining screws from the rear cover of the SabreBPM electronics enclosure and sliding the beta counting board out until the appropriate potentiometer is exposed. The beta and alpha threshold pots lie near the rear edge of the board and can be adjusted by sliding the board out about an inch. By using a small screwdriver you can set the pots.

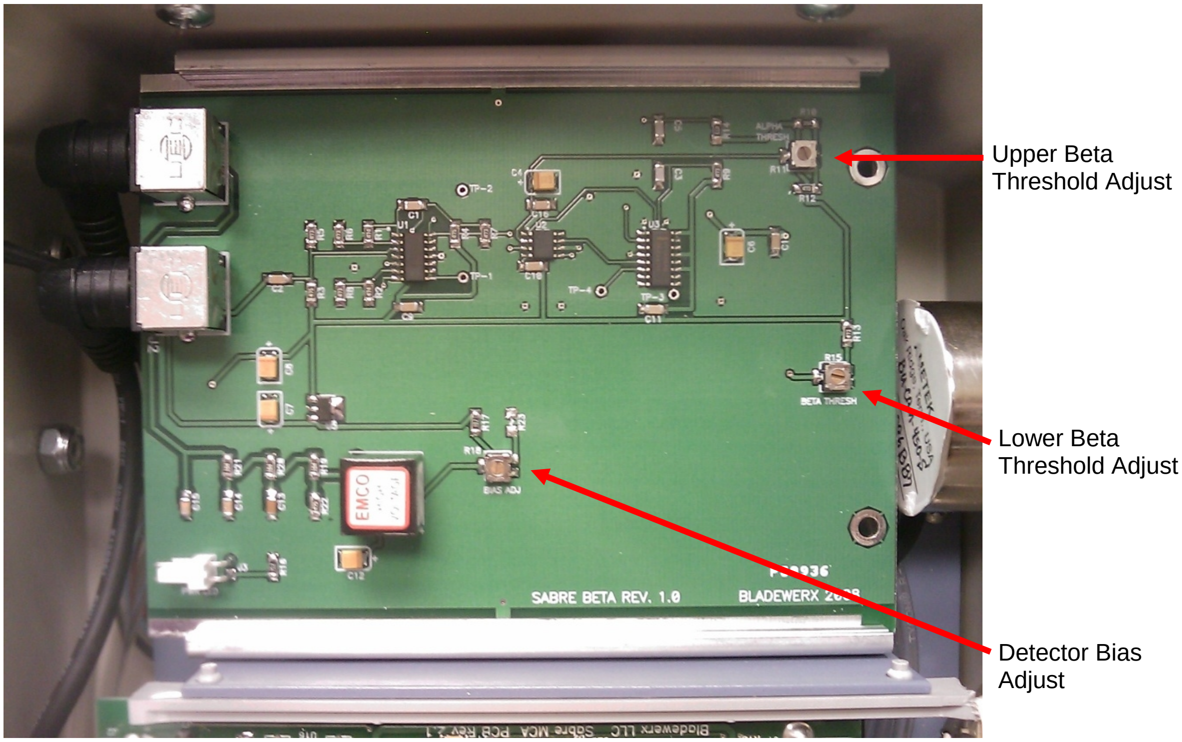

Figure 18 - Accessing the Beta board

The detector bias adjustment is located near the right edge of the board. Detector bias is typically set from 70 to 120 VDC and rarely requires adjustment from factory settings.

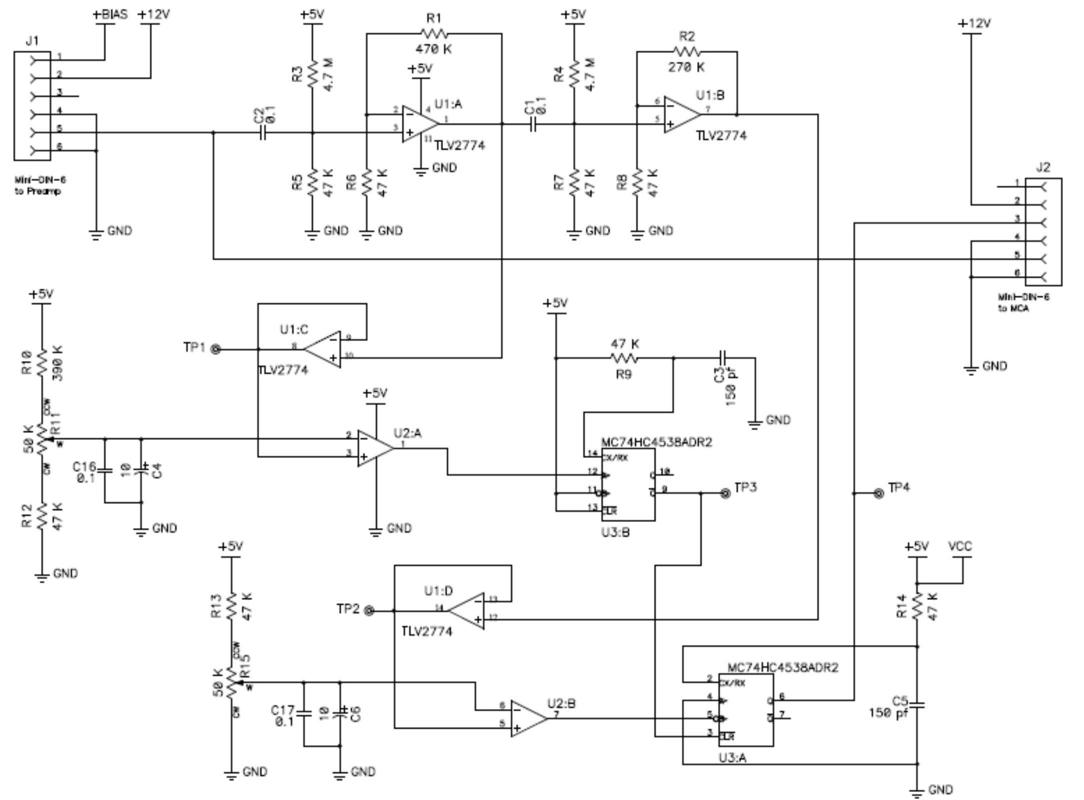

Figure 19 - Beta board schematic (logic)

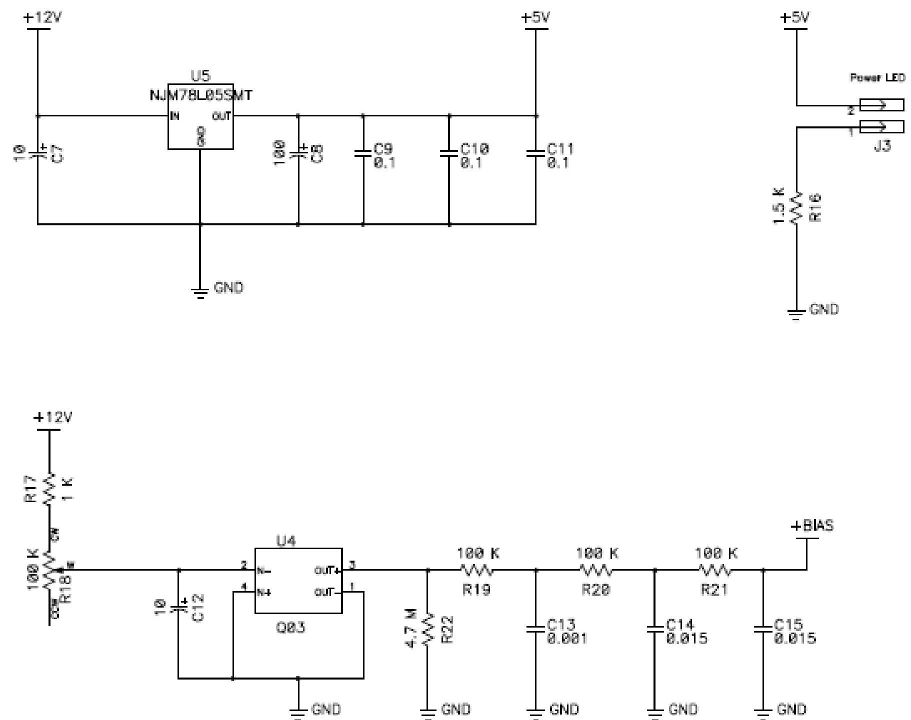

Figure 20 - Beta board schematic (power supplies)

Optional Guard Detector Thresholds

A second Beta board is included in instruments with the optional guard detector. These controls are identical to the three settings that control the beta detection hardware sensitivity, but instead, control the thresholds for counts from the guard detector. These hardware adjustments must also be made before performing the beta efficiency calibration. The alpha threshold should be set to its maximum, and the beta (i.e. guard) threshold should be set to show approximately the same background count rate as the beta channel. This count rate will be displayed in place of the Background CPM field.

Beta Efficiency Calibration

To begin the beta efficiency calibration select the *Calibrate—Advanced—Beta Efficiency…* **option from the menu. To perform the beta efficiency calibration, use a calibrated certified traceable beta source. A source of at least 3,000 DPM should be used for the calibration.**

First it is necessary to perform a count to determine the level of background beta activity in your environment. This gives the SabreBPM a background beta or guard detector reading to subtract from the gross beta readings, making the beta count more sensitive. For the background count make sure the sample collection tray is empty and uncontaminated. Then hit "Start Calibration" which will perform a 10 minute background count shown in progress in the screen capture below. If a guard detector is installed, the appropriate guard factor is calculated and stored on completion of the background count.

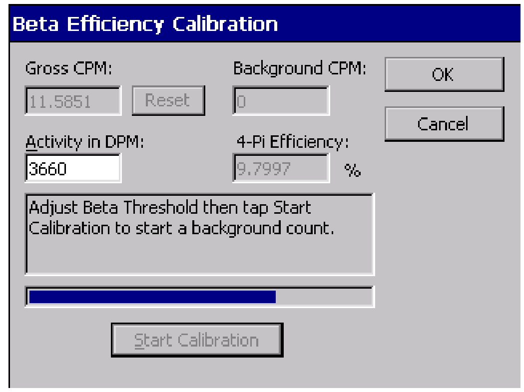

Figure 21

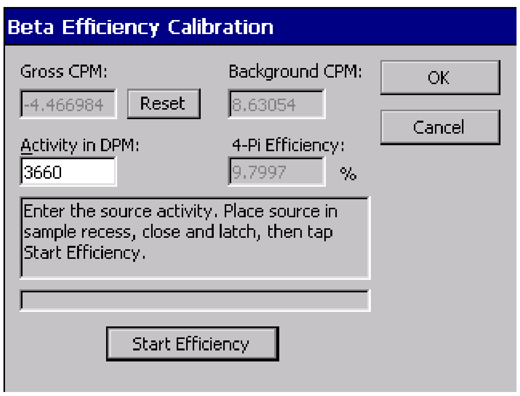

Figure 22

Next enter the level of activity for the Beta source in DPM/Bq in the "Activity in DPM/Bq" text entry, then place the source in the sample counter, making sure that the surface of the source is as close as possible to the position of the surface of the intended samples, and close it.

After entering the source, hit "Start Efficiency" to start the beta calibration process.

Next the SabreBPM will count the beta source, shown in progress below.

After the beta source count is complete the SabreBPM will display the 4-Pi efficiency in percent of activity of the real activity level. The efficiency should be in the range of 4-20% efficiency of the true activity, depending on the maximum beta energy (higher energy beta isotopes produce higher efficiencies. An efficiency result out of range could be the result of an improperly set beta or alpha threshold.

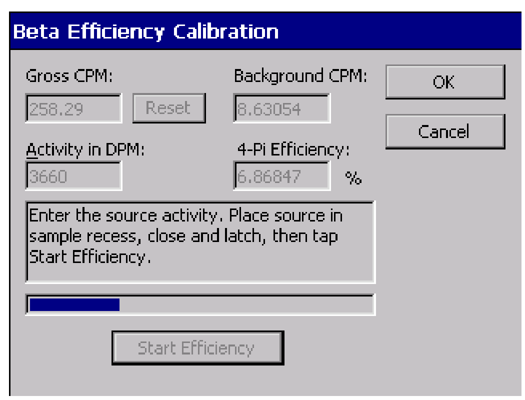

Figure 23

Flow Calibration

The SabreBPM sample flow is estimated by monitoring the pump current. As the pump works harder, the pump current increases. The SabreBPM program monitors the current and converts the current into a flow. This relationship is *not* linear. As a result, a three-point flow calibration is used, with validation at a fourth flow rate.

Setup:

This procedure requires the following:

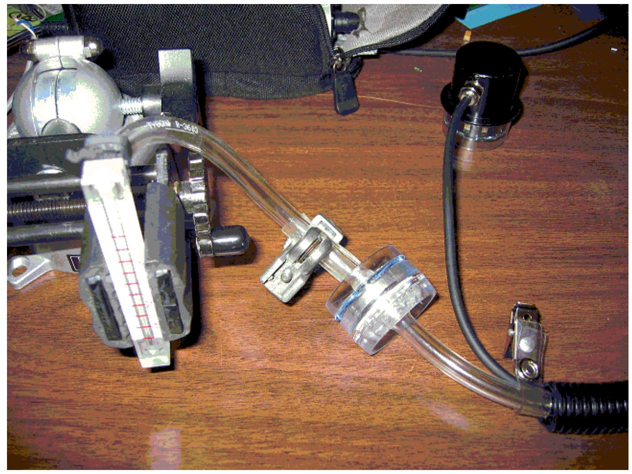

Figure 24

- Rotameter 0 – 5 LPM
- Tygon tubing
- Variable Restriction device (i.e. clamp, needle valve)
- Flow calibration fixture consisting of the mating half to the Millipore filter holder

Turn the SabreBPM off, open the filter holder, remove the filter, and carefully lay the filter holder to the side, being careful to protect the exposed face of the detector. Plug the provided flow calibration fixture into the filter holder assembly. Using Tygon tubing, connect the mating filter holder portion to the rotameter with the variable restriction device between the filter holder and the rotameter, as shown in the above photo.

NOTE: Ensure that the variable flow restriction does not completely cut off the airflow to the pump. The pump is not designed to operate at zero flow and the high vacuum could damage the pump diaphragm.

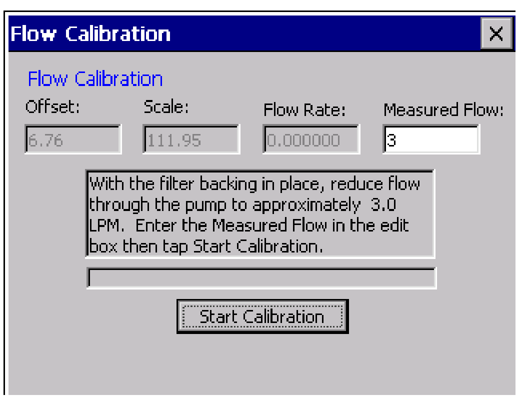

Figure 25

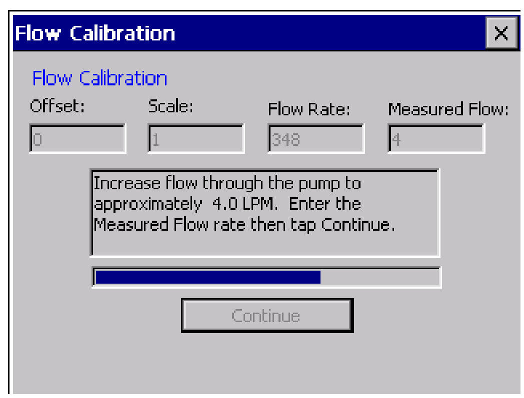

Figure 26

Three Point Flow Calibration

Turn on the SabreBPM, start the SabreBPM program, and enter the Flow Calibration routine. Adjust the variable flow restriction to the value prompted, enter the actual flow reading from the rotameter into the Measured Flow box (Figure 25), and tap the *Start Calibration* button.

When prompted, adjust the variable flow restriction to the value prompted, enter the actual flow reading from the rotameter into the Measured Flow box (Figure 26), and tap the *Continue* button.

When prompted, adjust the variable flow restriction to its full open position providing maximum flow, enter the actual flow reading from the rotameter into the Measured Flow box (Figure 27), and tap the *Continue* button.

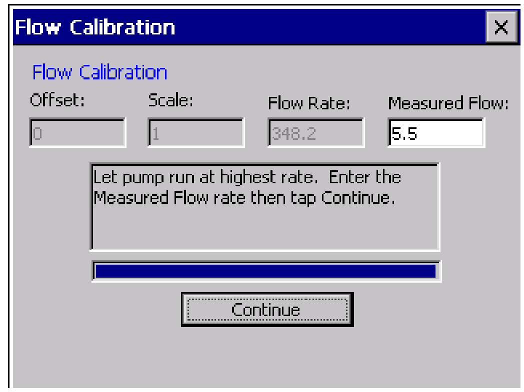

Figure 27

Validation of Flow Calibration

When prompted, adjust the variable flow restriction to the value prompted, enter the actual flow reading from the rotameter into the Measured Flow box (Figure 28), and tap the ***Validate*** button.

Calibration is complete at the conclusion of the validation step (Figure 29) and can be repeated if desired. Otherwise tap *OK* and a confirmation dialog will allow the new settings to be accepted and saved, or rejected.

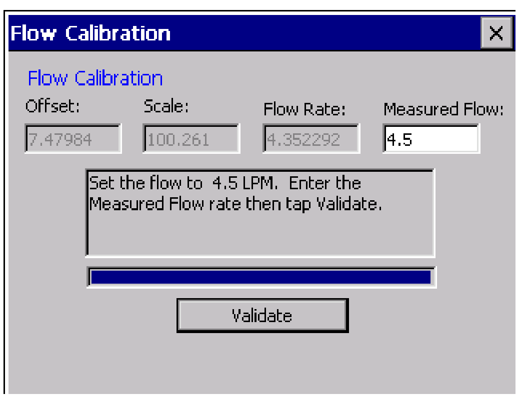

Figure 28

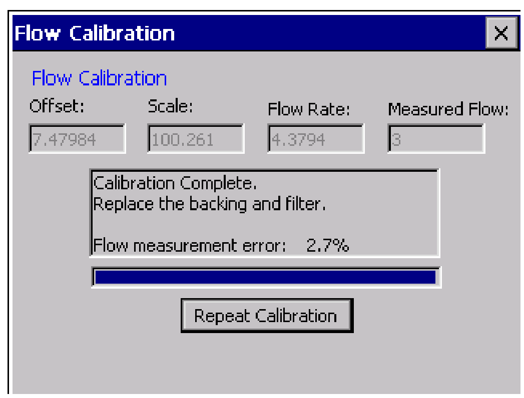

Figure 29

Reassemble the Detector Head

Remove the calibration fixture from the filter holder, replace the filter (if it fell out) and firmly press the filter holder to the detector head, setting the latches to lock it in.

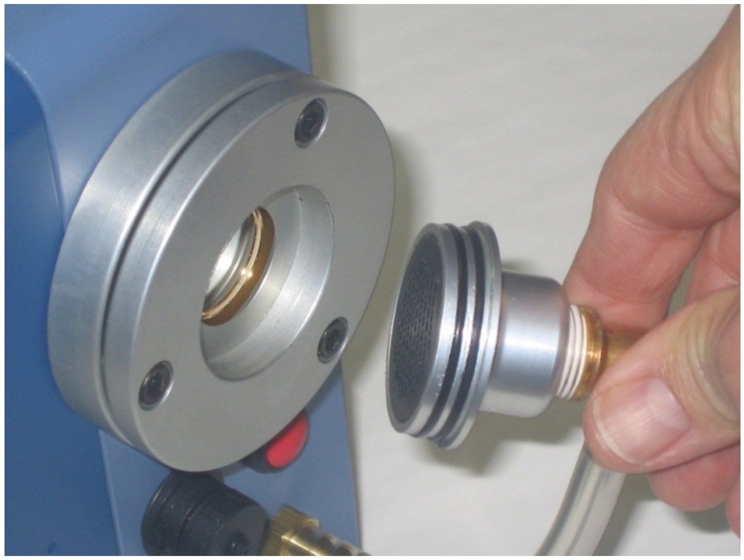

Figure 30

Calibration Expiration

The SabreBPM program keeps track of the last time the energy calibration was performed and will take the unit out of service if one of two conditions is met:

- **A user-defined number of days since the last calibration have elapsed. *Default is 365 days.***
- **The unit has exceeded the user-defined number of hours of run-time since the last calibration. *Default is 8800 hours.***

When the calibration expires, the SabreBPM display will indicate OUT OF CAL**.**

SECTION

3

Configuration

The SabreBPM program provides several dialogs to allow configuration of the instrument operation. These dialogs are accessed through the *File* and *Monitor* menus at the bottom of the screen. Each dialog and its property settings are described below.

User Interface Properties

This dialog controls the operation of the of the user interface aspects of the program. Tap the *File – Properties…* menu item to access the Instrument Properties dialog in Figure 31.

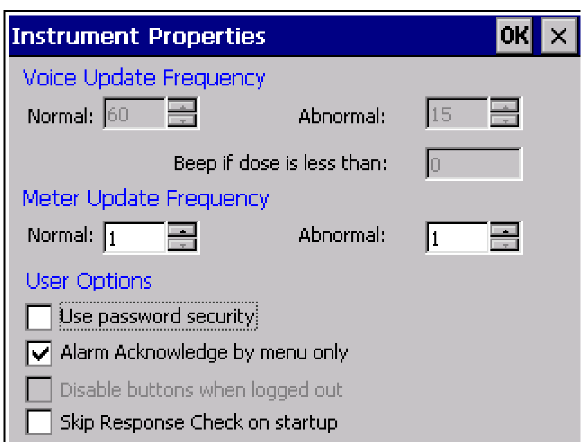

Figure 31

Voice Update Frequency

Voice output is not implemented in the SabreBPM so the settings are disabled. **The** *Normal* **and** *Abnormal* **settings control the frequency with which voice annunciations are made. While the instrument is in a normal status condition, the voice annunciation of the reading will**

occur at the interval specified by the *Normal* setting. Units are in seconds. *Default is 60 seconds.*

Any abnormal condition will cause voice annunciations to occur at the more frequent interval specified by the *Abnormal* setting in seconds. *Default is 15 seconds.*

Meter Update Frequency

The *Normal* **and** *Abnormal* **settings control the frequency with which the meter display is updated. While the instrument is in a Normal status condition, the meter display of the reading will occur at the interval specified by the *Normal* setting. Units are in seconds. *Default is 1 second.***

Any abnormal condition will cause meter updates to occur at the more frequent interval specified by the *Abnormal* setting. *Default is 1 second.*

User Options

The *Use password security* **option provides a method of disabling certain calibration and configuration functions unless the user has entered an acceptable password. Two password levels are supported: calibration and configuration. The calibration level allows access to all menus and features, while the configuration level provides access only to alarm settings and other non-calibration-related functions. *Default passwords are: calib for calibration, and config for configuration.***

The *Alarm Acknowledge by menu only* **check box, when checked, required that alarms are acknowledged and cleared only from the** *Monitor – Acknowledge Alarm* **menu selection. When unchecked, alarms may be acknowledged and cleared either from the menu, or by pressing the large Ack button on the face of the SabreBPM. Pressing the Alarm Ack button once silences the alarm. Pressing it a second time clears the alarm.**

The *Disable buttons when logged out* **setting prevents the use of the front panel buttons by unauthorized users.**

The *Skip Response Check on startup* **setting allows unattended startup. When this setting is active, the Response Check can only be performed from a menu command.**

Instrument Options

The Instrument Options dialog controls the functional behavior of the SabreBPM. Access the dialog from the menu by tapping *Monitor – Instrument Options…* The dialog consists of five pages of settings and information: a General page, a Logging page, an Isotope page, a Flow page, and a RadNet page. Each page is accessed by tapping the corresponding tab at the bottom of the dialog.

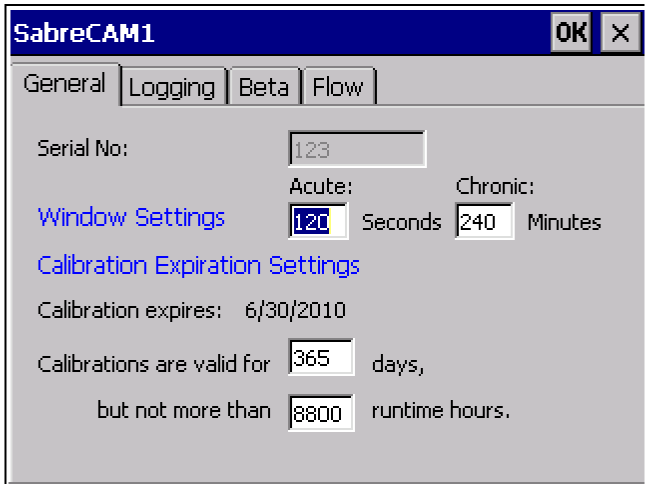

Figure 32

General Page

Serial No—This is a *non-editable* field that identifies the factory-defined serial number of the SabreBPM. *Default: Factory set*

Window Settings

Acute Window—This setting defines the count time used to determine the Acute Dose, NetCps and Activity. It should be set to provide the fastest response to high concentration spikes of a pre-determined level. Shorter times mean higher minimum-detectable levels but do not necessarily mean faster response times. Some experimentation may be required to achieve a desired alarm level and response time. *Default is 120 Seconds.*

Chronic Window—This setting define the count time used to determine the Chronic Dose, Concentration, NetCps and Activity. Longer times provide better sensitivity and lengthen the dose integration time. *Default is 240 Minutes.*

Calibration Expiration Settings

Calibration expires—This non-editable item displays the latest date on which the SabreBPM calibration will expire. The expiration could occur sooner if the maximum runtime hours are exceeded.

Calibrations are valid for XXX days—This field sets the maximum number of days between calibrations. *Default is 365 days.*

But not more than YYY runtime hours—This field sets the maximum number of hours of SabreBPM runtime between calibrations. *Default is 8800 hours.*

Logging Page

The *Logging Interval* settings control the data logging behavior of the SabreBPM. Several types of log files are created on the SabreBPM during operation. See *Retrieving and Analyzing the Data* **for more information on the log files.**

Log Acute readings every—This setting controls the frequency which Acute readings are written to the Pu239_AcuteYYYYMMDD.txt file. ***Default is 15 Seconds.***

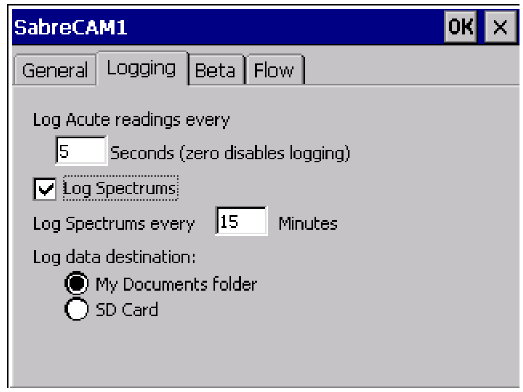

Figure 33

Log Spectrums—This setting controls whether spectrum snapshots are written to a log file (SpectrumYYYYMMDD.txt). If the setting is checked, the Log Spectrums frequency field will be enabled. ***Default is Spectrum Logging is ON.***

Log Spectrums every…—This setting defines the frequency in minutes that spectrums are time stamped and logged. Each spectrum filename created has the format SpectrumYYYYMMDD.txt, where *YYYY* represents the creation year, MM represents the month, and DD represents the creation day. ***Default is 10 Minutes.***

Log data destination

This selection defines the location where SabreBPM data will be saved.

My Documents folder—This setting saves log files in the My Documents folder. *This is a volatile folder that will be erased in the event of a complete battery discharge or loss of battery power.* ***Default is the My Documents folder.***

SD Card—this setting causes log data to be saved to the non-volatile SD memory card in the SabreBPM. ***Note: data saved to the SD Card is accessible from an attached PC/laptop, but data is not automatically synchronized with the PC as are files in the My Documents folder.***

Beta Page

This page defines the parameters concerning the measurement of and alarming on the net beta reading. It supports both a fixed beta background, and the use of a guard detector for real-time subtraction of gamma interference.

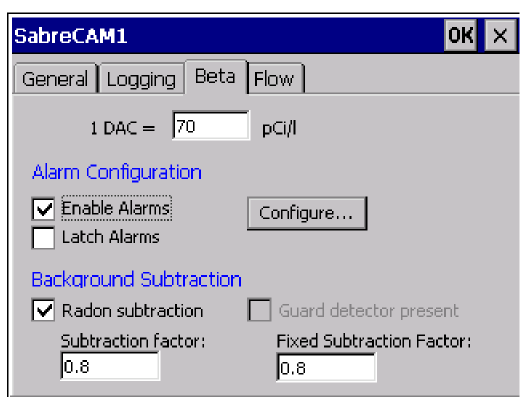

Figure 34

DAC Constant—This setting defines the conversion constant to convert from Pico-Curies per liter to DAC, defined by 10CFR835. Note that the constant uses units of Pico-Curies per liter to avoid the need for scientific notation. ***Default is 100 pCi/liter/ DAC.***

Radon subtraction—This setting controls whether counts due to beta-emitting radon progeny are subtracted from the beta reading. When set, the alpha activities of the radon/thoron progeny, determined by alpha spectroscopy, are used to estimate the beta activities of the progeny. Counts proportional to the estimated beta activity are then subtracted from the gross beta rate to determine the net beta rate. *Default is selected.*

Subtraction factor—This parameter is multiplied by the calculated radon/thoron beta activity to produce the value subtracted from the gross beta rate. Because the beta counting efficiency is dependent on the beta energy, the radon/thoron betas will have a higher or lower efficiency than the beta calibration efficiency. *Default is 1.0.*

Guard Detector Present—This checkbox is selected if the SabreBPM is factory–configured with a guard detector. It is not user-editable.

Fixed Subtraction Factor—This setting controls what portion of the fixed beta background (or guard detector) count rate is subtracted from the gross beta count rate. Tthe fixed background rate is determined during the beta efficiency calibration. *Default is 1.0.*

Alarm Configuration

Enable Alarms—This checkbox controls the checking for and annunciation of alarms for this isotope of interest. Left unchecked, all alarming will be disabled and no alarm checking will be performed! *Default is Alarm checking performed.*

Latch Alarms— This checkbox configures whether alarms are latching or non-latching. Latching alarms must be acknowledged by the user before the alarm status will be cleared. Non-latching alarms will clear automatically once the reading drops below the alarm set point. If checked, alarms must be cleared manually through the *Monitor - Acknowledge Alarm* menu item, or with the Navigation Button (if not disabled). *Default is Latching.*

Configure…—This button calls up alarm settings dialog to configure the alarm set points for the isotope-of-interest.

Alarm Settings Dialog

This dialog is accessed through the Isotope page of the Instrument Options dialog. It allows configuration of the acute and chronic alarm set points for dose and concentration alarms.

Chronic Alarms

Chronic Dose—This setting determines the alarm set point for a chronic dose alarm. *Default is 20 DAC-h.*

Chronic Concen.—This setting determines the alarm set point for a chronic concentration alarm. *Default is 1000 DAC.*

Acute Alarms

Dose (DAC-h)—This setting determines the alarm set point for an acute dose alarm. ***Default is 200 DAC-h.***

Net count rate (cps)—This setting determines the alarm set point for the acute Net Cps. Currently disabled. Cannot be edited.

Acceptable False Alarm Rate

This setting defines the acceptable number of false alarms per year. The limit has an effect on the calculated minimum-detectable dose and concentration limits, and therefore, on the dose and concentration sensitivities. The setting is used to determine the sigma factor which is multiplied by the standard deviation of the calculated dose and concentration to yield the minimum-detectable level. Allowing more false alarms will provide better alarm sensitivity at the expense of more frequent false alarms. ***Default is 10 false alarms per year.***

Isotope Page (in Alpha-Beta Mode only)

This page defines the parameters concerning the measurement isotope-of-interest. By default, the isotope of interest is Pu-239, however, this isotope may be changed to support the measurement of other alpha-emitting isotopes. Note that the radon daughters of Po-214 and Po-212 are always monitored and used in the background subtraction algorithm.

Isotope—This pull-down list provides for the selection of other isotopes of interest. This selection affects only the isotope of interest and not the measurement of radon daughters, which are always monitored. ***Default is Pu-239.***

Peak Channel—This setting identifies the channel where the peak of the selected isotope-of-interest is expected by the peak-fit algorithm. Although it can be changed from this dialog page, normally, it is set during the calibration procedure. ***Default is channel 160.***

DAC Constant—This setting defines the conversion constant to convert from Pico-Curies per liter to DAC, defined by 10CFR835. Note that the constant uses units of Pico-Curies per liter to avoid the need for scientific notation. ***Default is 0.002 pCi/liter/DAC.***

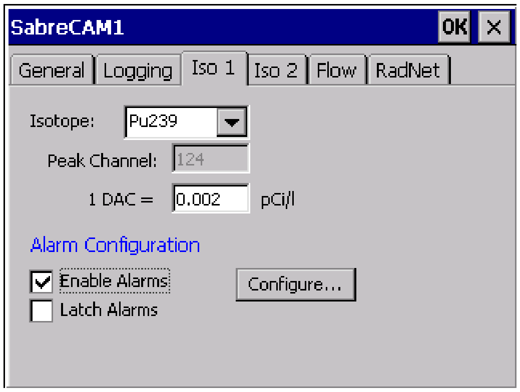

Figure 35

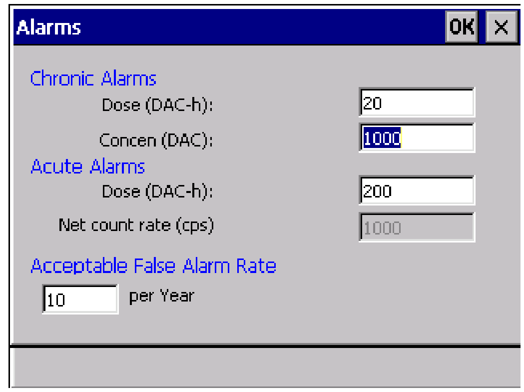

Figure 36

Alarm Configuration

See Beta Page for description of these settings and the Alarms dialog.

The second isotope-of-interest page (Iso 2) has the same inputs as the first.

Flow Page

This page defines the alarm and failure limits on the sample flow measurement.

Flow Properties

Low Limit—This setting defines the limit in liters per minute below which the SabreBPM will indicate a LOW FLOW status. A low flow status can indicate a loaded or wet filter. *Default is 5.0 LPM*

High Limit—This setting defines the limit in liters per minute above which the SabreBPM will indicate a HIGH FLOW status. A high flow status can indicate a leaking or disconnected vacuum line. *Default is 6.5 LPM.*

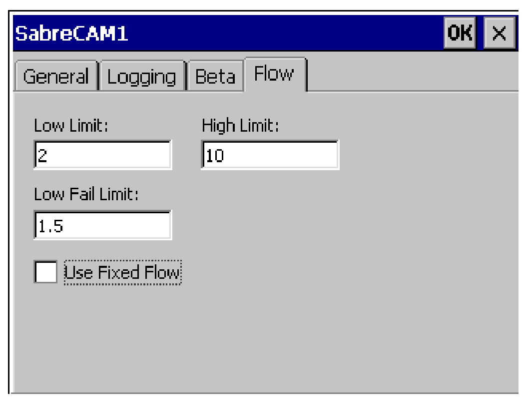

Figure 37

Low Fail Limit—This setting defines the limit in liters per minute below which the SabreBPM will indicate a FLOW FAIL **status and go out of service. A flow fail status can indicate a kinked or clogged vacuum line. *Default is 4.5 LPM.***

RadNet Page

This page contains the setting for RadNet broadcasts for SabreBPM units with the wireless RadNet Option installed.

NOTE: For non-wireless-enabled SabreBPM instruments, this page will not appear.

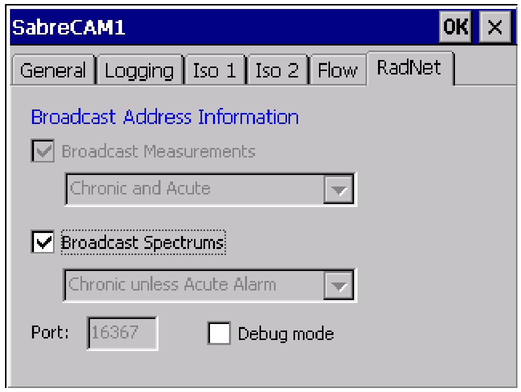

Figure 38

Broadcast Measurements—This checkbox enables or disables the transmission of measurement packets to RadNet clients. It is currently enabled and cannot be changed.

Measurement Type List Box—This list describes the options for measurement packet broadcasts. Allowable choices are Chronic and Acute data, Chronic Only, and Acute Only. *Default is Chronic and Acute. Currently not functional.*

Broadcast Spectrums—This checkbox enables or disables the transmission of SabreBPM spectrums to RadNet clients. Check the box to enable spectrum broadcasts.

Spectrum Type List Box—This list describes the options for spectrum packet broadcasts. Allowable choices are Chronic unless Acute Alarm, Chronic Only, and Acute Only. *Default is Chronic unless Acute Alarm. Currently not functional.*

Port—This field specifies the UDP Port number which RadNet packets are broadcast on. User editing of the port number is disabled. *Default is 16367.*

Debug mode—Checking this setting will insert wireless debug information into the status log. It can be of use to IT personnel when attempting to troubleshoot communications issues.

SECTION

4

Starting a Dose Measurement

Response Check Routine

Before starting a dose measurement, the SabreBPM should be tested to make sure that it is operating properly and in calibration. The Response Check routine provides a convenient method for insuring proper operation of the SabreBPM, prior to putting it in operation.

The purpose of the Response Check is to verify that a consistent activity is reported when a source of known activity is placed in front of the detector. A Response Check verifies that the detector and SabreMCA are functioning properly. For beta measurements, it verifies that the noise/background is properly compensated for and the beta efficiency has not changed. For alpha response checks, it verifies that the source isotope is correctly identified and the peak area properly measured, that the alpha efficiency has not changed. Both checks give an indication of whether the data is consistent with previous Response Checks.

In both beta or alpha source checks, the source used, which should be of the same isotope as the calibration source and/or the isotope-of-interest the SabreBPM is configured to measure, should be of 37 mm overall diameter and have an active (plated) diameter of 1.00 inch. This will closely model the active area of a filter and provide the most accurate assurance of repeatable geometry.

Running the Response Check

After starting the SabreBPM program, the Response Check dialog in Figure 39 is initiated. It may also be initiated from the menu by tapping *Monitor – Response Check…*. **There are four edit fields in the upper portion of the screen:**

> **Source—This list box displays the applicable sources that can be used for the response check. The** *Beta* **choice is always available. If the user has specified an alpha calibration**

source, that isotope will also appear. For alpha-beta mode SabreBPM instruments, the primary isotope-of-interest will also be listed.

High Limit (dpm)—This setting specifies an upper fail limit on the measured activity. Any reading above this value at the end of the test will cause the Response Check to fail. The user should set this value to be approximately the source activity in dpm, plus 10%.

Low Limit (dpm)—This setting specifies a lower fail limit on the measured activity. Any reading below this value at the end of the test will cause the Response Check to fail. The user should set this value to be approximately the source activity in dpm, minus 10%.

Count Time (sec)—This setting defines the time window in seconds over which the activity will be averaged. The actual duration of the Response Check will be longer to account for stabilization of the reading.

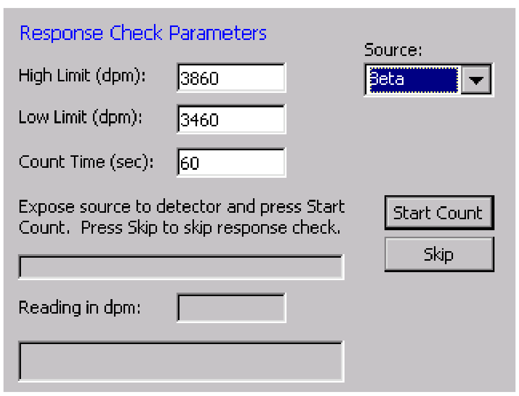

Figure 39

Set the High/Low Limits to reflect the desired tolerance and set the Count Time to produce a reading that is precise enough to reliably fall within the limits. The tolerance of ±10% is only a suggested limit and actual tolerances will vary based on source activity and Count Time.

Remove the filter holder, exposing the detector head, and place the source in front of the detector. The location and spacing of the source to the detector should be repeatable, and should produce geometry identical to the location and spacing of the filter while in the holder.

When the source is in position, tap the *Start Count* button to begin the test. A progress bar and *Reading in dpm* field provide visual feedback during the test.

When the test is complete, the final activity reading is displayed and the results of the test displayed.

As with any statistical test given a mean and a set of limits, there is a finite probability that the test may fail, even though the instrument is operating normally. In the event the Response Check fails, it is up to the user to determine whether the instrument is still serviceable. A reading slightly out of range may indicate only that the unit should be Response Checked again and the results compared to historical records. A reading significantly out of range is a warning that the instrument is not operational.

When the test is complete, remove the source, insert a clean filter, and reinsert the filter holder into the detector head.

Tap the *Skip* **button or just wait for the dialog to time out after a minute of inactivity to exit the Response Check routine.**

Dose Measurement

Once the Response Check is completed, the SabreBPM enters normal operation and begins monitoring for beta activity and, optionally, for the alpha isotope(s)-of-interest. The instrument will begin measuring dose and concentration immediately and can alarm on a measurable activity, however, the minimum-detectable levels of concentration and dose will be elevated until the Acute and Chronic Window times have elapsed. Until the full window times have elapsed, the SabreBPM is using incomplete spectrum accumulations to calculate the dose and concentration and has elevated statistical fluctuations of the results.

This means that for the first 240 seconds (using the twice the default Acute Window time), the Acute MDD will be elevated, and, for the first eight hours (again, using twice the default Chronic Window time), the Chronic MDC and MDD will be elevated. To alarm during these periods, the dose or concentration must exceed the minimum-detectable or the alarm set point—*whichever is higher!*

Operational Duration

When operating off the battery, the SabreBPM will run, under normal conditions, for approximately eight hours before the battery level forces a shutdown. The battery brand and capacity, as well as the use of wireless reporting capability, can affect the run time.

Note: In order to preserve program and log data, the SabreBPM will automatically shut down when the battery life reaches 15%.

SECTION

5

Dose Measurement Reporting

Displaying Readings

The SabreBPM meter displays readings on a continual basis during operation. The default meter display is the Chronic Dose reading for the beta channel. In alpha-beta mode, the Dose, Concentration, activity and net count rate for the isotope(s)-of-interest—as well as the radon daughters, Po-212, Po-214, Po-218—may be displayed as well through the use of the

Figure 40

buttons on the front panel of the SabreBPM shown in Figure 40.

To select between Acute and Chronic readings and the flow channel, press the *Channel* **button to cycle through the various readings.**

Note: Acute readings are denoted by Beta/A. Chronic readings are denoted by Beta/C. In alpha-beta mode, alpha channels are similar. For example, the Pu-239 Acute reading is labeled, Pu239/A and the Pu-239 Chronic reading by Pu239/C.

To select between DAC-h, DAC, NetCps and pCi/l, press the *Units* **button.**

In the event of an alarm, the SabreBPM will automatically display the channel of the chronic or acute reading that caused the alarm.

Displaying the Spectrum

The SabreBPM spectrum may be displayed from the menu by tapping *View—Spectrum*. In this view (Figure 41), the 256-channel spectrum is displayed instead of the log entries. Return to the log entry view by tapping *View—Log*.

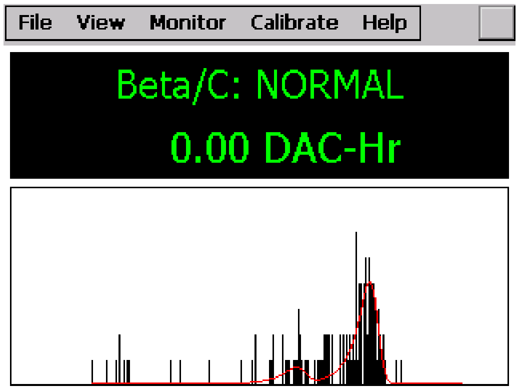

Figure 41

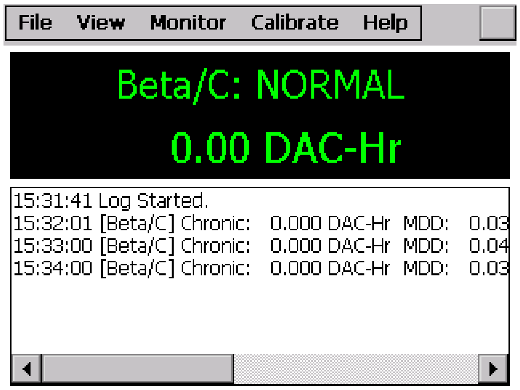

Figure 42

Beta Activity, Concentration and Dose Calculations

History and Moving-Window Behavior

In order to calculate a concentration, the counts for each counting channel are saved—along with the flow rate and volume—in a history array, so that the increase in counts over time can be used to determine the net count rate. For each counting channel, two different time intervals are used to determine concentrations and are referred to as the 'acute' and 'chronic' window times (sometimes called the "fast window" and "slow window"). The peak counts—based on the history values over one and two window times—are used to determine the net count rates. For instance, if the window time is 60 seconds, then the net count rates for the previous minute and also the minute previous to it, are calculated. For long-lived isotopes, the increase in net count rates over the two intervals is proportional to the concentration.

Beta Concentration and Dose Calculations

Because the counting efficiency for betas is dependent on the maximum isotope energy, the SabreBPM must be calibrated for the beta isotope-of-interest in order for the concentration and dose calculations to be accurate. Typically, the SabreBPM is calibrated to Cs-137.

To determine the net beta count rate, one or two forms of background subtraction are applied: fixed (or guard detector) compensation for gamma interference; and optional radon compensation.

$$Net = Gross - F_G G_{Bkg} - F_R[0.56 \times Po_{212} + 1.35 \times Po_{214}]$$

Where,

$Gross$	= **Gross beta counts**
F_G	= **Fixed(Guard) subtraction factor**
G_{Bkg}	= **Fixed(Guard) counts**
F_R	= **Radon subtraction factor**
Po_{212}	= **Po_{212} counts**
Po_{214}	= **Po_{214} counts**

Acute Net counts are stored in the acute history buffer every second, while Chronic Net counts are stored in the chronic history buffer every minute. The concentration equation used for the acute and chronic beta calculation is:

$$Concentration = \frac{Net_1 - Net_0}{T_{WA} \times Vol_{Sample} \times K_{DAC} \times Cal \times Eff}$$

Where,

T_{WA}	= **Actual chronic/acute window time in seconds**[1]
Net_0	= **Net counts from $T - 2T_{WA}$ to $T - T_{WA}$**
Net_1	= **Net counts from $T - T_{WA}$ to T**
Cal	= **Calibration constant**
Eff	= **Beta efficiency (4-Pi)**
Vol_{Sample}	= **Sampled volume since filter change**
K_{DAC}	= **DAC conversion factor (equals one if DAC not used)**

Beta Dose Calculation

The SabreBPM program calculates dose according to the activity collected on the filter paper. Because the SabreBPM is typically used to continuously monitor the air in a facility, the concept of "worker dose" is dependent upon the portion of time the worker spends in the facility in comparison to the time the SabreBPM filter has been accumulating activity. For instance, if a SabreBPM has been sampling air at 1 CFM for 40 hours, and the activity of Cs-137 is 150 dpm, the worker dose is dependent on how much of the 40 hours the worker spent inside the room being monitored. The determination of worker dose must be accomplished administratively by noting the dose readings when the worker enters and leaves the area and calculating the increase in dose.

$$Dose = \frac{Net_1}{\left(T_{WA} \times K_{DAC} \times Cal \times Eff \times Flow_{Sample} \times 60\right)}$$

Where,

T_{WA}	= **Actual chronic/acute window time in seconds**

[1] The actual window time may be shorter than the user-defined window time. When a new spectrum is begun, following a spectrum reset or a filter change, a window time equal to the elapsed time, is used so that a "best guess" concentration value can be calculated. This actual window time will increase until it is equal to the user-defined time. This occurs when the user-defined window time has elapsed since the filter change or spectrum reset. After this point, the user-defined time is used.

Net_1	=	**Net counts from $T - T_{WA}$ to T**
Cal	=	**Calibration constant**
Eff	=	**Beta efficiency (4-Pi)**
$Flow_{Sample}$	=	**Flow rate**
K_{DAC}	=	**DAC conversion factor (equals one if DAC not used)**

Alpha Activity, Concentration and Dose Calculations

For alpha-beta mode configurations, the curve fit function produces coefficients for each isotope that correspond to the counts under the peak. Like the beta channel behavior, alpha channels use a history array, so that the increase in counts over time can be used to determine the net count rate. The peak counts—based on the history values over one and two window times—are used to determine the net count rates. For long-lived isotopes, the difference in net count rates over the two intervals is proportional to the concentration. Once the change in net count rate is known, the calibration constant and flow volume are used to derive the concentration in the specified measurement units.

An additional term is included in the concentration calculation to account for the expected count rate losses due to activity that has decayed off during the last interval. For longer half-lived isotopes the term $Net_0 \lambda$ **goes to zero. However, this term is very important for the proper treatment of the short-lived radon daughters.**

It should be noted that in situations where the counts under a peak are changing very slowly or not at all, slight variations may occur in the determination of the net count rate, which can result in small negative concentrations. These effects are minimized by the use of the two different evaluation intervals, with a longer interval providing greater precision in low-level measurements.

Alpha Concentration Equation

The concentration equation used for the fast and slow calculation is:

$$Concentration = \left(\left(Net_1 - Net_0 \right) / T_{WA} + Net_0\, l \right) \times \frac{Yield}{Vol_{Sample} \times K_{DAC} \times Cal \times Eff}$$

Where,

T_{WA}	=	**Actual slow/fast window time in seconds**
Net_0	=	**Net counts from $T - 2T_{WA}$ to $T - T_{WA}$**
Net_1	=	**Net counts from $T - T_{WA}$ to T**
Cal	=	**Calibration constant**
Eff	=	**Detector efficiency (4-Pi)**
$Yield$	=	**Isotope Alpha yield**
Vol_{Sample}	=	**Sampled volume since filter change**
K_{DAC}	=	**DAC conversion factor (equals one if DAC not used)**
λ	=	**decay constant,** $l = \frac{\ln(2)}{T_{½}}$ **where,** $T_{½}$ **= isotope half-life**

The flow measurement is used to accurately determine the volume of air collected on the filter paper during the count time.

Alpha Dose Calculation

The determination of worker dose must be accomplished administratively by noting the dose readings when the worker enters and leaves the area and calculating the increase in dose.

$$Activity = \frac{Net_1 \times Yield}{T_{WA} \times Cal \times Eff}$$

$$Dose = \frac{Activity}{\left(K_{DAC} \times Flow_{Sample} \times 60\right)}$$

Where,

T_{WA} = **Actual slow/fast window time in seconds**[1]
Net_1 = **Net counts from T – T_{WA} to T**
Cal = **Calibration constant**
Eff = **Detector efficiency (4-Pi)**
$Yield$ = **Isotope Alpha yield**
K_{DAC} = **DAC conversion factor (equals one if DAC/DAC-h not used)**

Minimum Detectable Alpha Activity, Concentration and Dose

Uncertainties in Peak Counts

In most ROI-based Alpha-CAM's, the minimum detectible concentration is based on the statistical uncertainty of the background counts that fall within the region, in combination with the uncertainty of any counts in excess of the background. In the SabreBPM, the minimum detectible concentration (MDC) is not directly related to the spectrum counts, but to the uncertainty in the peak fit.

An examination of the peak area variances confirms that when the counts due to an interfering isotope greatly outnumber the counts due to the isotope of interest, the variance of the isotope of interest increases. Likewise, when there are very few interfering counts from other isotopes, the variance begins to approach a value equal to the peak area counts.

When spectrum counts are zero, there is still a minimum variance of the peak areas. This minimum variance affects the minimum detectable levels of dose, concentration and activity. At the start of operation, the program calculates and saves the minimum variance for the Isotope of Interest for use later in the calculation of the minimum detectable levels.

Uncertainties in Flow Rate

The measurement of the flow rate and volume has a statistical variance that contributes to the MDC and MDD. This statistical variance is calculated by the program and applied in the MDC and MDD calculations.

Calculation of the Variance of Peak Counts

The variances returned from the curve fit routine represent the uncertainties on the peak counts for each isotope during the last peak-fitting. The limit of detectability variance used is a combination of the fit variance with the previously saved 'zero-counts' variance.

$$Var_{LD} = \left[K\sqrt{VarZero} + 1.645\sqrt{Variance_0}\right]^2$$

Where, K is the Sigma Factor—a multiplier based on the False Alarm setting and the number of alarm determinations per year.

Calculation of the Minimum Detectable Activity

$$MDA = \frac{Var_{LD}}{T_{WA} \times Cal \times Eff}$$

Calculation of the Minimum Detectable Concentration

$$MDC = \sqrt{\left[\frac{\frac{\sqrt{Var_{LD} + Variance_0}}{T_{WA}} + l \times \sqrt{Variance_0}}{\frac{(Net_1 - Net_0)}{T_{WA}} + l \times Net_0}\right]^2 + \left[\frac{Error_{VOL}}{Volume}\right]^2} \times \frac{|Concentration|}{K_{DAC}}$$

Calculation of Minimum Detectable Dose

$$MDD = \sqrt{\left[\frac{MDA}{Activity}\right]^2 + \left[\frac{Error_{Flow}}{Flow_{Sample}}\right]^2} \times \frac{Dose}{K_{DAC}}$$

Where,

$Variance_0$ = **Peak area variance for previous T_{WA}**

$Variance_1$ = **Peak area variance for most recent T_{WA}**

Radon Mode Considerations

The SabreBPM may be configured to operate as a radon progeny monitor, measuring and alarming on PAEC (potential alpha energy concentration) levels of milli-Working Levels (mWL), and dose estimates in mWL-h. Alternatively, if configured for SI units, the instrument will display radon concentration in µJ/m³ and dose estimates in µJ-h/m³.

The PAEC reading is treated as the primary isotope-of-interest and the chronic PAEC dose is shown as the default reading on the instrument (i.e. PAEC/C).

The PAEC is based on the individual radon decay product concentrations as measured off the filter. The beta-decay product Pb-214 is estimated from the concentrations of Po-218 and Po-214 before its contribution to the PAEC can be added. The thoron contributions from Po-212 and Bi-212 are also included in the PAEC result and, when Bi-212 is present, the 6.0 MeV peak counts are corrected for known contributions from Bi-212 before the ultimate energy yield of 13.69 MeV of Po-218 are summed.

While its contribution is not included in the PAEC result, the SabreBPM does monitor for and report the concentration and dose estimate from Po-210.

SECTION

6

Ending a Dose Measurement

After a dose measurement period is complete, exit the SabreBPM program by tapping the *File—Close* **menu item. The program will terminate and close any open log data files. This should be unnecessary for continuous sampling mode operation.**

Note that if password security is enabled, the user will be required to log in before the *File—Close* **menu item will be accessible.**

SECTION

7

Retrieving and Analyzing the Data

The log data files stored on the SabreBPM may be retrieved and analyzed on a personal computer, laptop or workstation. The data can be imported into a spreadsheet or database and archived for future use.

Note: This operation can be performed while the SabreBPM program is running.

Installing and Using Microsoft ActiveSync

To access the data on the SabreBPM, the user must install the ActiveSync software from Microsoft (provided) and then connect the SabreBPM using the supplied USB and AC Power cables. This software is included on the SabreBPM CD included with your SabreBPM.

Once ActiveSync is installed on a PC, plug a USB cable from the computer to the mini-USB connection on the detector side of the SabreBPM. If the unit is turned on the SabreBPM should automatically synch with the computer.

When the dialog is presented that asks whether a Permanent or Guest Partnership be established, select Permanent, then click *Next* and disable all options except *Files* (We do not want *tasks*, *contacts* and *appointments* to be copied from the PC to the SabreBPM).

Log Files Stored on the SabreBPM

Once connected to the SabreBPM, the ActiveSync program window is displayed on the PC and file synchronization will occur. When a partnership is created, a folder is created on the PC in the *My Documents* folder with a name corresponding to the SabreBPM name (e.g. *BWSABR_102 My Documents*) and includes all the SabreBPM log files. Each log file contains time stamps in the name of the file. They are formatted with YYYY being the year MM being the month and DD being the day of the file creation. Each file begins with a header line describing the individual fields. Each subsequent entry in the log files is

stamped with the time and date of its creation. The list in Figure 44 describes the files and their contents:

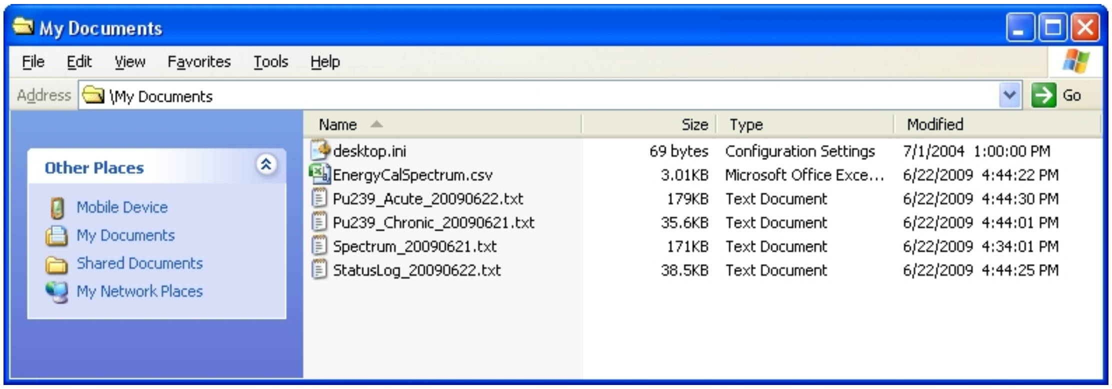

Figure 43

EnergyCalSpectrum.csv—This *comma-separated-variable* format text file contains the last saved spectrum from the Energy Calibration. Files with the *.csv* extension can be opened directly from Microsoft Excel.

Beta_Acute_YYYYMMDD.txt—This text file contains the log of acute beta readings archived during the SabreBPM dose measurement period. New acute log files are started every day at midnight.

Beta_Chronic_YYYYMMDD.txt—This text file contains the log of chronic readings archived during the SabreBPM dose measurement period. New chronic log files are started every Sunday morning at 12:00 midnight.

Pu239_Acute_YYYYMMDD.txt—Implemented in alpha-beta mode, this text file contains the log of acute readings archived during the SabreBPM dose measurement period. Note: the file name may be different if Pu-239 is not defined as the isotope-of-interest. New acute log files are started every day at midnight.

Pu239_Chronic_YYYYMMDD.txt— Implemented in alpha-beta mode, this text file contains the log of chronic readings archived during the SabreBPM dose measurement period. Again, the file name may be different if Pu-239 is not defined as the isotope-of-interest. New chronic log files are started every Sunday morning at 12:00 midnight.

StatusLog_YYYYMMDD.txt—This text file contains a copy of the readings and status changes logged to the SabreBPM display during dose measurement. It includes a listing of any alarm and the time at which it occurred, along with chronic and peak acute readings. A new status log files is started every day at midnight.

Spectrum_*YYYYMMDD*.txt—These text files contain chronic spectrum snapshots at fixed (user-defined) intervals during the dose measurement period. Part of the filename is a timestamp indicating the year (YYYY), month (*MM*), and day (dd) into the dose

measurement when the spectrum was archived. Each line in the file contains a set of peak-fit coefficients, a 255-channel spectrum of raw counts, and a 255-channel spectrum of the cumulative peak fit. A new spectrum log files is started every Sunday morning at 12:00 midnight.

You may select any or all of the log files and copy them to a more permanent storage location on the PC using drag-and-drop or copy-paste or any other standard Windows file copy operation. The files can then be opened, imported into a spreadsheet or printed.

Importing the data into Microsoft Excel

All files, except the SabreLog.txt are in *comma-separated-variable* (*.csv) format and can be imported into Microsoft Excel. If renamed with the *.csv* extension, they can be opened and viewed directly from Microsoft Excel by simply double-clicking on the file.

NOTE: A more convenient method for viewing different sessions of SabreBPM files is to open a blank Excel spreadsheet and select Data—Get External Data—Import Text File…

Next, select the SabreBPM log file from the ActiveSync folder and import it into cell A1. The data can now be graphed and analyzed. Save the spreadsheet to preserve the link to the imported data.

To examine the SabreBPM data from a different session it is only necessary to open the previously saved spreadsheet, then select *Data—Refresh Data* **and select the new log file.**

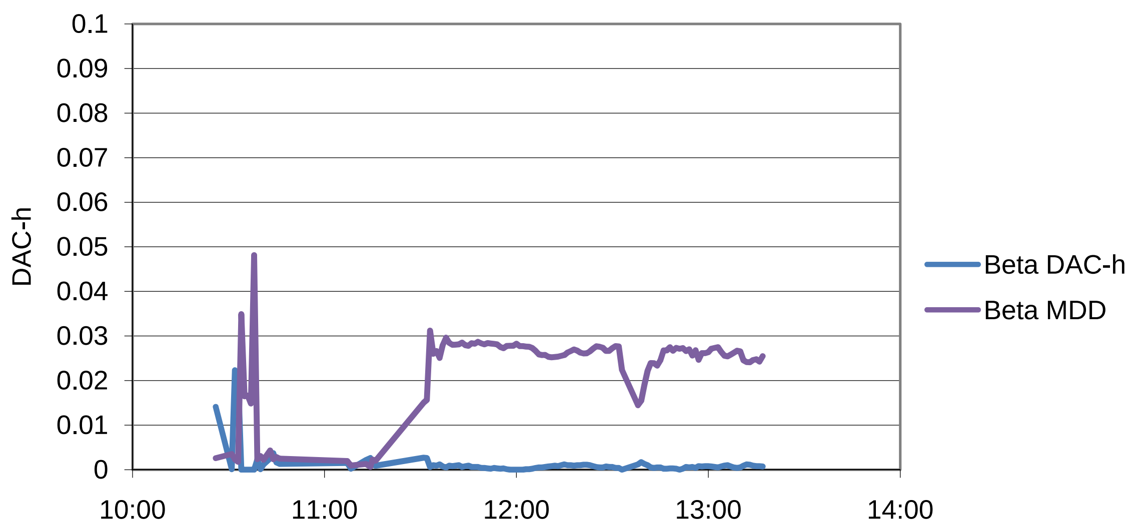

Figure 44

Closing ActiveSync

Once the SabreBPM log data has been retrieved, you may disconnect the USB cable from the computer to the SabreBPM. Disconnecting the USB cable will not affect the operation of the unit.

Section

8

Wireless RadNet Operation

General

SabreBPM units ordered with the wireless RadNet Output option come equipped with a 802.11b-compatible wireless smart card and are configured to allow broadcasting of RadNet Alpha CAM measurement and spectrum packets. These packets may be received and displayed by RadNet Client software available from several sources, including Bladewerx. A wireless access point (WAP) is required to receive the transmissions from the SabreBPM and relay those transmissions either via an Ethernet cable to the RadNet Client workstation, or via a second wireless link to the client workstation. The concentration readings and spectrums from up to nine SabreBPMs may be linked to a single RadNet Client workstation.

Configuration

SabreBPMs purchased with the RadNet Output Option come preconfigured for operation with the wireless access point, however, site security requirements may require changes to the setup. The tables below are included to provide a brief guide to the wireless configuration of the SabreBPM. Exact details of the setup are not provided here but sufficient information is included that will enable a network administrator or user experienced in network setup to perform the configuration.

Wireless and Network Setup

The SabreBPM is shipped configured as follows:

Device Name	BWALERT_xxx where xxx represents the SabreBPM serial number (e.g. BWALERT_127)
Description	Bladewerx SabreBPM
IP Address	192.168.0.xxx where xxx represents the SabreBPM serial number (e.g. 192.168.0.127)

Subnet mask	255.255.255.0
Network name SSID	Bladewerx
Connects to	Work
WEP encryption	Enabled (128-bit)
Network Authentication	Disabled
Key provided automatically	Disabled
Network Key	332a f3df 0836 3347 8b32 da1b c8
Bluetooth	Disabled
ActiveSync USB connection	Enabled

Netgear WG302 Wireless Access Point

The Netgear WG302 wireless access point (WAP) is an industrial-grade access point capable of extended range operation and can be operated in a Repeater mode. Configuration of the WAP is through a web browser such as *Internet Explorer*. Connect the WG302 to the PC used to configure the WAP using a Ethernet "crossover cable" or a cable into a network hub. Run the browser program and access the WG302 by entering the IP address 192.168.0.115 (if a different address has been factory-set, the IP Address will appear on a label underneath the WAP) in the address bar. When connected, the log-on screen will display. Enter "Admin" as the User and "master" as the password.

Name	Admin
Password	master
IP Address	192.168.0.115 where multiple access points are used, number sequentially (e.g. 116, 117, 118, etc.)
Subnet mask	255.255.255.0
Network name SSID	Bladewerx
WEP Authentication Type	Shared Key
WEP encryption	128 bits
WEP Passphrase	Willcox45

In the event that the WG302 no longer responds to the 192.168.0.116 address, reset it back to Netgear factory defaults by holding down the *Reset* button on the rear of the chassis for ten seconds then releasing. After the *Test* light goes out, the unit may be reconfigured. Run the web browser and enter 192.168.0.228, the Netgear factory default IP address. At the login screen enter *admin* for the User Name and *password* for the Password. The unit may then be set up according to the settings table above.

RadNet Client Workstation Setup

In order to communicate with the SabreBPM and wireless access point, the client workstation must be configured with a compatible IP Address in the 192.168.0.xxx Class-C

range. Choose and address that does not conflict with the addresses of the SabreBPMs or the wireless access point(s) (e.g. 192.168.0.12). Addresses below 115 are usually safe.

If the client workstation is operating wirelessly, be sure to set up the SSID of "Bladewerx" and use 128 bit WEP Encryption with the passphrase "Willcox45" (or the hex key 332a f3df 0836 3347 8b32 da1b c8**). Select "Infrastructure mode" or "Access Points Only."**

Appendix

I

SabreBPM Status Conditions

Status	Description
Initializing	SabreBPM program initialization (momentary)
Normal	Operating normally
High Alarm	Dose or Concentration set point has been exceeded
Low Flow	Flow rate is below Low Limit
High Flow	Flow Rate is above High Limit
Detector Fail	No counts received from detector
Low Battery	Battery is almost expired
Internal Comm	No communications with SabreMCA
Poor Fit	Could not fit the spectrum with the defined isotopes. Possible unknown isotope.
Flow Fail	Flow Rate is below Fail Limit
Out of Calib	Calibration has expired

Appendix

II

Specifications

Sampling Head and Flow

- **37 mm Filter holder**
- **Detector: Solid-state silicon 300-µm-depleted (450 mm² active area)**
- **Pump: diaphragm-type, 6.0 LPM with no load**

Beta Data Analysis

- **Dual threshold (beta with alpha cutoff) gross counting board**
- **Fixed background subtraction with subtraction factor**
- **Optional guard detector subtraction with subtraction factor**
- **Radon background subtraction with subtraction factor**
- **Acute (fast response) and Chronic (high sensitivity) dose determinations**
- **Processor: *Windows CE*-based, 533 MHz *Intel* X-Scale processor**
- **Typical 15% efficiency for Cl-36**

Alpha Data Analysis

- **MCA: 1024-channel analyzer binned to 256 channel spectrum**
- **Alpha Peak-shape-fitting algorithm**
- **Po-212, Po-214, Po-218, (optional one or two isotopes-of-interest)**
- **Acute (fast response) and Chronic (high sensitivity) dose determinations**

Physical

- **Battery powered: 8.4 V Lithium-Ion, 4.1Ah (8 Hr run-time)**

- **Weight: 8.3 lbs (3.8 kg)**
- **Dimensions: (W x H x D) 10.5 x 12 x 5 in.**
- **Temperature: 0 to 122 °F (-17 to 50 °C)**
- **Humidity: 5 to 100% (non-condensing), splash-proof electronics**