LUDLUM MODEL 53
GAMMA PERSONNEL PORTAL
OPERATOR'S MANUAL

July 2011

Version 1.0.0 / 21505N01

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OPERATOR'S MANUAL

July 2011

Version 1.0.0 / 53001n02

LUDLUM MEASUREMENTS, INC.
501 OAK STREET, P.O. BOX 810
SWEETWATER, TEXAS 79556
325-235-5394, FAX: 325-235-4672

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REVISION HISTORY			
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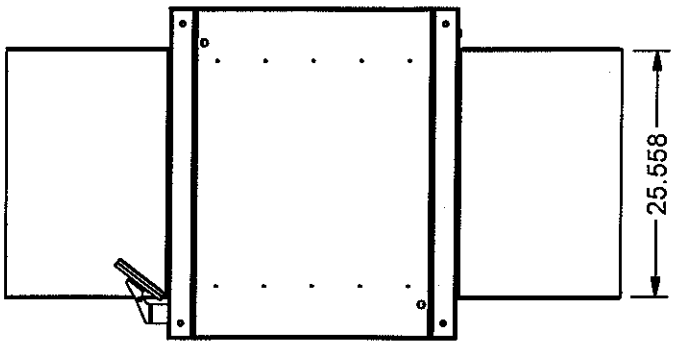

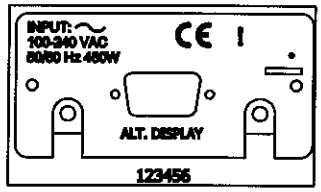

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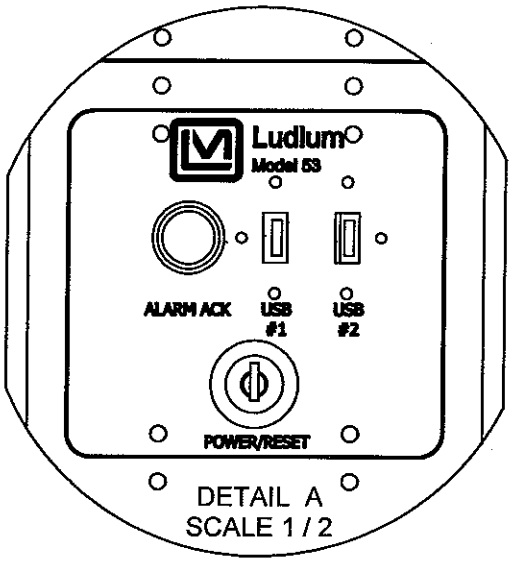

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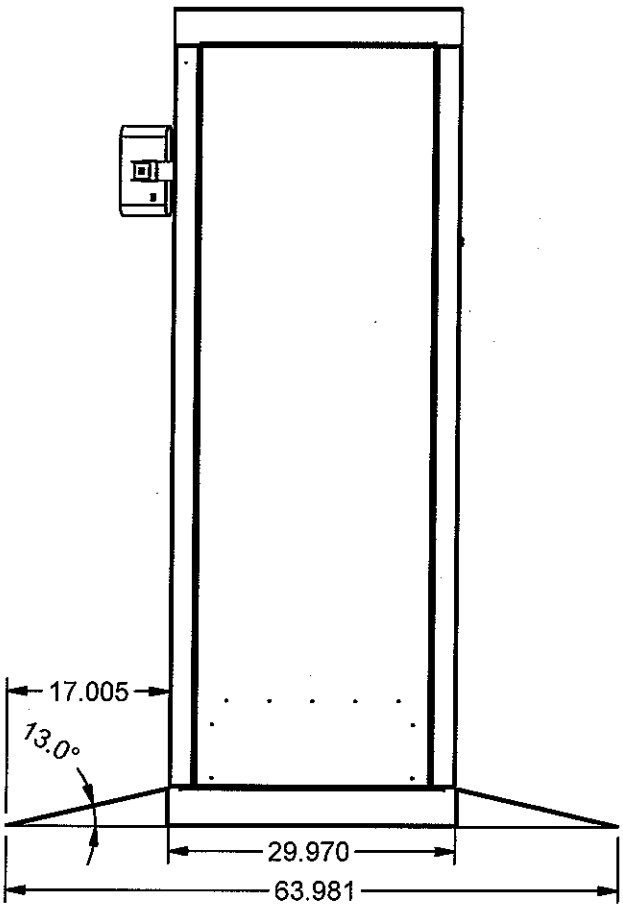

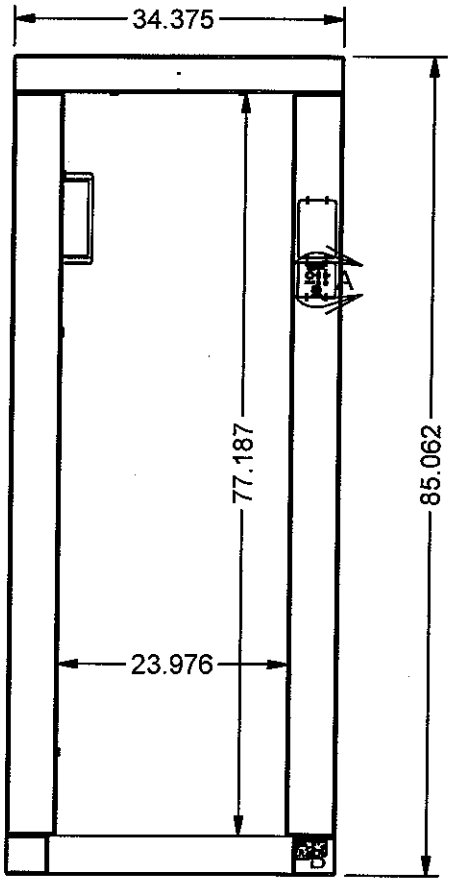

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CMC	7-18-11			PW	7-18-2011

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LUDLUM MEASUREMENTS, INC.
501 OAK STREET
SWEETWATER, TEXAS 79556

SERIES	SHEET
540	231A

Section 1

Introduction

The Model 53 Gamma Personnel Portal is used to detect gamma radiation in or on personnel passing through the portal. The portal has eight large plastic scintillation detectors and is shielded with lead, making it very heavy and highly sensitive. The Model 53 is designed to be user friendly – users follow automated voice prompts and see status clearly on the 22.9 cm (9 in.) color liquid crystal display (LCD). Instrument technicians have password-protected access to advanced automated routines to calibrate or verify operation.

The Model 53 Gamma Personnel Portal can be configured with several different options including:

- 1 or 2 inch thick lead shielding
- 1 or 2 light stack status indicators

There are three statistical counting modes to maximize throughput, sensitivity, or to fix the MDA (Minimum Detectable Activity). Several parameters can be modified to adjust the alarm set point, including the false alarm probability, detection probability, background sigma coefficient (K_B), and the composite sigma coefficient (K_{S+B}). Fast alarm and clean options provide the ability to quickly determine if personnel are contaminated or clean before the entire count cycle has ended.

There are also several user modes to choose from. Calibrators can choose to use the walk-through mode, a pause mode, a pause-and-turn mode, or front-and-back mode. Voice prompts may be customized in any language for each of these modes. These prompts can, for example, dictate in-house procedures to follow.

Instrument status is communicated clearly through the use of color LCD displays, the light stack status indicators, and the Ethernet link. Ludlum Universal™ software can be used to log instrument status, user activity, and other information. This optional software allows emails to be sent whenever radiological alarms or instrument failures occur. Camera images from network cameras may be acquired when activated. Ludlum Universal™ also allows network-wide visibility of all attached Ludlum units.

Section 2

Features

- Large plastic scintillator detectors for optimized detection efficiency
- Fast Alarm/Fast Clean counting technology for shorter counting cycles
- Three counting modes to maximize throughput, maximize sensitivity, or fix the MDA
- Automatic background updating
- Recount and contaminated detector check options
- Individual detector, sum zone and sum channel alarms
- PIR (Passive Infrared) sensor to sense personnel approach
- Photoelectric sensor to detect personnal presence
- Two levels of password security
- Four user modes: Walk-Thru, Pause, Pause-and Turn, Front-and-Back
- 1 inch thick lead shielding (option for 2 inch)
- 196 x 61 x 50.8 cm (77 x 24 x 20 in.) inside dimensions
- Single Board Computer (SBC) running Windows 7 Operating System
- Additional USB (Universal Serial Bus) connectors to transfer information from the system, or for input of user ID, etc.

Section 3

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Section 4

Safety Considerations

Environmental Conditions for Normal Use

Indoor use only

No maximum altitude

Temperature range of to 0 to 50 °C (32 to 122 °F)

Maximum relative humidity of less than 95% (non-condensing)

Mains supply voltage range 85-250 Vac, 50-60 Hz single phase (less than 1A) to desktop power supply supplies DC voltage to instrument.

Replacement of Fuses

Warning!

For continued protection against risk of fire, replace only with fuses of the specified type and current rating!

Cleaning Precautions

The Model 53 is ruggedly designed and requires very little maintenance. The only routine maintenance item is the periodic cleaning of the displays and sensors using a soft cloth dampened with water only.

Lead Shielded Detectors

The detectors are shielded with lead, which makes the system very heavy. Use caution when moving the portal. Lead shielding can and should be removed to facilitate moving.

Section 5

Operation

Controls and Functions

The following is a description of the controls and functions on the Gamma Personnel Portal.

LCDs (Liquid Crystal Displays): 22.9 cm (9 in.) color LCDs are mounted on ingress and egress sides

Acknowledge Button(s): Red alarm acknowledge buttons are mounted on the ingress and egress sides. Press button once to acknowledge the audio and again to clear the alarm.

Detector Doors: Locking panel doors provide internal access to the power switch, main electronics, and detectors.

Light Stack with Audio: Three color (red, yellow, and green) lights indicate the Gamma Personnel Portal status.

- Red- Radiological Alarm
- Yellow- Inoperational Warning
- Green- Unit Operational

Power on Sequence

When the Gamma Personnel Portal is first powered up, approximately one to two minutes are required to finish booting, and display the initializing screen. After initialization, the system will determine the level of background radiation. The system then begins updating background radiation levels every second.

Powering the Model 53 On

1. Using the supplied key, unlock and open the detector panel.
2. Connect the AC adapter to a 120-240 Vac electrical outlet.

3. Close and lock the panel.

4. Turn the Start/Stop key switch fully clockwise momentarily and release.

5. The Model 53 will take approximately one to two minutes to start.

Powering the Model 53 Off

1. Tap the Exit button on the main screen and enter the level 1 or 2 password.

2. Tap the Shutdown Gamma Personnel Portal button.

3. Wait until the system powers down completely.

4. Alternately, the Start/Stop key switch can be turned fully clockwise and momentarily and released to initiate Model 53 system shutdown.

Note: Do not remove power from the Model 53 without first shutting down the computer.

Status Colors

The Gamma Personnel Portal uses color to identify the status of the instrument at any given time. The status box in the upper-left corner of the main screen and the detector map change colors depending on the various states of the Gamma Personnel Portal and detectors. The colors are:

- Green – Indicates the Gamma Personnel Portal is ready to scan personnel.
- Yellow – Indicates the Gamma Personnel Portal has a failure.
- Red – Indicates the Gamma Personnel Portal has a radiation alarm.
- White – Indicates the Gamma Personnel Portal is scanning personnel.
- Blue – Indicates the Gamma Personnel Portal is initializing or updating background.

The lights and audio on the light stack operate as follows:

- Red – Indicates the Gamma Personnel Portal has a radiation alarm. In addition to the voice audible alert, there will be a fast beeping audible alarm.
- Yellow – Indicates the Gamma Personnel Portal is in a fail condition or is not ready to scan personnel. If a fail condition is present, there will be a slow-beeping audible alarm. While in any setup screens, when the

Gamma Personnel Portal is forcing a background update, or when the Supervisor application is not running, the yellow light will be ON.

- Green – Indicates the Gamma Personnel Portal is ready to scan personnel.

Instrument Failure

There are several conditions that cause system failure:

1. LOW BACKGROUND - The instrument continually checks the detectors for abnormally low readings as defined by the low-background alarm set points. When this condition is detected, the detector map on the main screen will indicate which detector failed. This condition normally signals a failure of either the detector or its associated preamp electronics.

2. HIGH BACKGROUND - The instrument continually checks the detectors for abnormally high readings as defined by the high-background alarm set points. When this condition is detected, the detector map on the main screen will indicate which detector failed. This condition normally signals a failure of either the detector or its associated preamp electronics, but can also warn of some nearby strong source of radiation. At any rate, the possibility of such a nearby strong source of radiation warrants further investigation.

If the background for a detector fails or it becomes contaminated, the Scaler screen in the Setup menu can be used to determine if the failure or contamination has been corrected.

Sum Zones and Sum Channel

The Model 53 can be set to use individual detectors, a combination of sum zones, or it can be configured to use a single sum channel. The Gamma Personnel Portal physical detectors are grouped into various sum zones composed of two and three detector combinations. The sum zones are helpful in detection of widespread contamination.

Sum Zone Alarm Priority

Alarm priority is dependent on the number of detectors. A two-detector sum alarm will not be posted if either of its constituent detectors have alarmed. A three-detector sum alarm will not be posted if any of its single detectors or two-detector sum zones have alarmed. The Sum Channel will only alarm if no other single detector or sum zone alarmed.

Normal User Operation by User Mode

The Model 53 may be programmed to use one of several user modes. The different user modes have different sensitivity levels and throughput levels. The user modes and operation are described below:

Walk-Thru Mode-user simply walks through the portal, achieving the highest throughput, but the lowest sensitivity. Specific actions are:

1) User approaches portal if green status light is active: portal is continually determining background levels of radiation.

2) User will trigger approach sensors, halting background measurements, and trigger an ENTRANCE vocal message, which is typically "PLEASE PASS THROUGH THE PORTAL." The green status light will flash slowly when only approach sensors are active.

3) When user interrupts the occupancy sensor in the center of the portal, the portal will look for radiation levels above the background measurements. The green status light will flash quickly while the portal is occupied.

4) If a radiological alarm is determined, the ALARM vocal message will be triggered, typically "RADIATION ALARM." If the automatic recount feature is enabled, the vocal messages "RETURN FOR RECOUNT" and "RECOUNTING" are used, depending on whether the user has cleared the occupancy sensor. If latching alarm mode is enabled, the RADIATION ALARM status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

5) If no alarm is triggered, the OK vocal message, typically a chime sound, is activated once. The green status light flashes slowly until all sensors are clear. A preset delay, typically four seconds, follows. If any of the sensors are active after this time, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

6) The green status light is activated (no flashing), and the portal will update the background measurements and be ready for additional occupancies.

Pause Mode-user pauses inside the portal until counting is complete, achieving lower throughput, but higher sensitivity than the Walk-Thru Mode. Specific actions are:

1) User approaches portal if green status light is active – portal is continually determining background levels of radiation.

2) User will trigger approach sensors, halting background measurements, and trigger an ENTRANCE vocal message, which is typically "PLEASE ENTER AND PAUSE INSIDE THE PORTAL." The green status light will flash slowly when only approach sensors are active.

3) When user interrupts the occupancy sensor in the center of the portal, the portal will look for radiation levels above the background measurements. The vocal PAUSE message, typically "PAUSE UNTIL COUNTING IS FINISHED," is triggered. The green status light will flash quickly while the portal is occupied.

4) If the occupancy sensor is cleared before counting is complete, the vocal INCOMPLETE message is triggered, typically "COUNTING INCOMPLETE, PLEASE RETURN TO CENTER OF PORTAL." The message is repeated for a preset time or until the occupancy sensor is triggered again. If the occupancy sensor is not triggered again and the preset time elapses, the portal will either:

    - return to ready mode (steady green status light and background measurements) if all sensors are clear;

    - activate the CLEAR PORTAL vocal message, typically "PLEASE CLEAR THE PORTAL," if the approach sensors are not clear; or

    - activate the INCOMPLETE ALARM message, typically "INCOMPLETE COUNT ALARM," if the incomplete alarm option is selected during calibration. If latching alarm mode is enabled, the INCOMPLETE COUNT ALARM status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

5) If a radiological alarm is determined, the ALARM vocal message will be triggered, typically "RADIATION ALARM." If the automatic recount feature is enabled, the vocal messages "RETURN FOR RECOUNT" and "RECOUNTING" are used, depending on whether the user has cleared the occupancy sensor. If latching alarm mode is enabled, the RADIATION ALARM status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

6) If no alarm is triggered and counting is complete, the OK vocal message, typically "OK PLEASE PROCEED," is activated once. The green status light flashes slowly until all sensors are clear. A preset delay, typically four seconds, follows. If any of the sensors are active after this time, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

7) The green status light is activated (no flashing), and the portal will update the background measurements and be ready for additional occupancies.

Pause-And-Turn Mode-user pauses inside the portal until counting is complete, then turns 90 degrees and counts again, achieving lower throughput, but higher sensitivity than the Pause Mode. Specific actions are:

1) User approaches portal if green status light is active – portal is continually determining background levels of radiation.

2) User will trigger approach sensors, halting background measurements, and trigger an ENTRANCE vocal message, which is typically "PLEASE ENTER AND PAUSE INSIDE THE PORTAL." The green status light will flash slowly when only approach sensors are active.

3) When the user interrupts the occupancy sensor in the center of the portal, the portal will look for radiation levels above the background measurements. The vocal PAUSE message, typically "PAUSE UNTIL COUNTING IS FINISHED," is triggered. The green status light will flash quickly while the portal is occupied.

4) If the occupancy sensor is cleared before counting is complete, the vocal INCOMPLETE message is triggered, typically "COUNTING

INCOMPLETE, PLEASE RETURN TO CENTER OF PORTAL." The message is repeated for a preset time or until the occupancy sensor is triggered again. If the occupancy sensor is not triggered again and the preset time elapses, the portal will either:

- return to ready mode (steady green status light and background measurements) if all sensors are clear;
- activate the CLEAR PORTAL vocal message, typically "PLEASE CLEAR THE PORTAL," if the approach sensors are not clear; or
- activate the INCOMPLETE ALARM message, typically "INCOMPLETE COUNT ALARM," if the incomplete alarm option is selected during calibration. If latching alarm mode is enabled, the INCOMPLETE COUNT ALARM status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

5) If a radiological alarm is determined, the ALARM vocal message will be triggered, typically "RADIATION ALARM." If the automatic recount feature is enabled, the vocal messages "RETURN FOR RECOUNT" and "RECOUNTING" are used depending on whether the user has cleared the occupancy sensor. If latching alarm mode is enabled, the RADIATION ALARM status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

6) If no alarm is triggered and counting is complete, the OK-TURN vocal message, typically "OK PLEASE TURN LEFT AND REMAIN IN PORTAL…COUNTING," is activated once. Return to Step 4, except when counting is completed without triggering an alarm. The OK vocal message, typically "OK PLEASE PROCEED," is activated once. The green status light flashes slowly until all sensors are clear. A preset delay, typically four seconds, follows. If any of the sensors are active after this time, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

7) The green status light is activated (no flashing), and the portal will update the background measurements and be ready for additional occupancies.

Front-And-Back Mode-user enters the portal, turns 90 degrees, steps forward until they are against the detectors facing them and pauses until counting is complete, then steps backward until they are against the detectors behind them and counts again, achieving lower throughput, but higher sensitivity than the Pause Mode. Specific actions are:

8) User approaches portal if green status light is active – portal is continually determining background levels of radiation.

9) User will trigger approach sensors, halting background measurements, and trigger an ENTRANCE vocal message, which is typically "PLEASE ENTER AND PAUSE INSIDE THE PORTAL." The green status light will flash slowly when only approach sensors are active.

10) When the user interrupts the occupancy sensor in the center of the portal, an additional positioning vocal message is triggered, typically "PLEASE TURN LEFT, STEP FORWARD AND STAND AGAINST THE DETECTORS." is triggered. The portal then gives the "COUNTING" vocal message and begins looking for radiation levels above normal background. The green status light will flash quickly while the portal is occupied.

11) If the occupancy sensor is cleared before counting is complete, the vocal INCOMPLETE message is triggered, typically "COUNTING INCOMPLETE, PLEASE RETURN TO CENTER OF PORTAL." The message is repeated for a preset time or until the occupancy sensor is triggered again. If the occupancy sensor is not triggered again and the preset time elapses, the portal will either:

    - return to ready mode (steady green status light and background measurements) if all sensors are clear;

    - activate the CLEAR PORTAL vocal message, typically "PLEASE CLEAR THE PORTAL," if the approach sensors are not clear; or

    - activate the INCOMPLETE ALARM message, typically "INCOMPLETE COUNT ALARM," if the incomplete alarm option is selected during calibration. If latching alarm mode is enabled, the INCOMPLETE COUNT ALARM

status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

12) If a radiological alarm is determined, the ALARM vocal message will be triggered, typically "RADIATION ALARM." If the automatic recount feature is enabled, the vocal messages "RETURN FOR RECOUNT" and "RECOUNTING" are used depending on whether the user has cleared the occupancy sensor. If latching alarm mode is enabled, the RADIATION ALARM status is maintained until the ALARM ACK button is pressed. If non-latching alarm mode is enabled, the alarm will sound for a preset time interval before clearing. In either case, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

13) If no alarm is triggered and counting is complete, the "PLEASE STEP BACKWARD, AND STAND AGAINST THE DETECTORS," vocal message followed by "COUNTING" vocal message is issued. Return to Step 4, except when counting is completed without triggering an alarm. The OK vocal message, typically "OK PLEASE PROCEED," is activated once. The green status light flashes slowly until all sensors are clear. A preset delay, typically four seconds, follows. If any of the sensors are active after this time, the vocal message "PLEASE CLEAR THE PORTAL" is then utilized until occupancy and approach sensors are clear.

14) The green status light is activated (no flashing), and the portal will update the background measurements and be ready for additional occupancies.

Section 6

Supervisor

The Model 53 Gamma Personnel Portal is controlled by the Supervisor application. The Supervisor is started automatically when the Gamma Personnel Portal is booted. If the Supervisor is not running, it can be started from the Model 53 Gamma Personnel Portal icon on the desktop. When the Supervisor is not running, the yellow light on the light stack will be lit to indicate that the Gamma Personnel Portal is not in service.

Touchscreen Operation

For normal operation, the Supervisor requires little to no interaction. When interaction is required, the Supervisor can be controlled using the LCD touchscreen or through an external USB keyboard and mouse. Simply tap on the screen to "click" on buttons. Each screen in the Supervisor has a button at the top right, which will open an on-screen keyboard. Numeric fields have up and down arrows, which provide a means to quickly increment or decrement the value. By tapping directly in a numeric field, an onscreen keypad is displayed for quick data entry.

Operate Screen

The Operate screen (see page 17 for screen shot) is the main display of the Gamma Personnel Portal and contains the following items:

Title Bar – Displays the user-definable site, location, customer ID, and LMI serial number of the Gamma Personnel Portal along the top of the screen.

Status Display – Displays the current status of the Gamma Personnel Portal. The status can be one of the following:

- Ready
- Clean
- Counting
- Alarm
- High Alarm

- Failure
- Updating Background
- Extending Background
- Initializing
- Contamination Check
- Contaminated

Status Text – Displays information about the current status, including which detector has alarmed or failed.

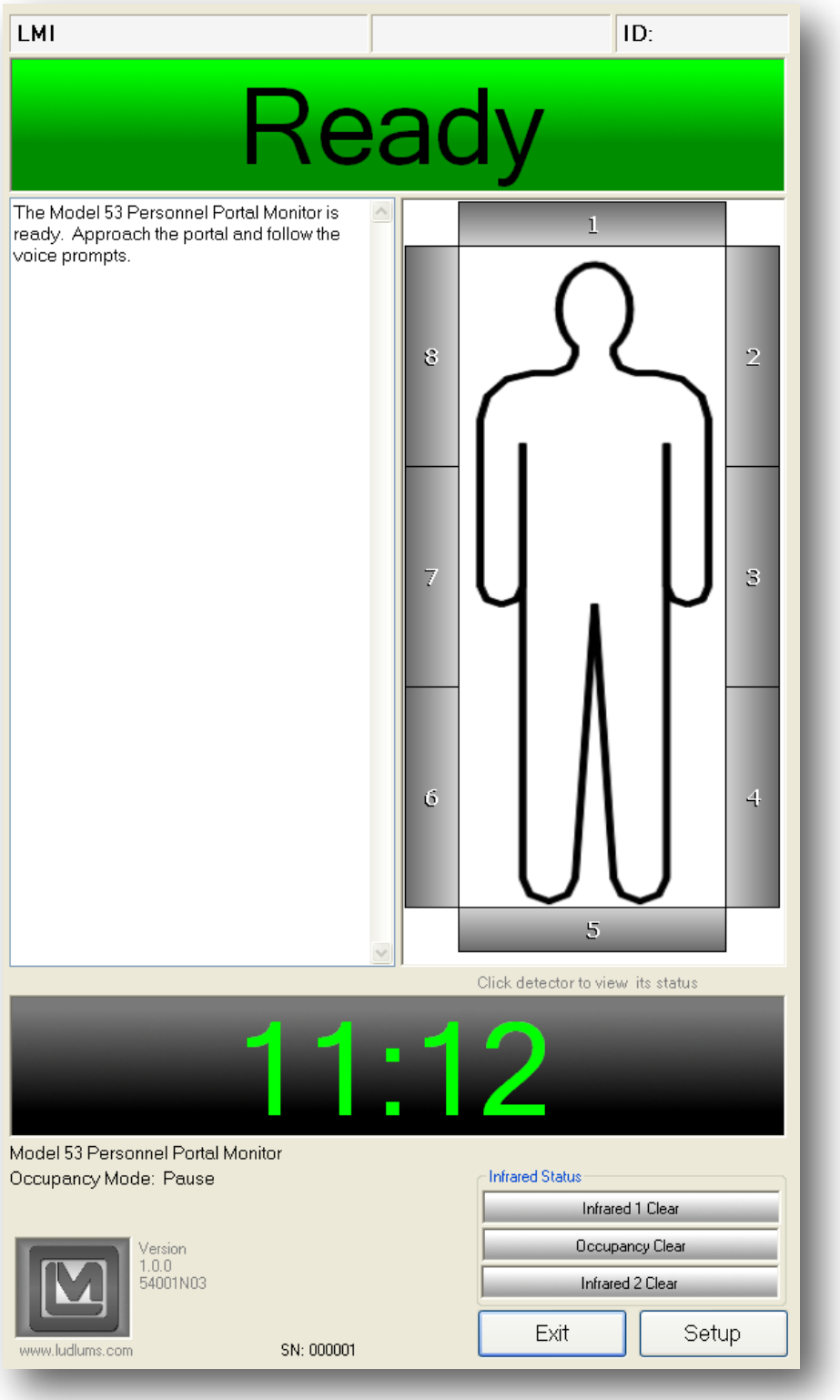
Clock/Timer – Displays the current time when not counting and a countdown timer when the Gamma Personnel Portal is counting or initializing a new background.

Detector Status Display – Graphical representation of the detectors with color-coded status display. Tapping on a detector brings up the detector detail screen.

Exit Button – Allows the user to exit the Supervisor application, restart the Gamma Personnel Portal, or shut down the Gamma Personnel Portal. It is password protected.

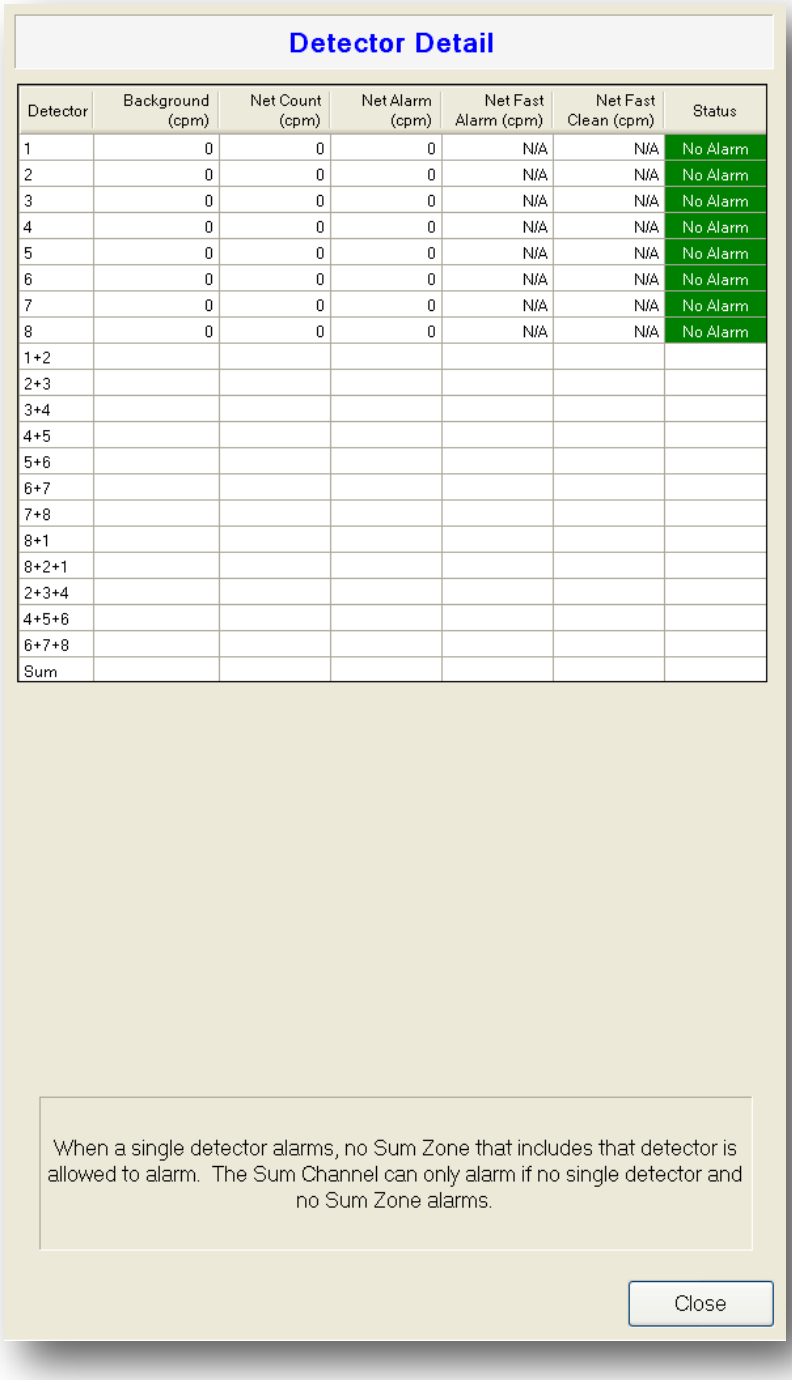
Setup Button – Allows access to the various setup screens. It is password protected.

Version – The software version and host board firmware version are displayed next to the LMI logo in the bottom, left corner of the screen.


LMI
ID:
Ready
The Model 53 Personnel Portal Monitor is ready. Approach the portal and follow the voice prompts.
1
2
3
4
5
6
7
8
Click detector to view its status
11:12
Model 53 Personnel Portal Monitor
Occupancy Mode: Pause
Infrared Status
Infrared 1 Clear
Occupancy Clear
Infrared 2 Clear
Exit
Setup
Version
1.0.0
54001N03
www.ludlums.com
SN: 000001

Detector Detail Screen

A detail screen for a detector can be displayed by tapping on the detector in the graphical display. The detail screen provides the background count, net count (if a count is in progress), alarm set point, and status. Also displayed are the values for each sum zone that the detector it's included in.



Detector	Background (cpm)	Net Count (cpm)	Net Alarm (cpm)	Net Fast Alarm (cpm)	Net Fast Clean (cpm)	Status
1	0	0	0	N/A	N/A	No Alarm
2	0	0	0	N/A	N/A	No Alarm
3	0	0	0	N/A	N/A	No Alarm
4	0	0	0	N/A	N/A	No Alarm
5	0	0	0	N/A	N/A	No Alarm
6	0	0	0	N/A	N/A	No Alarm
7	0	0	0	N/A	N/A	No Alarm
8	0	0	0	N/A	N/A	No Alarm
1+2						
2+3						
3+4						
4+5						
5+6						
6+7						
7+8						
8+1						
8+2+1						
2+3+4						
4+5+6						
6+7+8						
Sum						

Shutdown Menu

The Shutdown menu provides access to restart or shut down the Gamma Personnel Portal or to exit the Supervisor application and is accessed through the Exit button on the Operate screen. The level 1 or 2 password is required before accessing this screen. Always shut down the Gamma Personnel Portal properly through software or the key switch before removing power from the personnel portal monitor; otherwise, data corruption may occur.

Exit Supervisor – Closes the Supervisor application and provides access to the Windows 7 Embedded environment. This is necessary for performing software updates, configuring windows settings, such as printing or networking, or to provide access to the data files. A confirmation window will be displayed before the Supervisor application is closed.

Restart Gamma Personnel Portal – This function performs a restart of the Gamma Personnel Portal's single board computer. A confirmation window will be displayed before the Gamma Personnel Portal is restarted.

Shutdown Gamma Personnel Portal – This function shuts down the Gamma Personnel Portal. This option should always be used before removing power from the Gamma Personnel Portal to prevent data corruption.

Setup Screen

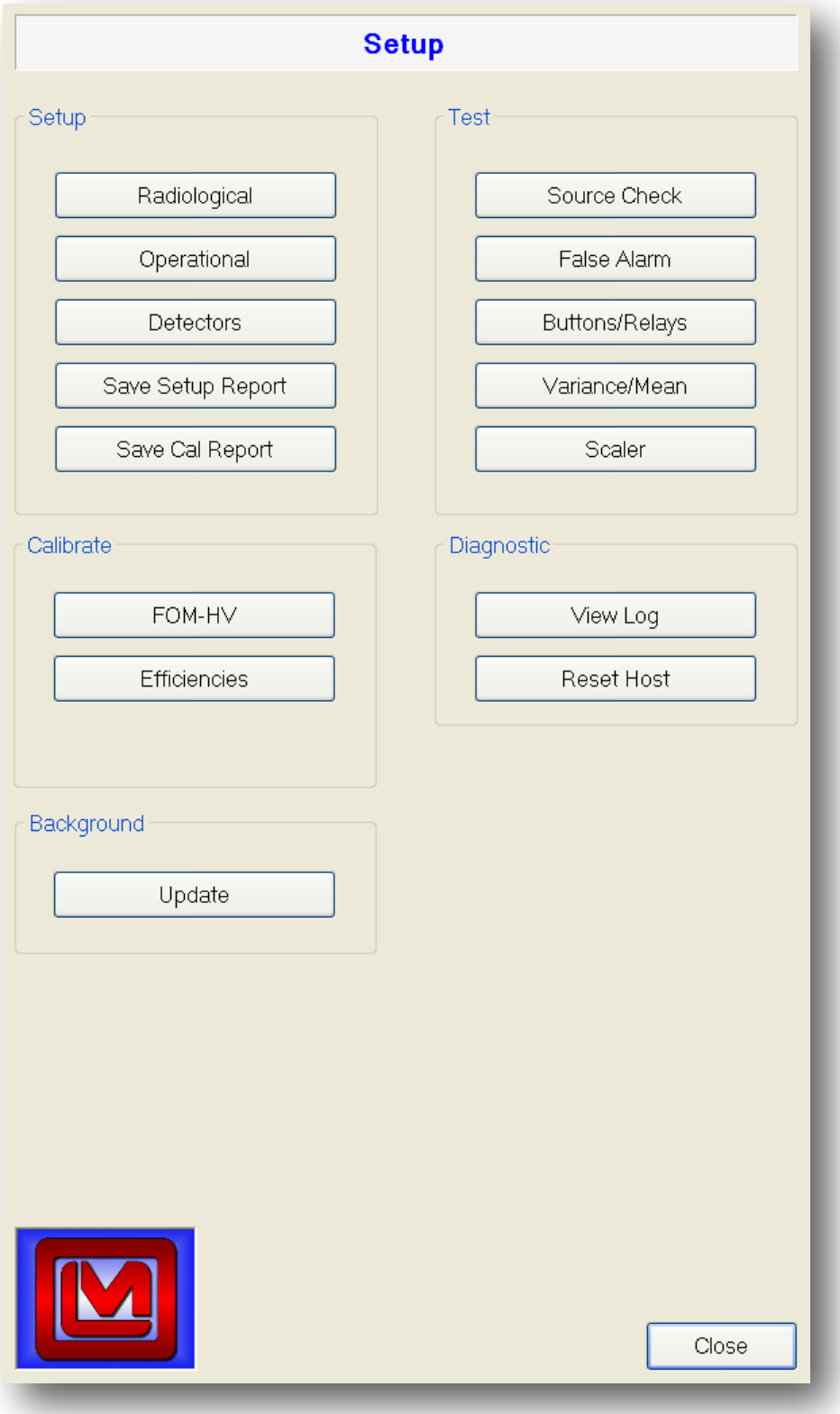
The Setup button on the Operate screen (see screen shot on page 21) provides access to the various setup and calibration functions of the Gamma Personnel Portal. The level 2 password provides full access to all setup screens. The level 1 password only provides access to the following screens:

- Save Setup Report
- Save Cal Report
- Update Background

- Source Check
- Buttons/Relays
- Scaler
- Reset Host
- View Log

If the Gamma Personnel Portal is in a fail or contaminated state (other than a host communication hardware failure), only the following setup screens are available regardless of the password level:

- Radiological Setup
- Operational Setup
- Detectors
- Save Setup Report
- Scaler
- Reset Host
- View Log


Setup
Setup
Radiological
Operational
Detectors
Save Setup Report
Save Cal Report
Test
Source Check
False Alarm
Buttons/Relays
Variance/Mean
Scaler
Calibrate
FOM-HV
Efficiencies
Diagnostic
View Log
Reset Host
Background
Update
Close

Radiological – Sets up the counting mode and its parameters, isotopic mix, occupancy mode, and units of measurement.

Operational – Sets up passwords, user-definable information, and options that control how the Supervisor application operates and displays information.

Detectors – Sets up the detector high voltage (HV), lower level discriminator (LLD), and upper level discriminator (ULD). A calibration wizard is available to calibrate the various voltages and calibration constants.

Save Setup Report – Saves a report that contains the current hardware and software configuration.

Save Cal Report – Saves a calibration report that contains all the calibration and setup information. The report covers the counting parameters, source information, detector settings, FOM data, and application settings. After saving the file, the report can be copied from the Gamma Personnel Portal and printed if necessary. Open the file in WordPad and change all margins to 0.5 inches and the font size from 10 pts to 9.

Update – Starts a new background initialization.

Source Check – Performs a source check to verify all detectors are operating correctly.

False Alarm – Performs a false alarm test with a specified number of counting cycles for each detector.

Buttons/Relays – Tests the input and output, including buttons, door locks, lights, and relays.

Variance/Mean – Calculates the variance and mean for each detector.

Scaler – Performs a scaler count for a user-definable count time. Also used to clear fail or contaminated conditions.

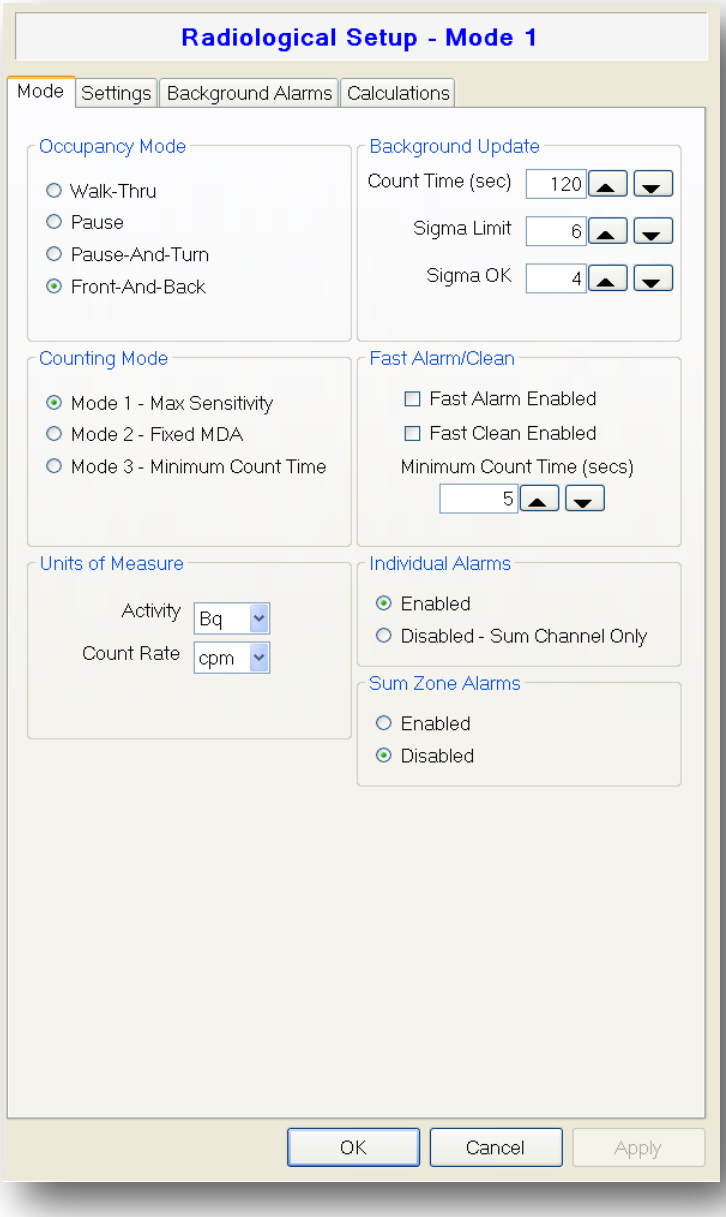
FOM – Finds the optimum HV set point for each detector by running a high-voltage plateau and calculating the Figure of Merit.

Efficiencies – Calculates the efficiencies for each detector.

Reset Host – Resets the internal host board. The host board is responsible for collecting the count data and passing it to the SBC though a USB serial port.

View Log – Views the log and report files. System, background, and scan logs are created automatically. Other screens provide the ability to save a report, which can be viewed here.

Section 7 Radiological Setup



The Radiological Setup screen (see further explanation on following pages) provides access to the various parameters and options that control the counting modes, occupancy modes, isotopic mix, background alarm set points, and units of measure. The title indicates the current counting mode.

After making a change, press the Apply button to save the changes immediately. Press the OK button to save the changes and exit the Radiological Setup screen. Press the Close button to exit the screen without saving any changes.

Occupancy Modes

There are four occupancy modes available.

Walk-Thru Mode

Walk-Thru mode allows maximization of personnel throughput requiring only a short walk-thru scan. As personnel approach the portal they are sensed by one of the motion sensors and instructed to pass through the portal. Sampling begins once the subject has entered the portal (broken the occupancy beam) and ends shortly after when the subject has passed through the portal. Results of the count are then displayed on the LCDs as well as indicated by the light stack, and audible voice and noise alarms. Detection sensitivity is limited in this mode by short count times, but personnel can be scanned at a high rate. For more details regarding Walk-Thru mode operation see Section 5 – Operation.

Pause Mode

Pause mode maintains a simple subject interaction and relatively quick throughput while also providing an extended count time for greater portal sensitivity. As personnel approach the portal they are instructed to enter and pause inside the portal. Once the portal is entered the subject is informed that counting has begun. Once the count is complete, results are indicated visually and audibly. For more details regarding Pause mode operation see Section 5 – Operation.

Pause-And-Turn Mode

Pause-And-Turn mode combines multiple counts with multiple subject positions to improve both scan sensitivity and subject coverage. Personnel are instructed to enter the portal and pause as their approach is detected. Once in the portal an initial count is taken with the subject standing as if in a doorway. Once this count is complete the subject is instructed to rotate 90 degree and again pause as another count is taken. The addition of the second 90 degree rotated count provides for greater exposure of the subject's front and back to the detectors. Upon count completion visual and audibly results are given. For more details regarding Pause-And-Turn mode operation see Section 5 – Operation.

Front-And-Back Mode

Front-And-Back mode minimizes subject distance from detectors by scanning personnel when the front and back of their body is placed in direct contact with the detector covers. As personnel approach they are instructed to enter the portal. Once inside the portal the subject is instructed to turn 90 degrees (left) and move forward until against the side detectors. A count is then taken followed by instructions to move backward until against the opposite side detectors. Another count is taken and results given visually and audibly. For more details regarding Front-And-Back mode operation see Section 5 – Operation.

Counting Modes

There are three counting modes available.

Mode 1 – Maximum Sensitivity

The alarm set point is computed at the minimum allowable value that is determined by the background count rate and acceptable false alarm probability. **Note:** Alarm set points are computed as background-subtracted (net) count rates.

$$R_{A(min)} = K_B \sqrt{\frac{R_B}{T} + \frac{R_B}{T_B}}$$

Where:

$R_{A(min)}$ = Alarm set point in cps.

K_B = Background sigma coefficient that determines the false alarm probability.

R_B = Average background count rate in cps for the detector.

T = Count time in seconds.

T_B = Background count time in seconds.

After calculating the alarm set point, a check is made to see if the computed MDA exceeds the maximum MDA. If it does, then a high-background alarm is posted.

$$MDA = \frac{R_{A(\min)} + K_{S+B}\sqrt{\frac{MDA \times Eff + R_B}{T} + \frac{R_B}{T_B}}}{Eff}$$

Where:

$R_{A(min)}$ = Alarm set point in cps.

K_{S+B} = Composite sigma coefficient for controlling the false alarm probability.

MDA = Minimum Detectable Activity.

Eff = Detector efficiency.

R_B = Average background count rate in cps for the detector.

T = Count time in seconds.

T_B = Background count time in seconds.

Mode 2 – Fixed MDA

The alarm set point is calculated on the basis of the maximum allowable, as determined by the MDA and its associated detection probability.

$$R_{A(\max)} = MDA \times Eff - K_{S+B}\sqrt{\frac{MDA \times Eff + R_B}{T} + \frac{R_B}{T_B}}$$

Where:

$R_{A(max)}$ = Alarm set point in cps.

K_{S+B} = Composite sigma coefficient for controlling the false alarm probability.

MDA = Minimum Detectable Activity.

Eff = Detector efficiency.

R_B = Average background count rate in cps for the detector.

T = Count time in seconds.

T_B = Background count time in seconds.

If the value of $R_{A(max)}$ is less than $R_{A(min)}$, as is computed using the Mode 1 equation, a high-background alarm is posted.

Mode 3 – Minimum Count Time

The minimum count time is calculated based on the user-defined MDA and is rounded up. If the resulting count time is greater than the user-defined maximum count time, then a high background alarm is posted.

$$T_{MIN} = \left[\frac{K_B\sqrt{2R_B} + K_{S+B}\sqrt{MDA \times Eff \times 2R_B}}{MDA \times Eff}\right]^2$$

If the computed value for the minimum count time exceeds the background update time, then the background update time will be extended to match the

minimum count time. When this occurs, the status will change to Extending Background.

The minimum count time is calculated as follows:

1. Calculate T_{MIN} using the equation above. If the calculated value of T_{MIN} exceeds the background update time, extend the background to match.

2. If T_{MIN} is less than or equal to the background update time, then the equation below is used to iteratively compute the minimum count time.

$$T_{MIN} = \frac{R_B}{\left[\frac{MDA \times Eff - K_{S+B}\sqrt{\frac{MDA \times Eff + R_B}{T_{MIN}} + \frac{R_B}{T_B}}}{K_B}\right]^2 - \frac{R_B}{T_B}}$$

   Where:

   T_{min} = Computed minimum count time.

   K_{S+B} = Composite sigma coefficient for controlling the false alarm probability.

   K_B = Background sigma coefficient for controlling the false alarm probability.

   MDA = Minimum Detectable Activity.

   Eff = Detector efficiency.

   R_B = Average background count rate in cps for the detector.

   T_B = Background count time in seconds.

3. The iteration is complete when the resulting T_{MIN} is greater than or equal to the T_{MIN} used on the right side of the equation.

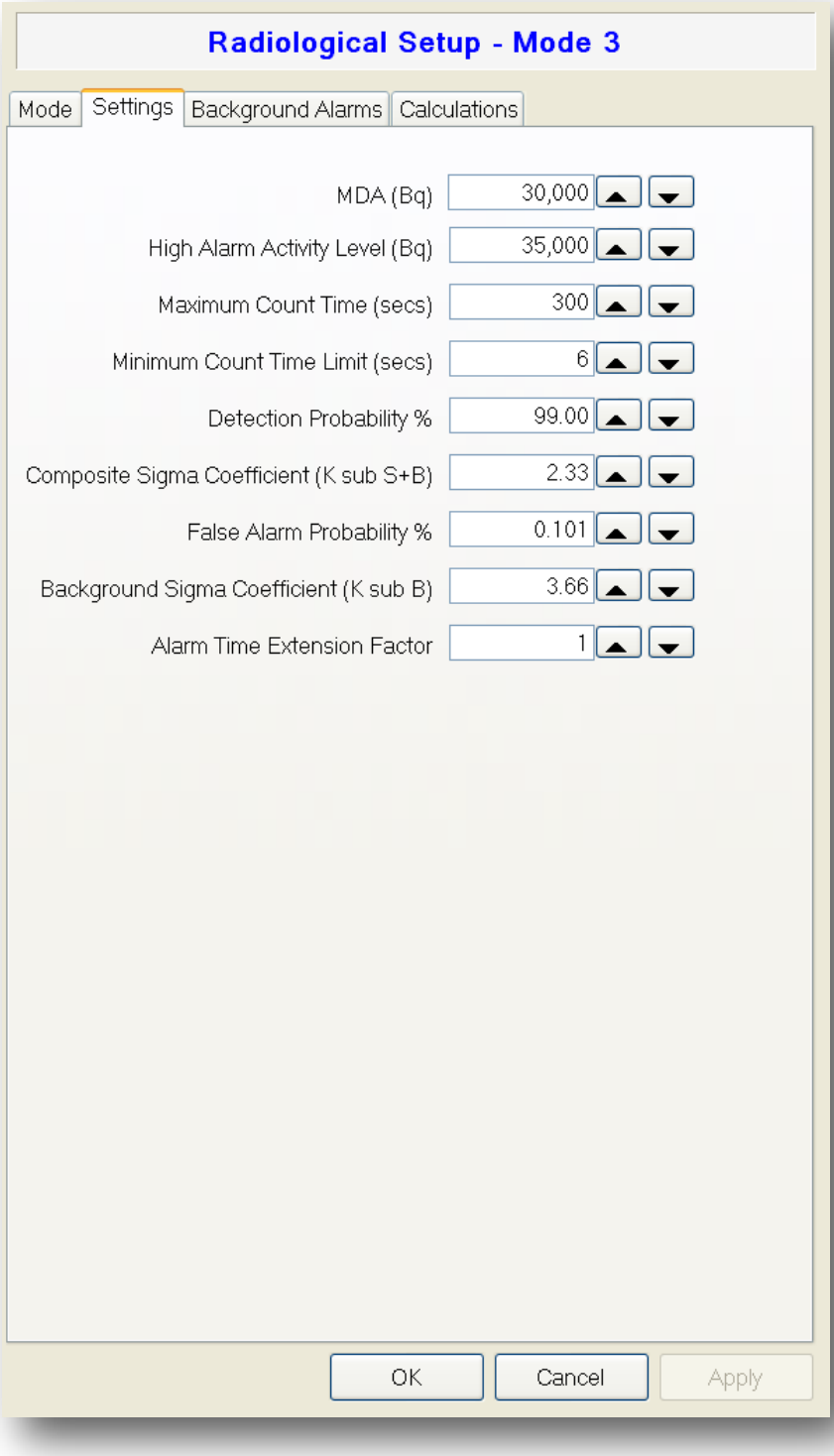
4. If the calculated count time is greater that the user-defined maximum count time, a high-background alarm is posted.

5. The Mode 3 alarm set point is calculated using the $R_{A(MIN)}$ formula for Count Mode 1.

Count Mode Settings

The Settings tab allows the various parameters that affect the operation of the count modes to be modified. After changing a setting, press the Apply button to save the changes immediately.

Note: Only the settings that apply to the current count mode are shown.



Max MDA – Sets the Mode 1 maximum MDA value. If the calculated MDA is greater than this value, a high background is posted. This value is set in specified activity units and is automatically converted when changed. The default value is 675 Bq.

High Alarm Activity Level – If an alarm exceeds this value, it is considered to be a high alarm. A high alarm displays a different message than a low-level alarm.

MDA – Sets the minimum detectable activity used in Mode 2 and 3. This value is set in specified activity units and is automatically converted when changed. The default value is 675 Bq.

Count Time – Specifies the count time in seconds for Mode 1 and 2. The count time is adjustable from 6 to 1000 seconds. The default value is 10 seconds.

Max Count Time – Specifies the maximum allowed count time in seconds for Mode 3. If the computed count time is greater than this value, a high background is posted. The count time is adjustable from 6 to 1000 seconds. The default value is 60 seconds.

Minimum Count Time – Specifies the minimum count time allowed in seconds for Mode 3. The computed count time will not be allowed to be less than this value. The count time is adjustable from 6 to 1000 seconds. The default value is 6 seconds.

Detection Probability % - Sets the detection probability percentage for all counting modes. Changing this value updates the K_{S+B} parameter. The detection probability is adjustable from 0 to 100 percent. The default value is 95%.

K_{S+B} – Sets the composite sigma coefficient for all counting modes. Changing this value updates the Detection Probability % parameter. The detection probability is adjustable from 0 to 100. The default value is 1.65.

False Alarm Probability % - Sets the false alarm probability for all counting modes. Changing this value updates the K_B parameter. The false alarm probability is adjustable from 0 to 100 percent. The default value is 0.10%.

K_B – Sets the background sigma coefficient for all counting modes. Changing this value updates the False Alarm Probability % parameter. The detection probability is adjustable from 0 to 100. The default value is 4.00.

Alarm Time Extension Factor – Sets a multiplier of elapsed time that is used whenever an alarm condition is detected. The alarm time extension factor is adjustable from 0 to 1000. The default value is 0.

Fast Clean

The Fast Clean option provides the ability to determine if personnel is clean before the count time has completed. If enabled, the accumulated count rate is evaluated at the end of each one-second interval throughout the monitoring cycle. If the count rate is statistically shown to have a very high probability of being free of contamination, an early clean condition will be posted immediately after the minimum count time has elapsed. The Fast Clean option only applies to the individual detectors and the Sum Channel. The following equation is used:

Individual Detectors Enabled

$$\frac{Accumulated\ Counts}{T_E} < R_B + MDA \times Eff - K_{S+B}\sqrt{\frac{MDA \times Eff + R_B}{T_E} + \frac{R_B}{T_B}}$$

Only Sum Channel Enabled

$$\frac{Accumulated\ Counts}{T_E} < R_B + MDA \times Eff - K_B\sqrt{\frac{MDA \times Eff + R_B}{T_E} + \frac{R_B}{T_B}}$$

Where:

T_{min} = Computed minimum count time.

K_{S+B} = Composite sigma coefficient for controlling the false alarm probability.

K_B = The background sigma coefficient.

MDA = Minimum Detectable Activity.

Eff = Detector efficiency.

R_B = Average background count rate in cps for the detector.

T_B = Background count time in seconds.

T_E = Elapsed count time since the start of the monitoring cycle.

If all single-detector channels and/or the Sum channel are found to satisfy this test, then a clean condition is posted immediately.

Fast Alarm

The Fast Alarm option provides the ability to determine if personnel is contaminated before the count time has completed. If enabled, the counts required for an alarm condition are calculated at the end of each one-second interval and compared to the accumulated counts. A Fast Alarm will only be posted after the minimum count time has elapsed. The following equation is used:

$$\frac{Accumulated\ Counts}{T_E} > R_B + K_B\sqrt{\frac{R_B}{T_E} + \frac{R_B}{T_B}}$$

Where:

R_B = Average background count rate in cps for the detector.

K_B = Background sigma coefficient.

T_B = Background count time in seconds.

T_E = Elapsed count time since the start of the monitoring cycle.

Sum zone alarm conditions are not processed using the Fast Alarm algorithm.

Individual Alarms

Alarms can be enabled for individual detectors or for the sum channel only. When the individual detectors are enabled, then the sum zones and the sum channel are also active. When the individual detectors are disabled, then only the sum channel is enabled.

Units of Measure

The activity units of measure are used where a value is displayed as an activity. When changing the activity unit, the activity is automatically converted into the new unit of measure. The following units of measure are supported:

- dpm
- pCi
- nCi
- µci
- mCi
- Ci

- Bq
- kBq
- MBq

The count rate units are used where a value is displayed as a count rate. The following units of measure are supported:

- cps
- cpm

Updating Background

A new background is taken after the Supervisor application is started. The background count time is set here and is valid from 30 to 600 seconds. The default value is 120 seconds. A background update is forced when returning to the Operate screen from the Setup menu, or when the Update button is pressed. During this time the Gamma Personnel Portal is considered not ready for use. Once a new background update is complete, the background is updated once every second.

The Sigma Limit and Sigma OK parameters are used to detect sudden increases or decreases in the background. If the sigma for the current one-second count is greater than the last one-second count, a tentative background update is started. If after 10 seconds the background falls to within the Sigma OK parameters, the background is restored and normal operation continues. If after the 10 seconds background is greater than the Sigma OK parameter, a background update is forced.

Background Update Method

The background update method involves using a simple "sliding window" for computing an average. A FIFO buffer the size of the number of seconds in the background update count time is created. After the full background update, this buffer will be filled with readings in cps. As additional counts are collected, the oldest count will be replaced with the newest count and an average will be calculated using the equation:

$$Avg_{New} = Avg_{Old} + \frac{x_{Newest} - x_{Oldest}}{N}$$

Where:

Avg_{New} = New background average in cps. This is the new value for R_B used in other equations.

Avg_{Old} = Old background average in cps.

x_{Newest} = Newest 1 second count in FIFO buffer.

x_{Oldest} = Oldest 1 second count in FIFO buffer.

N = Number of samples in the FIFO buffer.

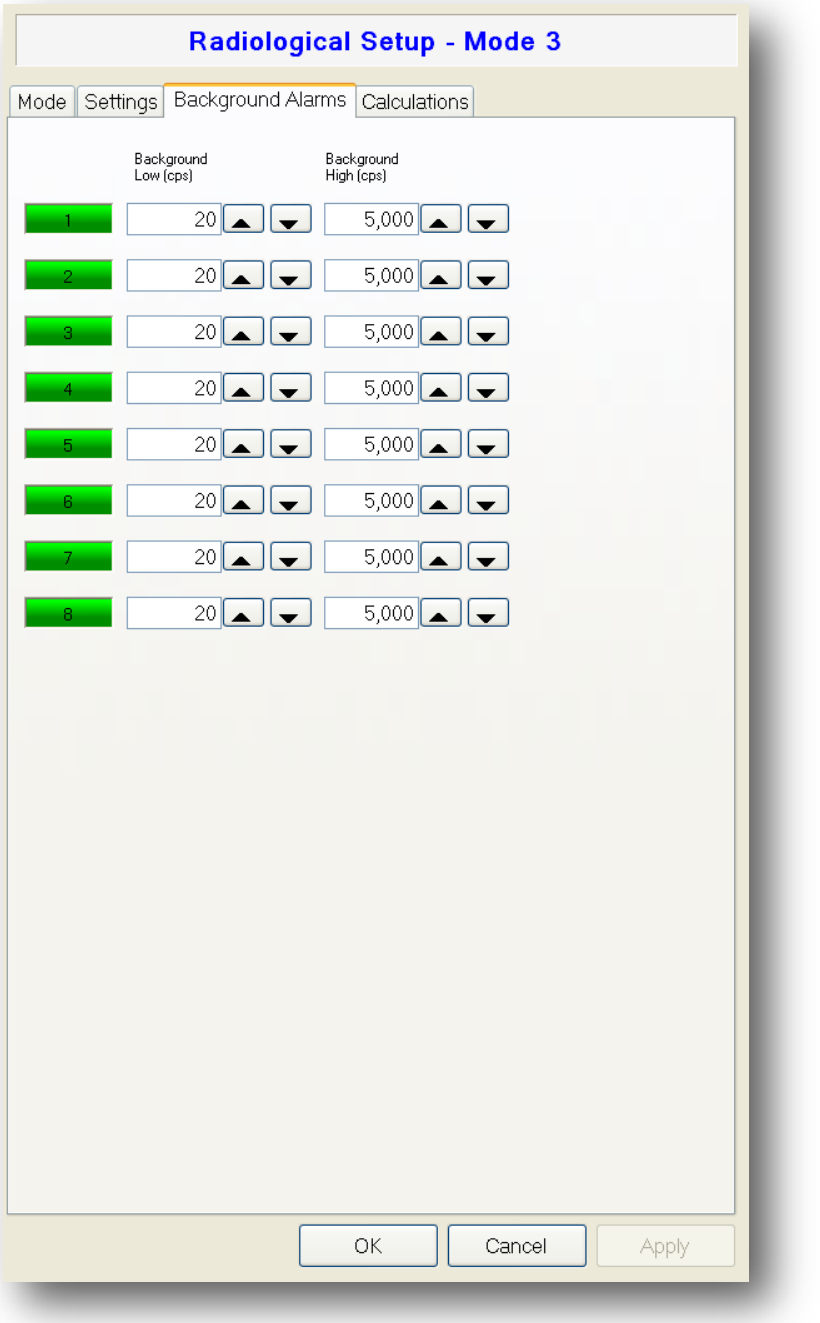
To determine when a new background update is required, the following equation is used:

$$\sigma = \frac{x_{Newest} - (Avg_{Old})}{\sqrt{Avg_{Old}}}$$

If the sigma is greater than or equal to Sigma Limit parameter, a tentative 10-second background update is started. If the count rate returns to within the sigma value set by the Sigma OK parameter of the old average rate at the end, the old background average is kept. If it has not, then a background update is forced

Background Alarms

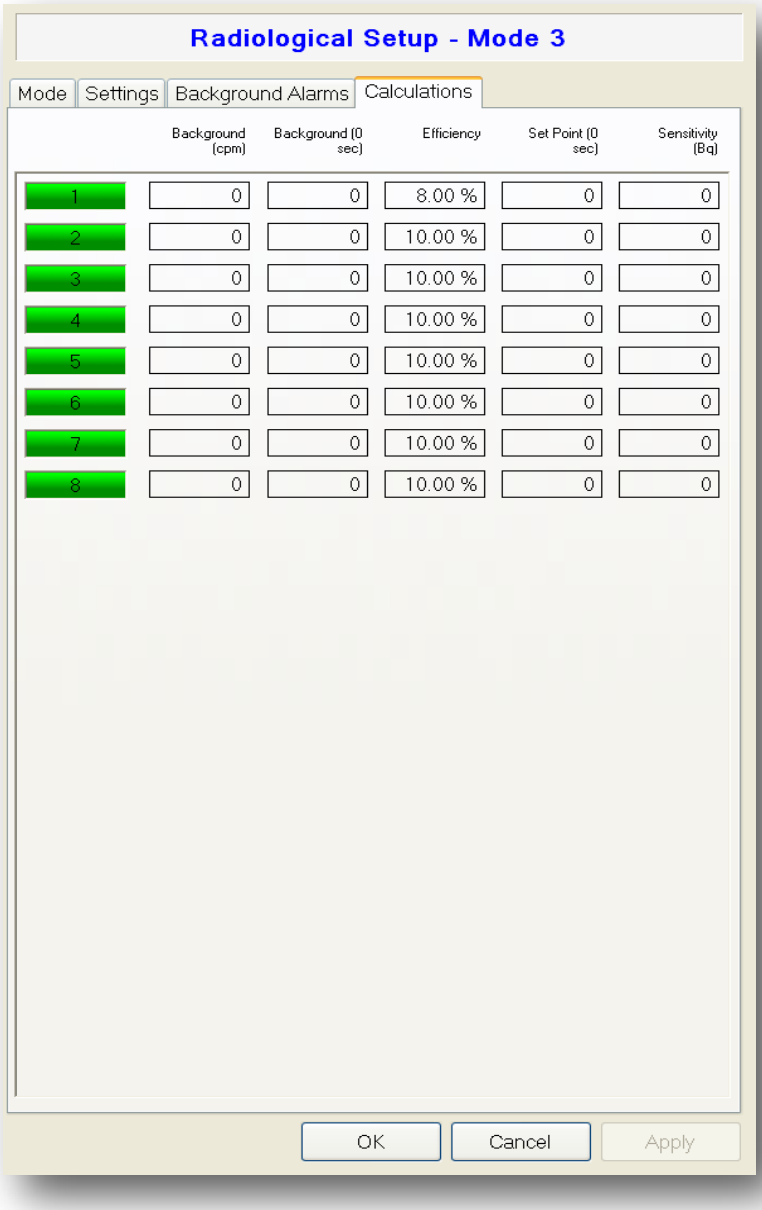
Each detector has a low and high background alarm set point which is used to identify a detector that is failing. If the background drops below the low set point or goes above the high set point a detector failure will occur. A low or high background alarm normally signals a failure of either the detector or its associated preamp electronics. A high background alarm can also warn of some nearby strong source of radiation.



Calculations

The Calculations tab shows the current alarm set point and other values relating to the counting mode for all detectors, sum zones, and sum channel. These values are updated once per second. In the far right column, Mode 1 and 3 show the sensitivity, and Mode 2 shows the false alarm probability.

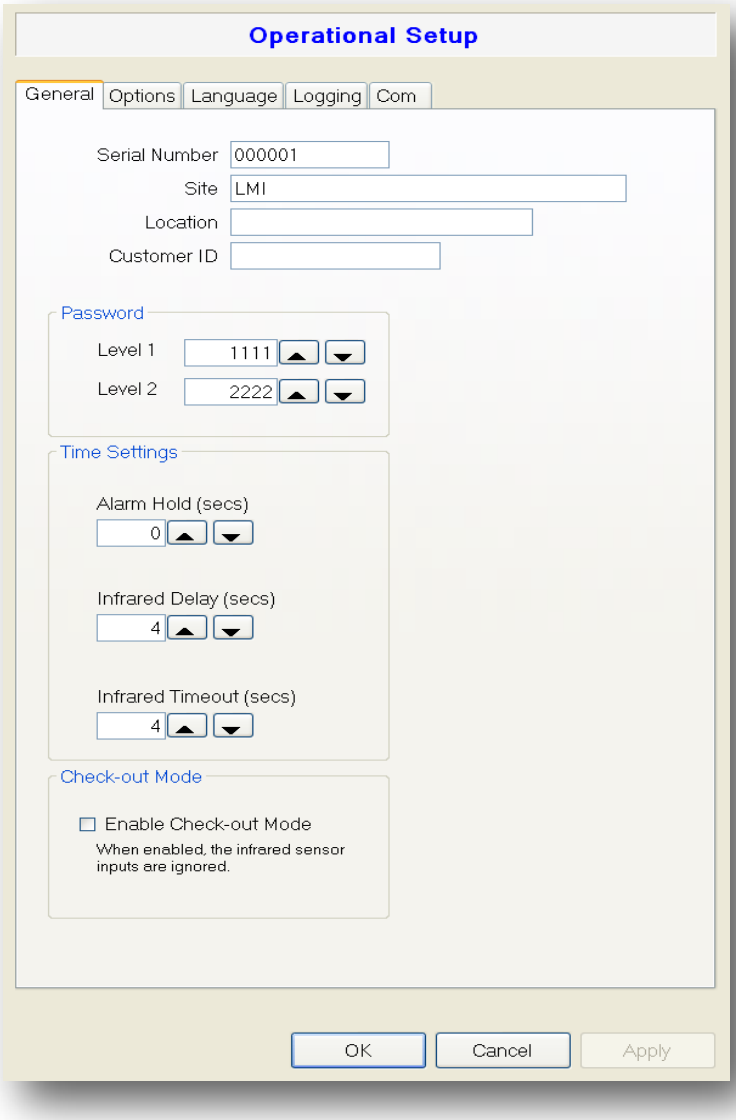
The background is displayed in cpm or cps, depending on the units selected along with the background and alarm set point adjusted for the current count time. The composite efficiency for each detector, sum zone, and sum channel is displayed.



Section 8

Operational Setup

The Operational Setup screen is used to configure the various options that define how the Supervisor software operates.



General

Serial Number

This sets the serial number of the Gamma Personnel Portal. This is displayed on the title bar of the Operate screen. The serial number is also stamped onto a plate mounted on the top, inside corner of the Gamma Personnel Portal.

Site

This user-defined field is 20 characters in length. The Site is displayed in the title bar of the Operate screen.

Location

This user-defined field is 15 characters in length. The Location is displayed in the title bar of the Operate screen.

Customer ID

This user-defined field is 10 characters in length. The Customer ID is displayed in the title bar of the Operate screen.

Password

Setup involves a two-level numeric password. A level 1 password does not allow access to the following setup screens: Radiological, Operational, FOM, Variance/Mean, and False Alarm. A password is required to access the setup menu and to exit/reboot/shut down the application.

Alarm Hold

This function sets the number of seconds before the alarm will automatically clear. When the alarm hold time is set to zero, pressing the Acknowledge button once within six seconds of the alarm will silence the audio, and pressing it again after six seconds will clear the alarm. When the alarm hold time is greater than zero, pressing once will silence the audio, and pressing again will have no effect.

Infrared Delay

The time in seconds from an IR sensor detecting a person until that person must enter the portal. If the portal is not entered in this time interval the portal assumes the sensor was triggered by a passer-by and returns to normal operation pending another sensor indication.

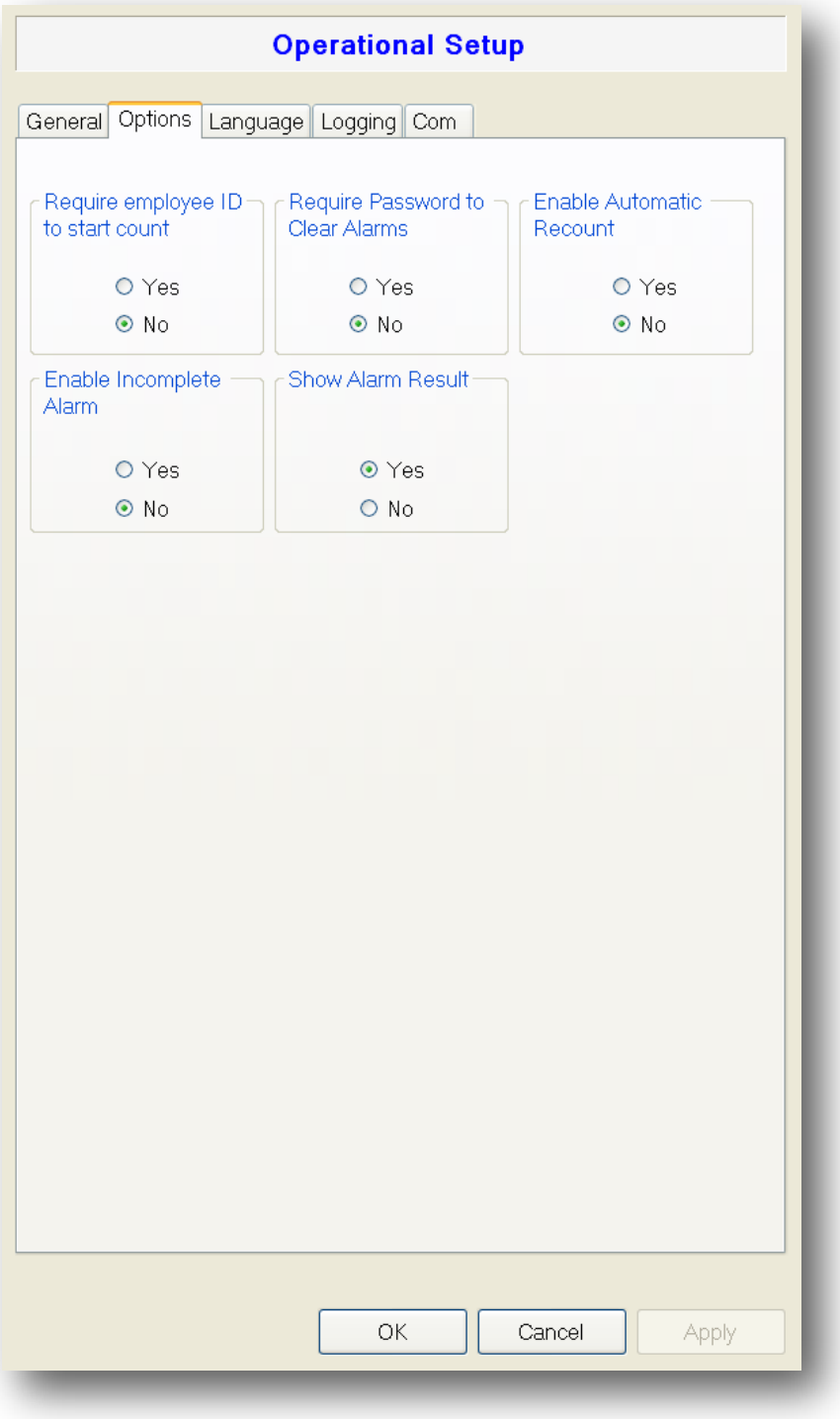
Infrared Timeout

Time in seconds that an IR sensor can remain on before triggering a sensor error. If an IR sensor input remains active for this amount of time a sensor error is assumed.

Enable Check-out Mode

The Enable Check-out mode option allows infrared sensor inputs to be ignored for the purpose of testing, calibration and maintenance.

Options


Operational Setup
General
Options
Language
Logging
Com
Require employee ID to start count
Yes
No
Require Password to Clear Alarms
Yes
No
Enable Automatic Recount
Yes
No
Enable Incomplete Alarm
Yes
No
Show Alarm Result
Yes
No
OK
Cancel
Apply

Require Employee ID to Start Count

When enabled, the user must enter in an Employee ID before a monitoring cycle can be started. The employee ID is logged in the scan log.

Require Password to Clear Alarms

When enabled, the level 1 or 2 password is required before the alarm can be cleared.

Enable Automatic Recount

Automatic recount causes a second count to be taken immediately after an alarm count.

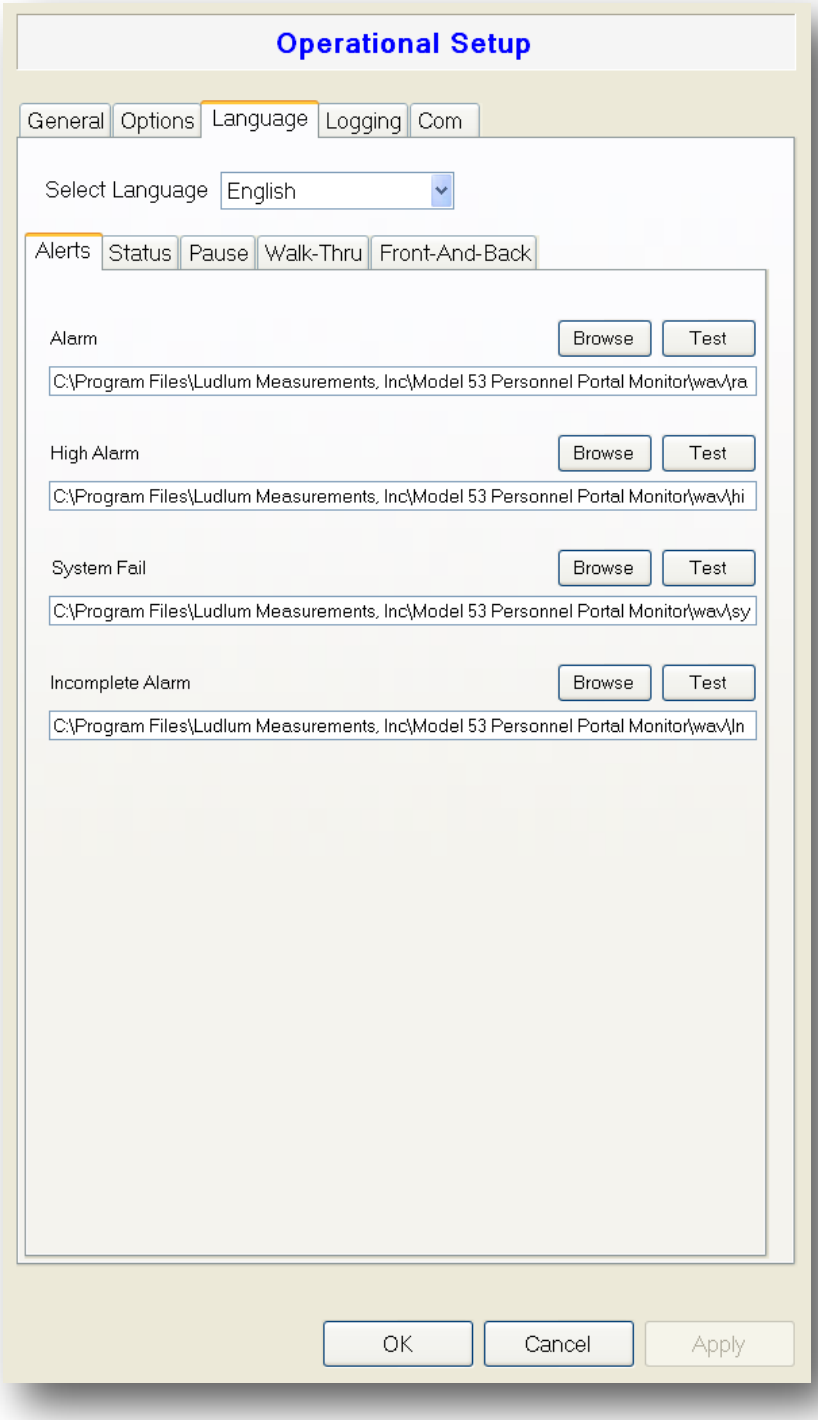
Enable Incomplete Alarm

When enabled, an incomplete alarm is triggered anytime the subject leaves the portal before completing the count procedure.

Show Alarm Result

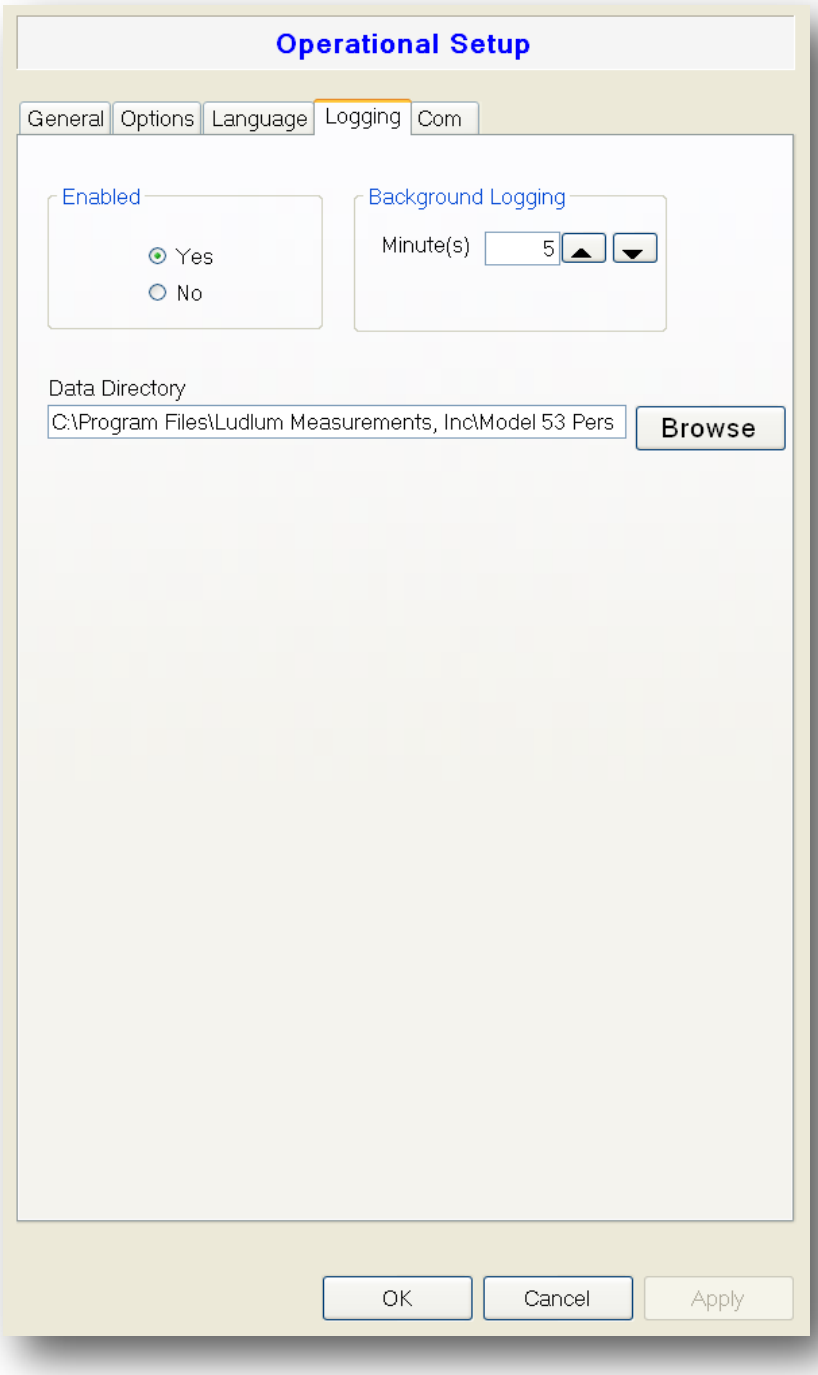
When enabled, this option will display as a percentage of how much over the alarm set point the reading was.

Language

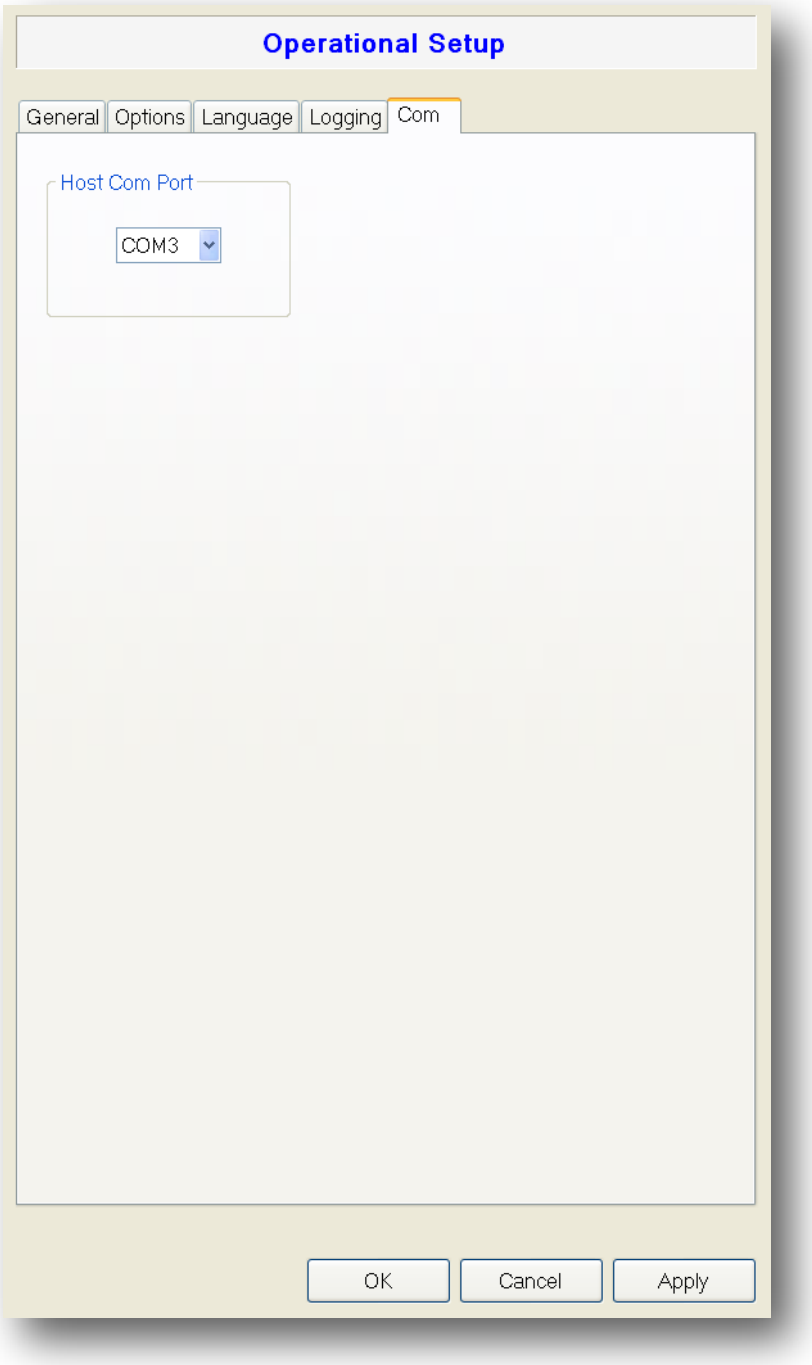


The Language tab allows the various audible voice alerts to be individually selected. The voice alert files are standard WAV files and can be replaced with custom audio files.

Logging



The Logging screen is used to set whether data logging is enabled, the directory where the data will be logged, and how often to log the background readings. When logging is disabled, no data will be saved to the scan, background, and system event logs.



Com

The Com screen is used to select the RS-232 communication port used by the onboard computer to the host board. This is set at the factory and normally should not need to be changed.

Section 9

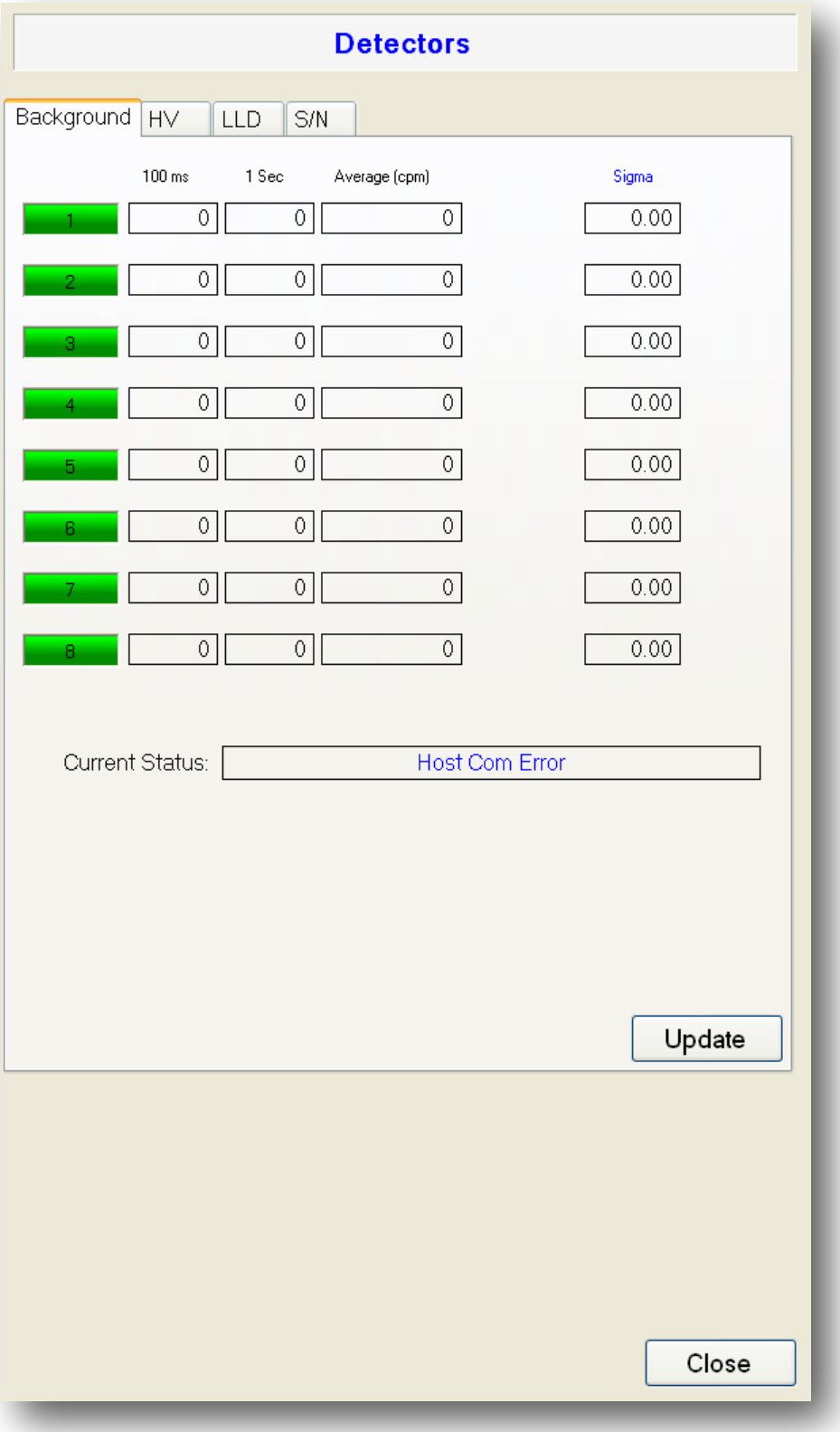
Detectors

The Detectors screen is used to view and set the detector's high voltage, lower level discriminator, and upper level discriminator. The calibration constants can be set through an easy-to-use, wizard which guides the user through the process. The current background readings can also be viewed here.

Background

The background screen (see screen shot on following page) shows the current background detail for each detector. Status for each detector is displayed using the background color of the detector indicators. Count data is received from the host board every 100 ms. These 100 ms counts are accumulated together every one second. The Average count is the current background average. The Sigma is the standard deviation from the old background average and the new one-second count.

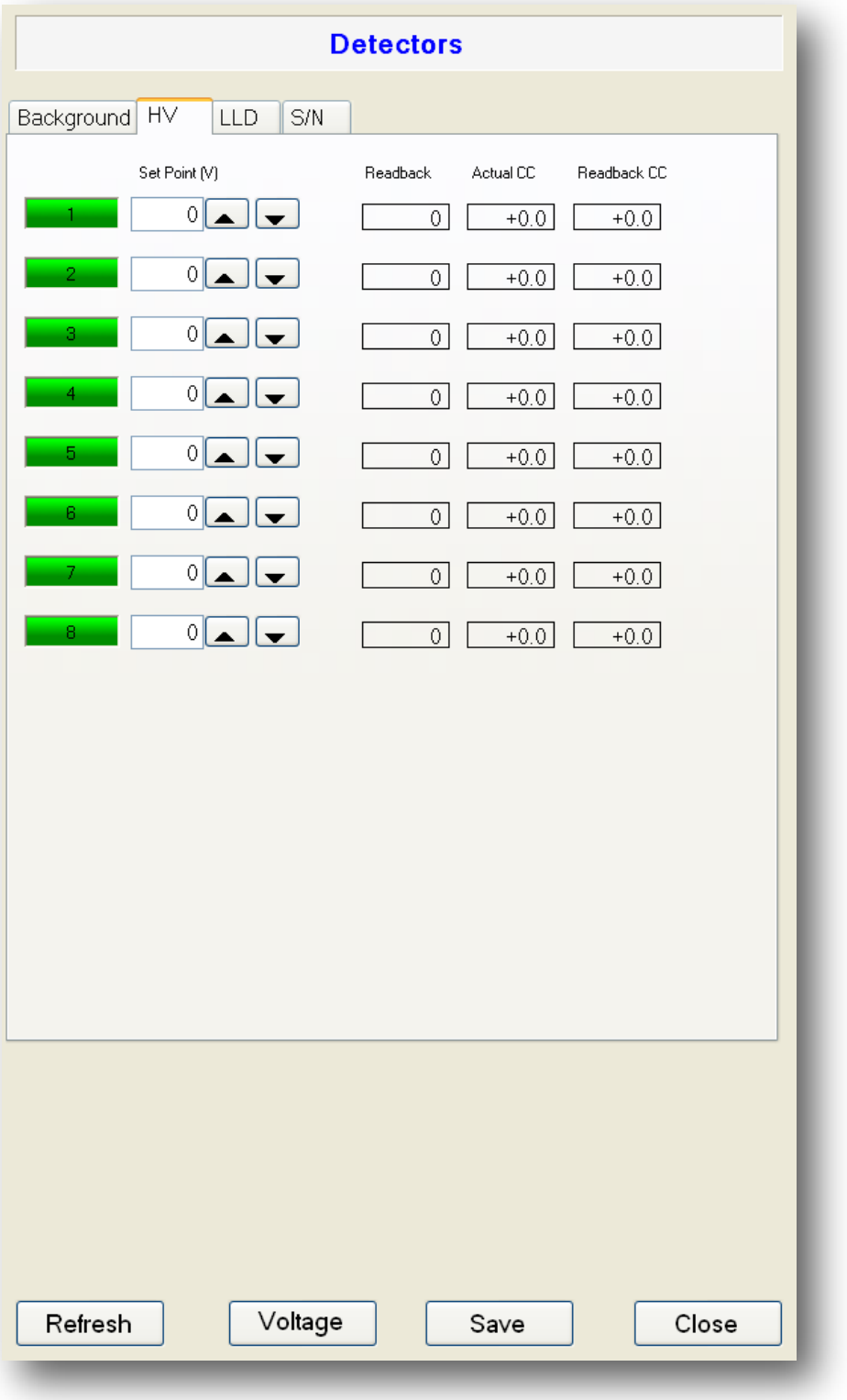
These values only update when the background is updating. The detector indicators will change color to indicate the detector's status with green for OK, yellow for fail, and red for alarm. The current Gamma Personnel Portal status is displayed at the bottom. Press the Update button to start a new background update cycle.


Detectors
Background
HV
LLD
S/N
100 ms
1 Sec
Average (cpm)
Sigma
1 0 0 0 0.00
2 0 0 0 0.00
3 0 0 0 0.00
4 0 0 0 0.00
5 0 0 0 0.00
6 0 0 0 0.00
7 0 0 0 0.00
8 0 0 0 0.00
Current Status:
Host Com Error
Update
Close

The background screen (previous page) shows the current background detail for each detector. Status for each detector is displayed using the background color of the detector indicators. Count data is received from the host board every 100 ms. These 100 ms counts are accumulated together every one second. The Average count is the current background average. The Sigma is the standard deviation from the old background average and the new one-second count.

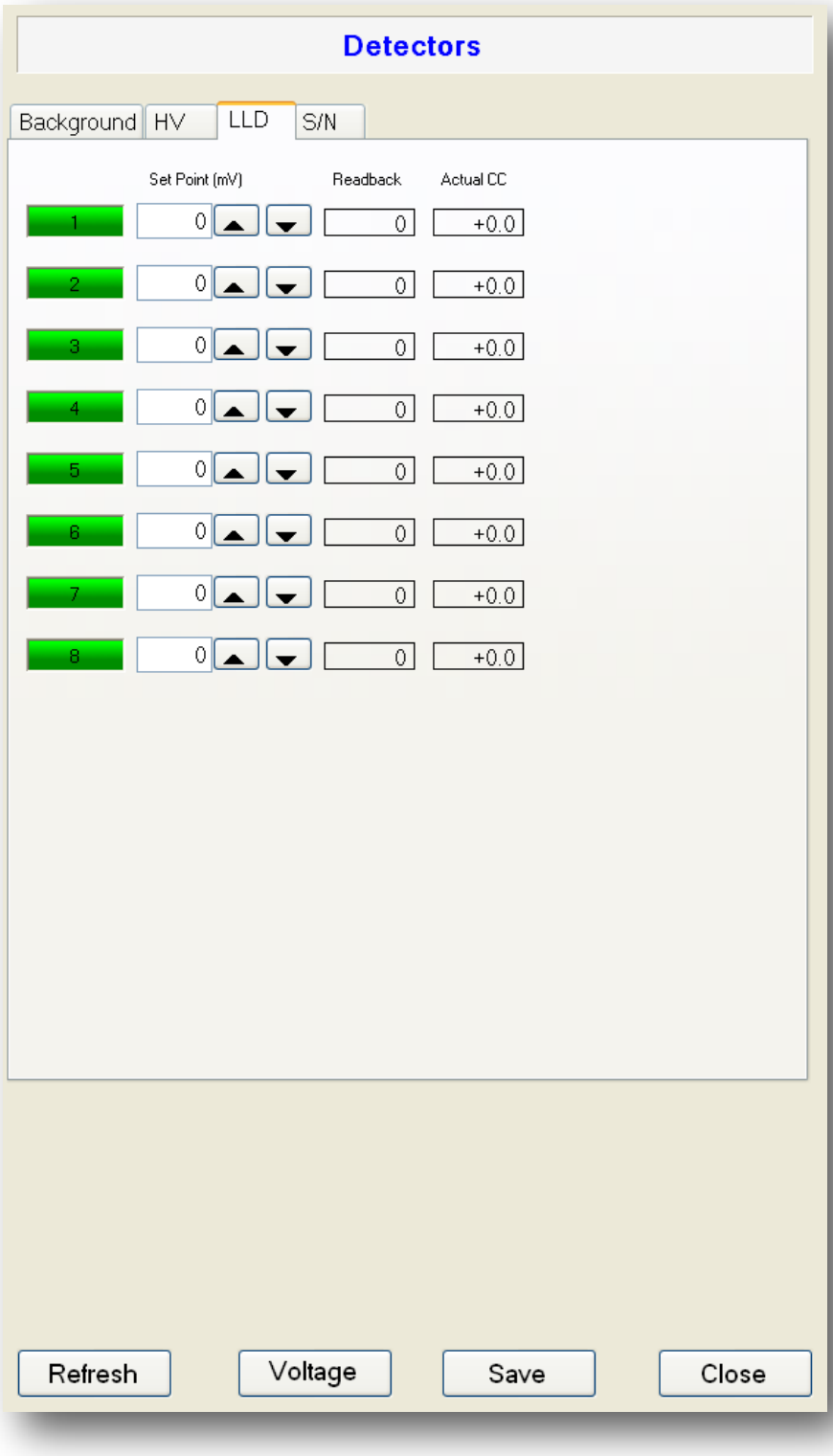
These values only update when the background is updating. The detector indicators will change color to indicate the detector's status with green for OK, yellow for fail, and red for alarm. The current Gamma Personnel Portal status is displayed at the bottom. Press the Update button to start a new background update cycle.

High Voltage (HV)



The HV screen (previous page) displays the current high-voltage set point and calibration constants for each detector. High voltage is typically set using the FOM-HV screen. Read-back voltage is the value from the A/D converter. There are two calibration constants associated with the high voltage. The Actual calibration constant is used to calibrate the high-voltage output while the read-back calibration constant is used to calibrate the read-back value from the A/D converter. The high voltage is adjustable from 0 to 2500 V and the calibration constants are adjustable from -9.9 to +9.9. Click the Refresh button to reload the parameters from all detector boards. After changing the high-voltage set point, click the Save button to apply the changes. The calibration constants can only be changed from the Voltage Calibration Wizard. See Page 41 for more information on the Voltage Cal button.

Lower Level Discriminator (LLD)



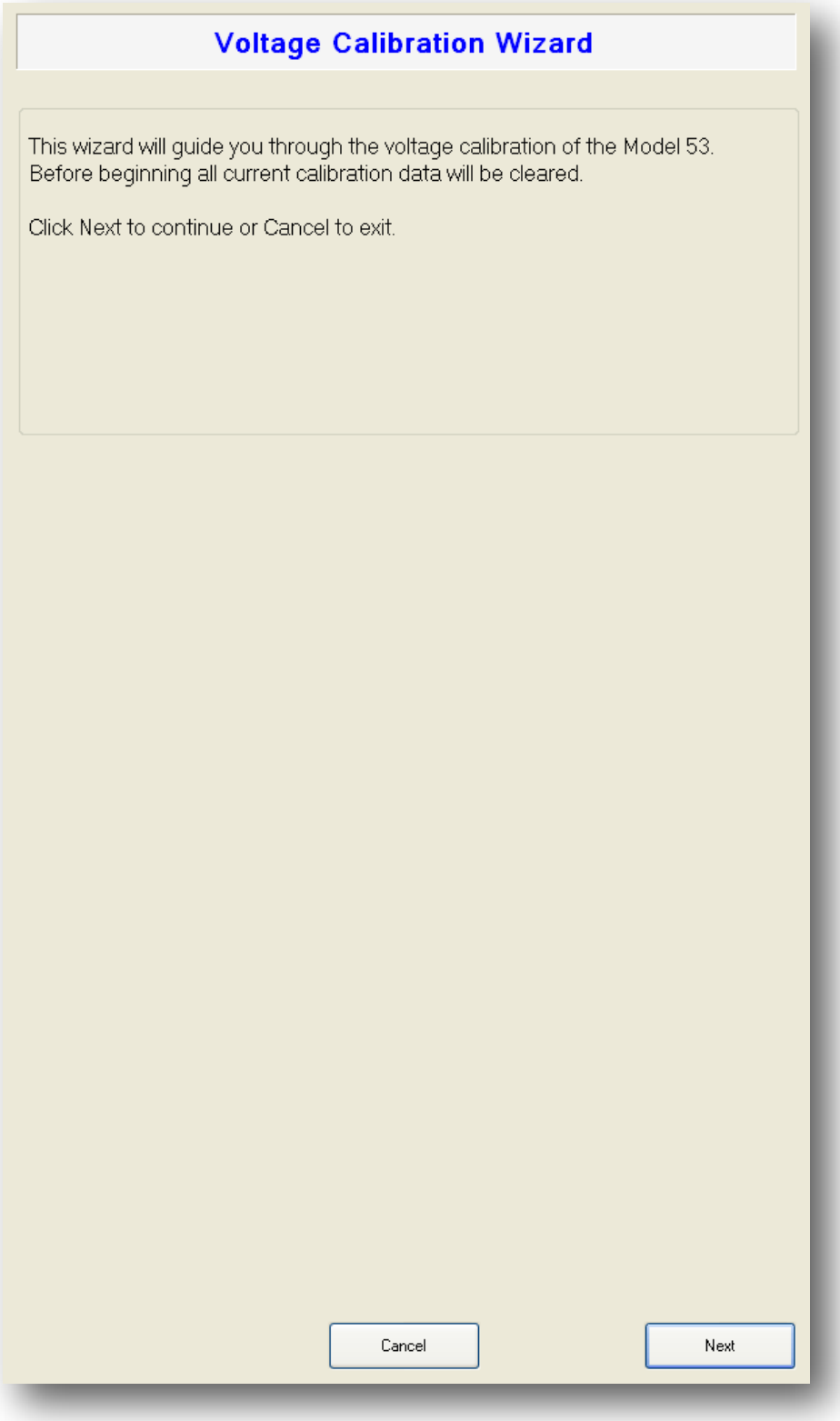
The LLD screen (previous page) displays the current lower-level set point and calibration constant for each detector. Read-back is the value from the A/D converter, and should be close to the set point. The Actual calibration constant is used to calibrate the LLD output. The LLD is adjustable from 0 to 3300 mV, and the calibration constant is adjustable from -9.9 to +9.9. Click the Refresh button to reload the parameters from all detector boards. After changing the LLD set point, click the Save button to apply the changes. The calibration constant can only be changed from the Voltage Calibration Wizard. See the following page for more information on the Voltage Cal button.

Voltage Calibration

The Voltage Calibration Wizard (see next page) is accessed through the Voltage Cal button. The wizard guides the user through the process of setting the calibration constants for each detector. The following parameters will be set by the wizard:

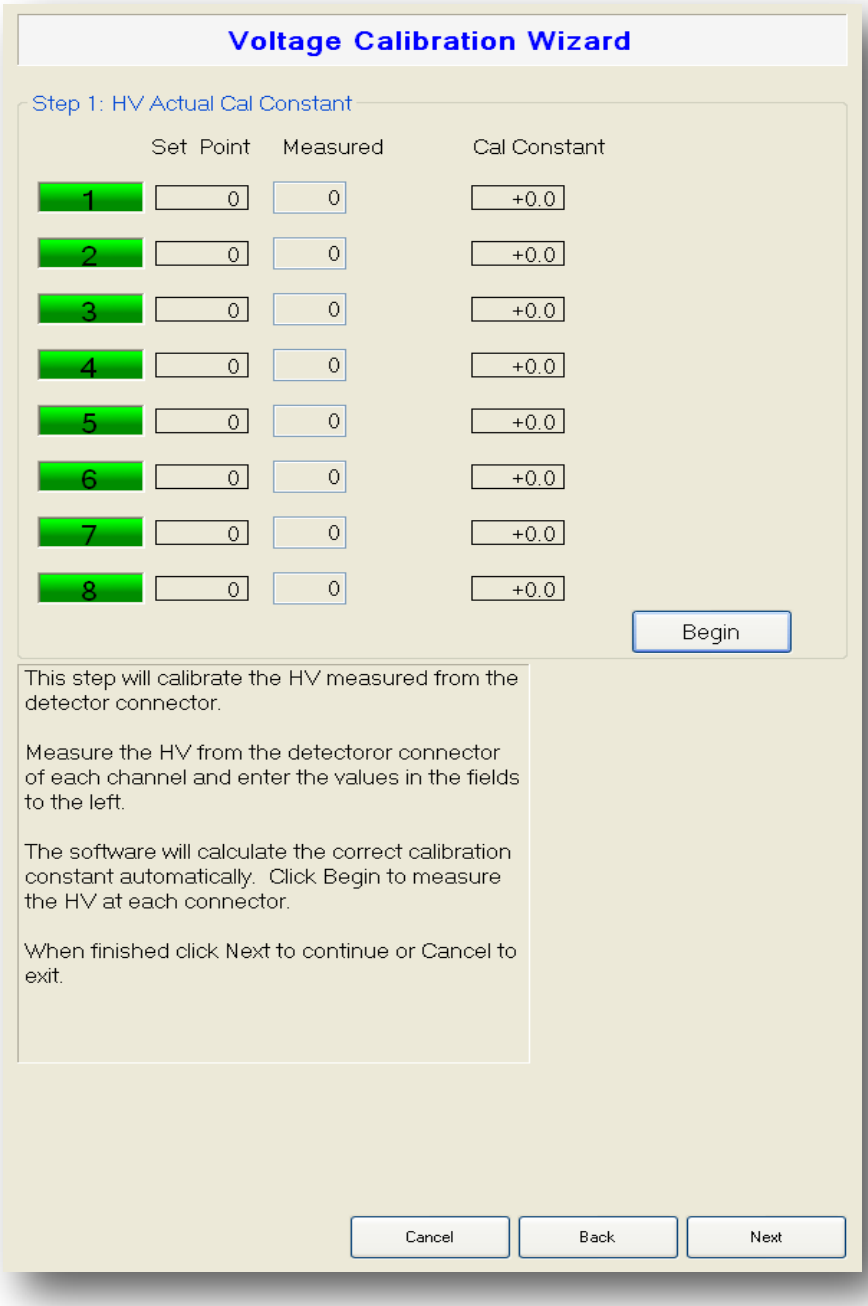
- HV Actual Calibration Constant
- HV Read Back Calibration Constant
- LLD Actual Calibration Constant
- ULD Actual Calibration Constant

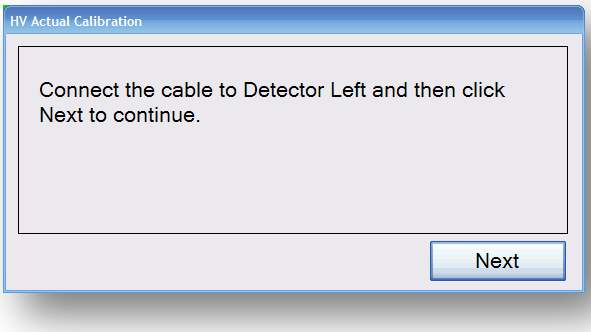
The wizard automatically calculates the calibration constant based on the measurements entered for each detector. All calibration constants are zeroed out at the beginning. Calibration requires a Model 500 Pulser with high-voltage readout or a high-impedance voltmeter, with at least 1000 Megohm meter input resistance. Click the Next button to begin the calibration.


Voltage Calibration Wizard
This wizard will guide you through the voltage calibration of the Model 53.
Before beginning all current calibration data will be cleared.
Click Next to continue or Cancel to exit.
Cancel
Next

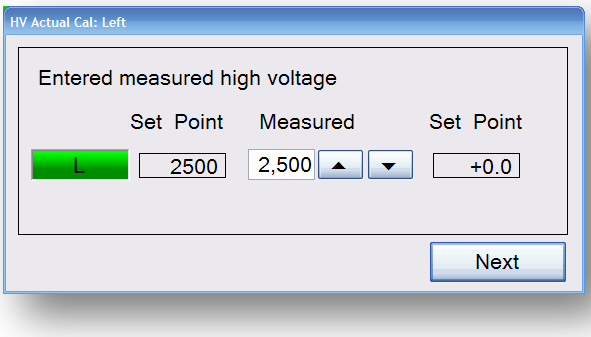
HV Actual Calibration Constant

Click the Begin button to start the process of calibrating the HV Actual Calibration Constant. The calibration constant is calculated automatically by entering the high voltage measured at the detector connector. The wizard will set the high voltage of all detectors to zero and then prompt for the cable to be connected to the first detector. The detector order is: Left, Top, Right, Bottom, Front Door, and Rear Door.



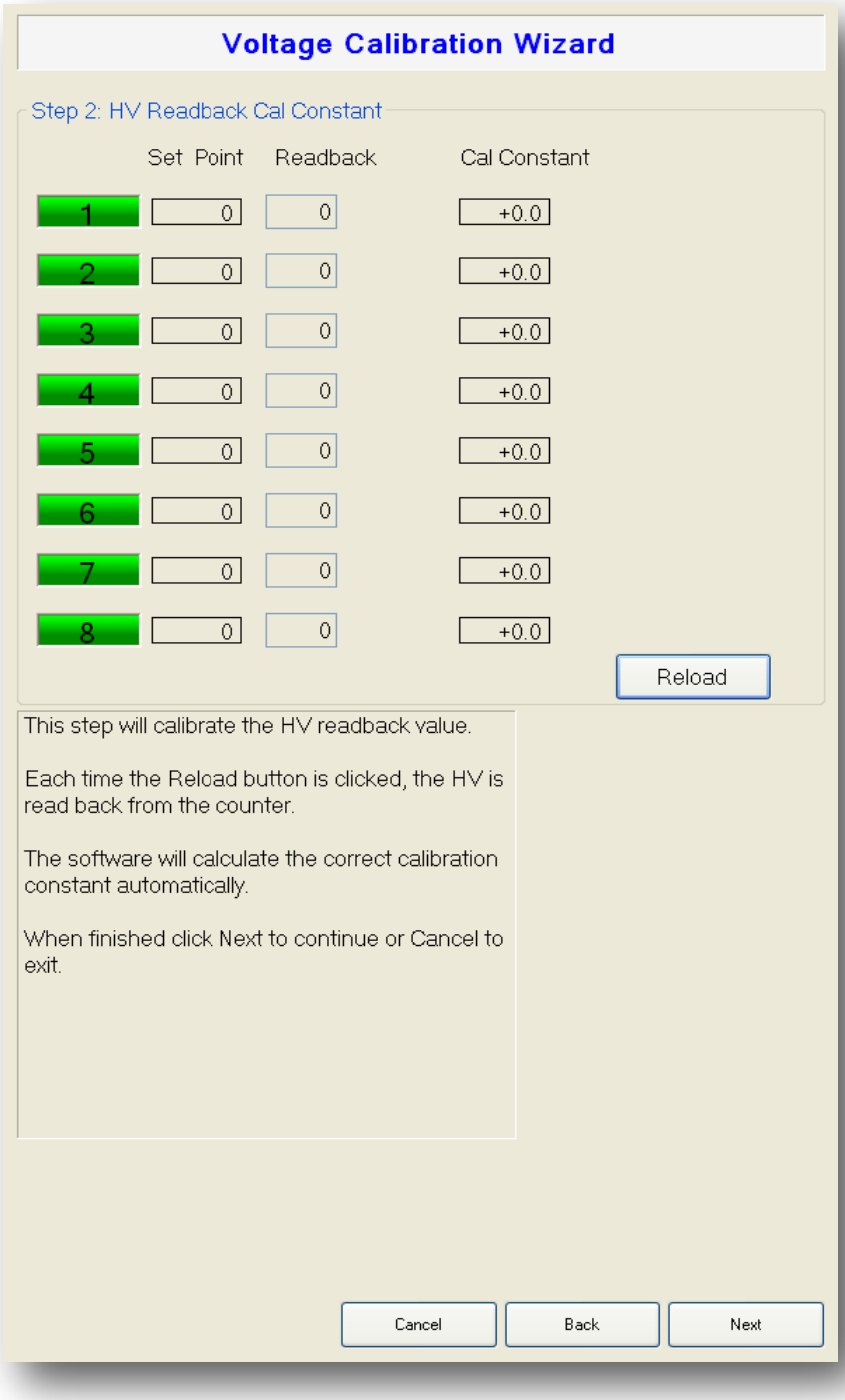


After connecting the cable and clicking the Next button, the high voltage will be restored to the set point. Enter the measured high voltage and click Next. Continue repeating this process until all detectors are completed.



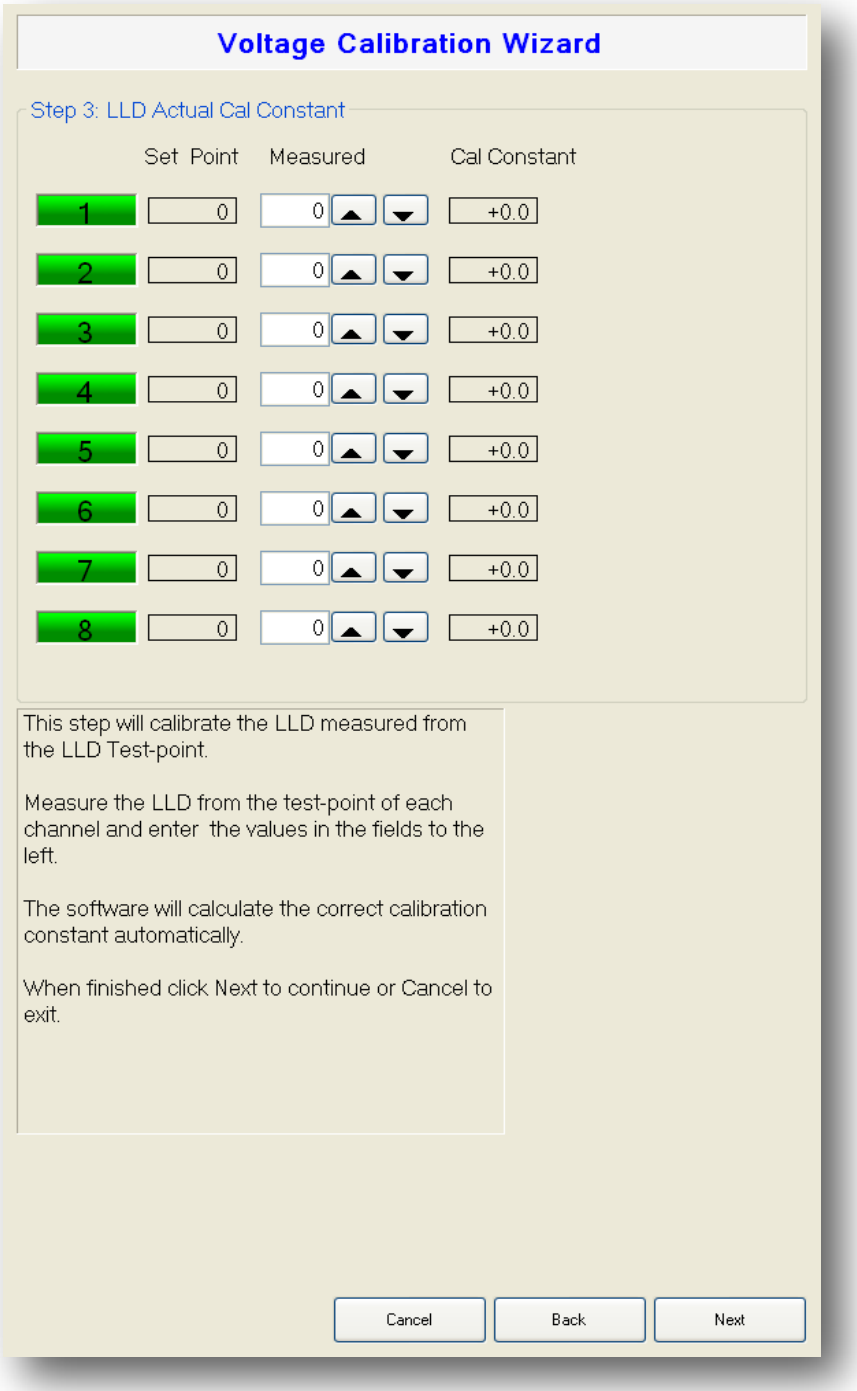
HV Read Back Calibration Constant

The calibration of the Read Back value is automatic. The wizard will automatically calculate a new calibration constant each time the Reload button is clicked. If the values returned are consistent, click the Next button.



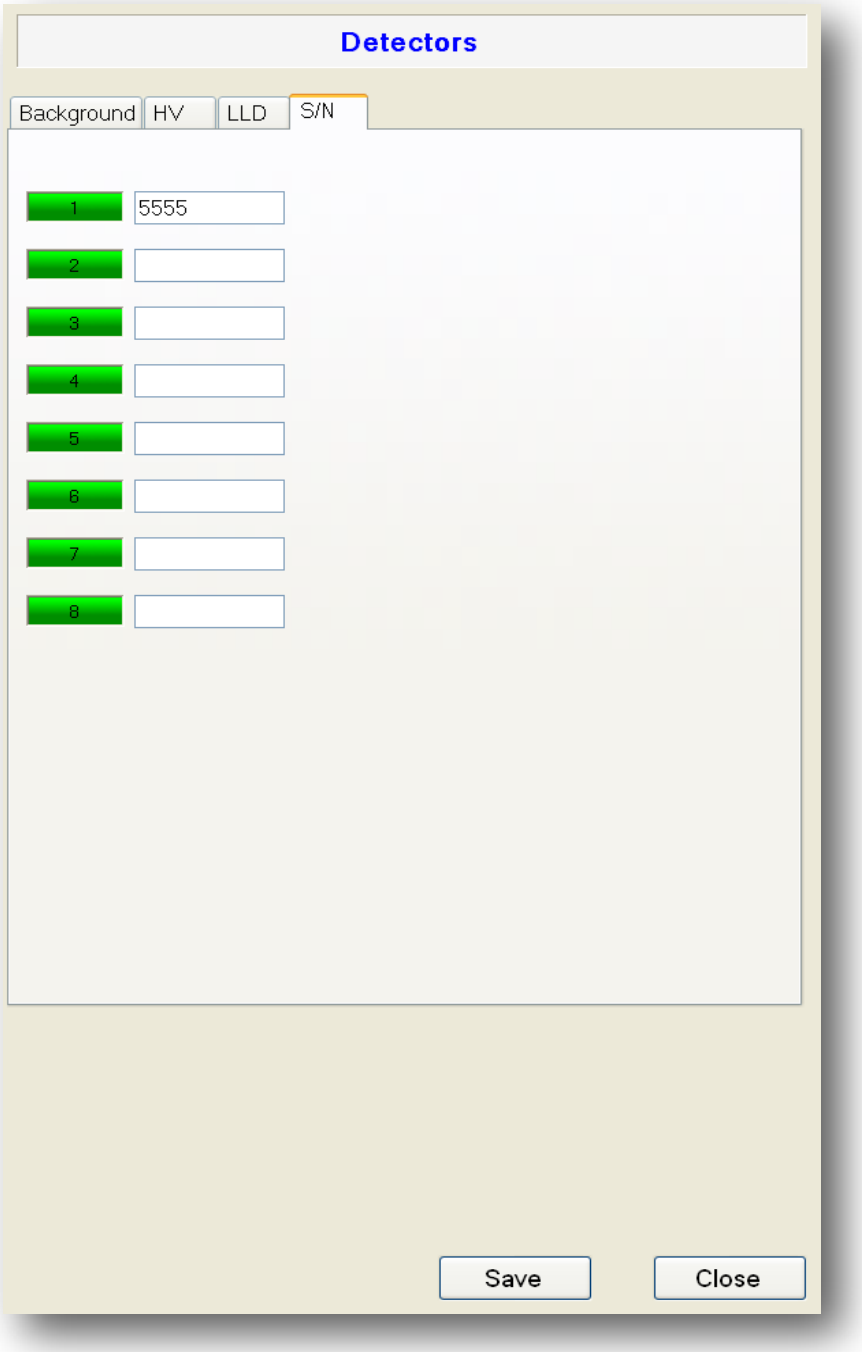
LLD Actual Calibration Constant

The LLD actual calibration constant is obtained by measuring the LLD from the test point on each detector and entering the measured reading in the appropriate field. The calibration constant is automatically calculated. Click the Next button when finished.



Detector Serial Numbers

The detector serial numbers screen allows the user to enter and save the serial number of each detector in the Model 53 Portal Monitor. This is to allow easy lookup and tracking of detector numbers via software, rather than being forced to open the Model 53 covers in order to check detector serial numbers.



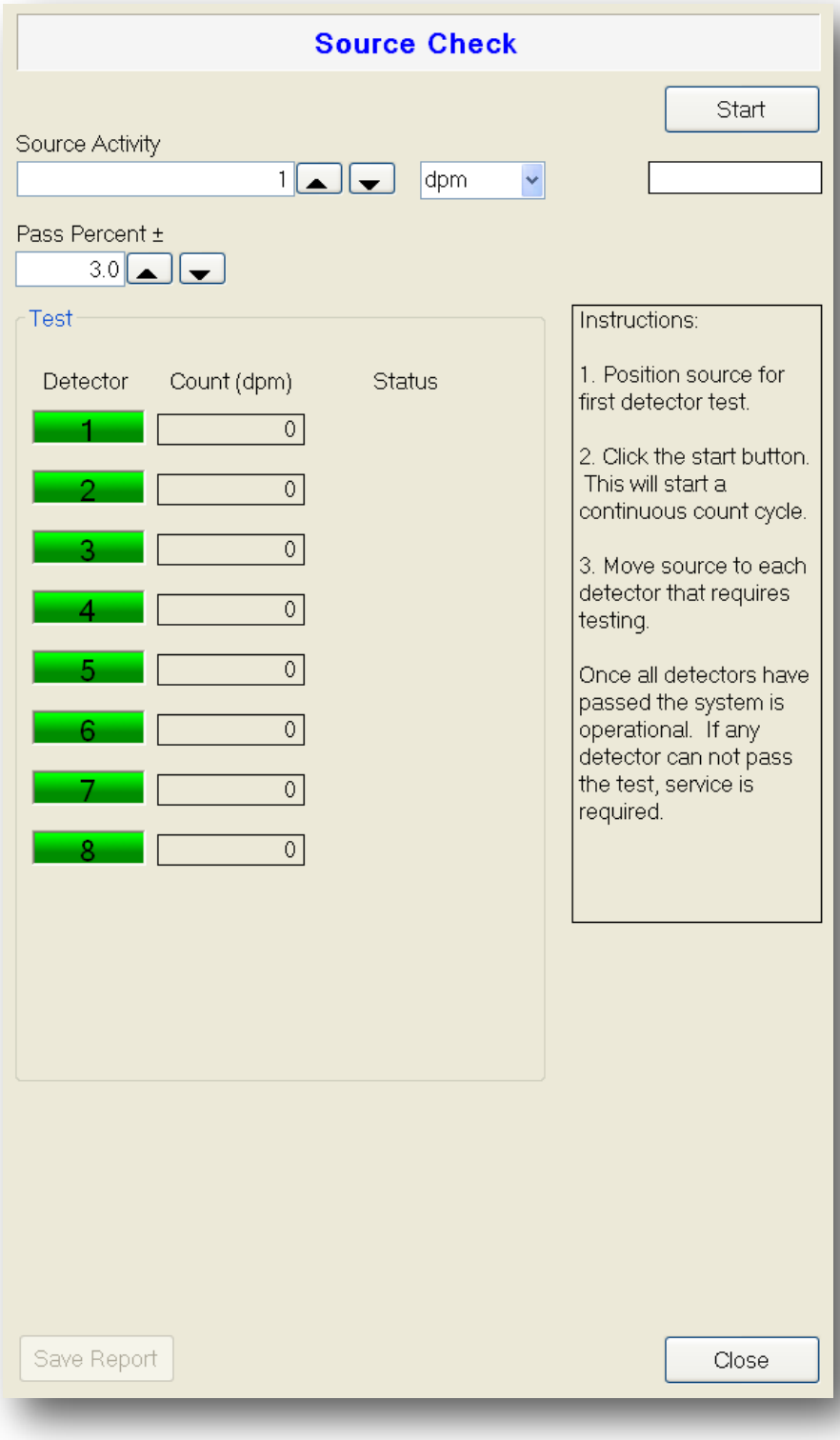
Section

10

Source Check

The Source Check screen (see screen shot on following page) can be used to perform a daily test on the detectors to verify they are still functioning correctly.

Enter the source size of the check source and a percentage that the counts must fall within to be considered acceptable. Open the door, position the source, and close the door. Click the Start button to start the test. The system will run continuous counts using the normal monitoring count time until all detectors pass or the test is cancelled. The composite efficiency is used to convert the count rate into activity


Source Check
Start
Source Activity
1
dpm
Pass Percent ±
3.0
Test
Detector
Count (dpm)
Status
1
0
2
0
3
0
4
0
5
0
6
0
7
0
8
0
Instructions:
1. Position source for first detector test.
2. Click the start button. This will start a continuous count cycle.
3. Move source to each detector that requires testing.
Once all detectors have passed the system is operational. If any detector can not pass the test, service is required.
Save Report
Close

Section

11

False Alarm

The False Alarm screen (see screen shot on following page) is used to run a series of counts to determine the false alarm rate. The number of samples to run defaults to 1000, but can be changed from 10 to 10,0000. The Gamma Personnel Portals current background update and count times are used to perform the test.

After setting the number of samples, click the Start button to begin the false alarm test. A new background will be acquired before the test is started. The current sample number, count time remaining, end time, and total false alarms are displayed.

Should an alarm be posted, an immediate background update will follow so as to track any potentially changing background average.

During the false alarm test, the current background, gross count, total alarms, alarm set point, and highest count are displayed in the grid for each detector. Click the Cancel button to stop the test.

The criterion for an alarm is satisfied when the net (background-subtracted) count rate for any detector exceeds the alarm set point (R_A).

$$R_A = K_B \sqrt{\frac{R_B}{T} + \frac{R_B}{T_B}}$$

Where:
R_A = Alarm set point in cps.

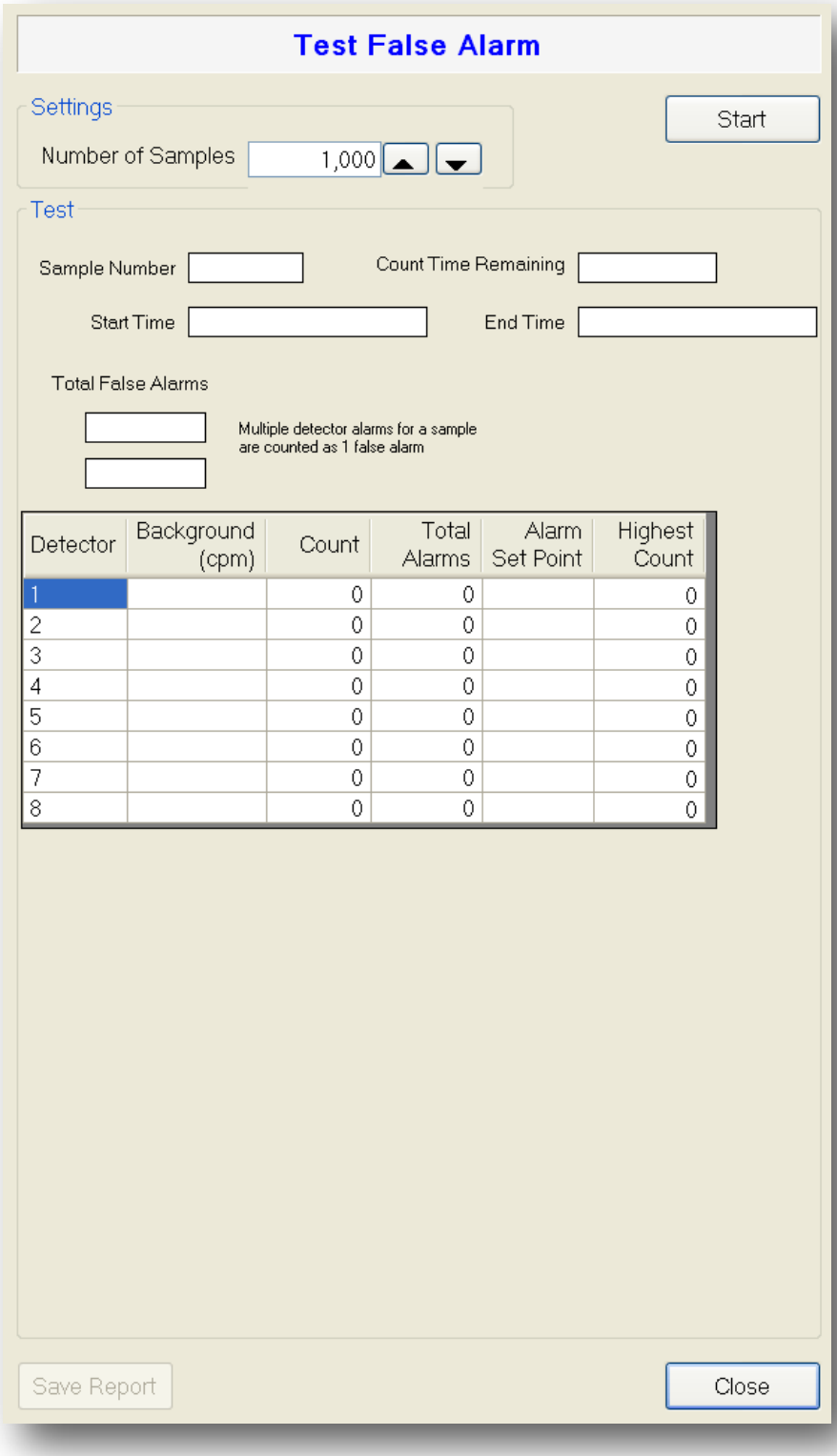
K_B = Background sigma coefficient, which determines the false alarm probability.

R_B = Average background count rate in cps for the detector.

T = Count time in seconds.

T_B = Background count time in seconds.

Only one false alarm will be reported regardless of how many detectors alarmed.


Test False Alarm
Settings
Number of Samples
1,000
Start
Test
Sample Number
Count Time Remaining
Start Time
End Time
Total False Alarms
Multiple detector alarms for a sample are counted as 1 false alarm
Detector
Background (cpm)
Count
Total Alarms
Alarm Set Point
Highest Count
1 0 0 0
2 0 0 0
3 0 0 0
4 0 0 0
5 0 0 0
6 0 0 0
7 0 0 0
8 0 0 0
Save Report
Close

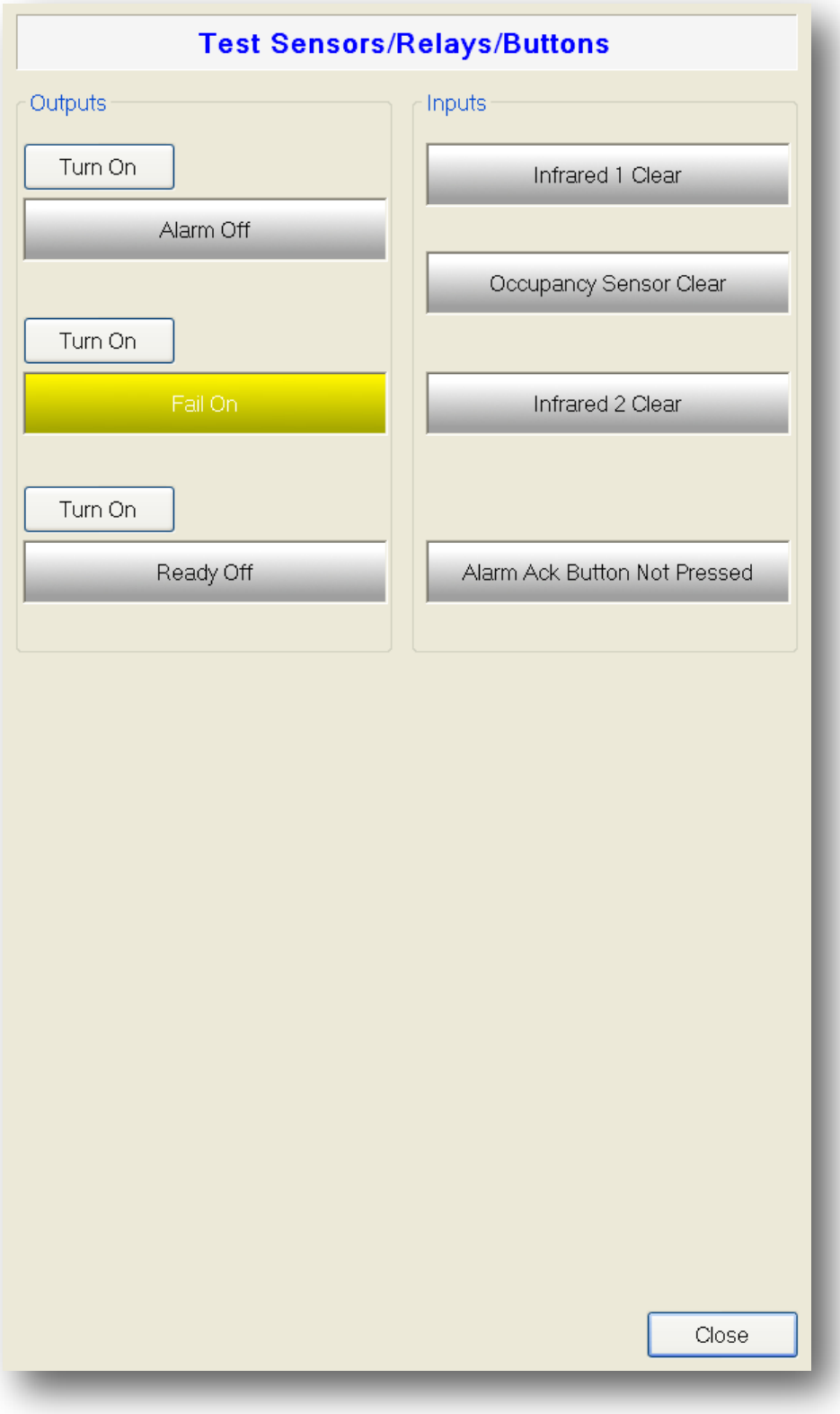
Section

12

Buttons/Relays

The Buttons/Relays screen (see screen shot on following page) is use to test the various inputs and outputs on the Gamma Personnel Portal.

The outputs include the lights in the stack and relays. The inputs include the IR sensors, occupancy sensor and push-buttons. Click on the buttons to turn on/off the lights/relays. When a push-button is pressed, the indicator should light up to indicate the button was read successfully. The Gamma Personnel Portal should be taken out of service if any button, sensor, or light fails to respond correctly.


Test Sensors/Relays/Buttons
Outputs
Turn On
Alarm Off
Turn On
Fail On
Turn On
Ready Off
Inputs
Infrared 1 Clear
Occupancy Sensor Clear
Infrared 2 Clear
Alarm Ack Button Not Pressed
Close

Section

13

Variance/Mean

The Variance/Mean screen (see screen shot on the following page) is used to determine the stability of the background and should be run once the Gamma Personnel Portal is setup. The number of samples and count time are user adjustable.

Click the Start button to begin the test. The current sample number, count time remaining, and end time are displayed along with the detector count, mean, and variance. Click the Cancel button to stop the test.

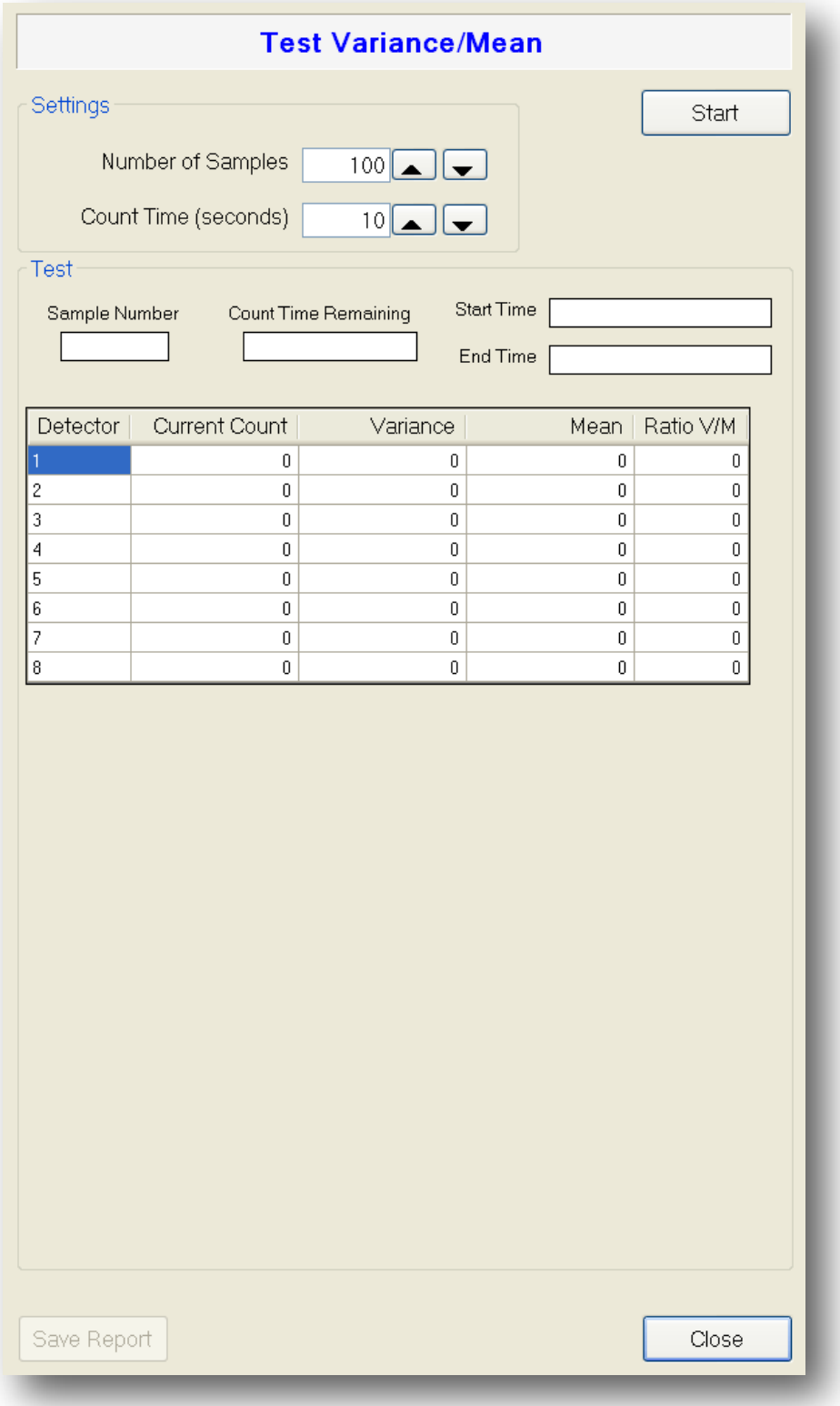
The algorithm for computing the variance and mean at the end of each sampling period follows:

Initialization at beginning of Variance/Mean Test

```
mean = 0
sampleCounter = 0
m2 = 0
```

At end of each count:

```
sampleCounter = sampleCounter + 1
delta = count – mean
mean = mean + delta
m2 = m2 + delta * (reading / sampleCounter)
variance = m2 / (sampleCounter -1)
```

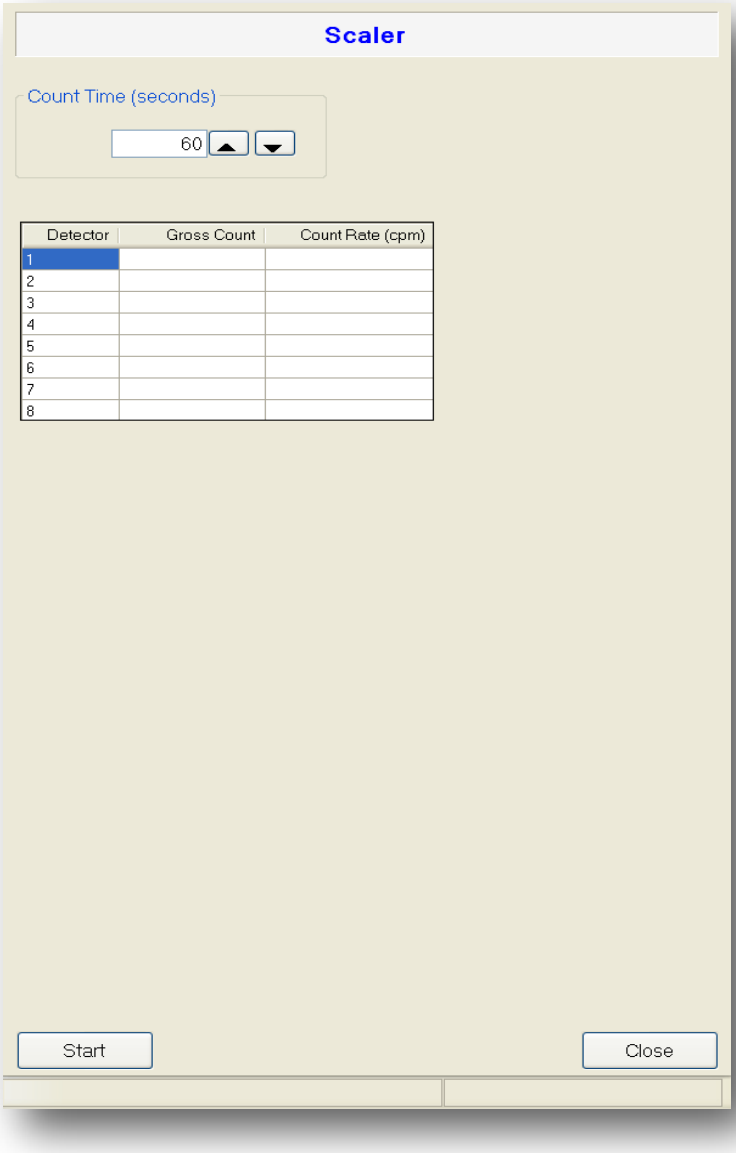

Test Variance/Mean
Settings
Start
Number of Samples
100
Count Time (seconds)
10
Test
Sample Number
Count Time Remaining
Start Time
End Time
Detector
Current Count
Variance
Mean
Ratio V/M
1 0 0 0 0
2 0 0 0 0
3 0 0 0 0
4 0 0 0 0
5 0 0 0 0
6 0 0 0 0
7 0 0 0 0
8 0 0 0 0
Save Report
Close

Section

14

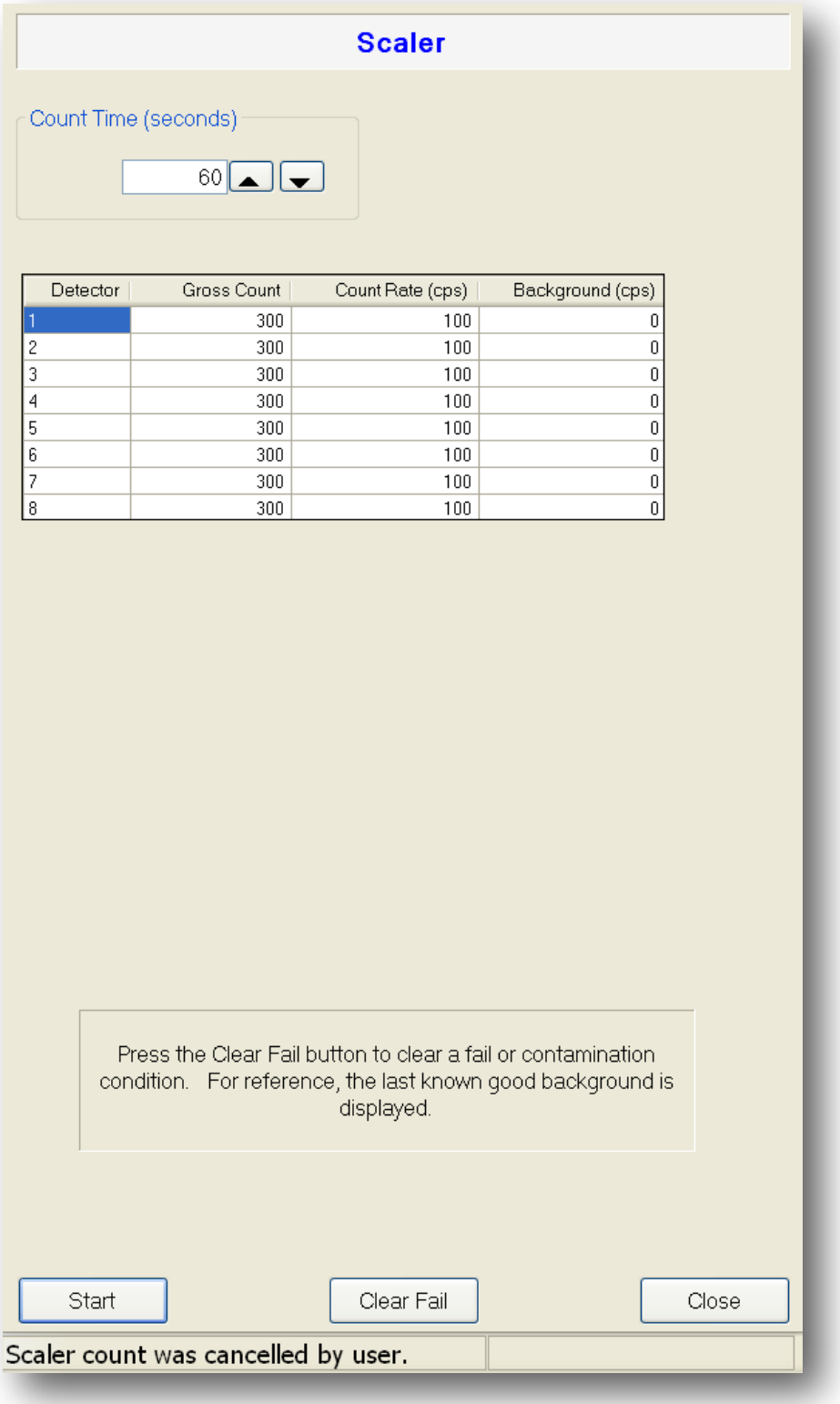
Scaler

The Scaler screen provides a way to start a count and see the results as gross counts and count rate. It is also used to clear

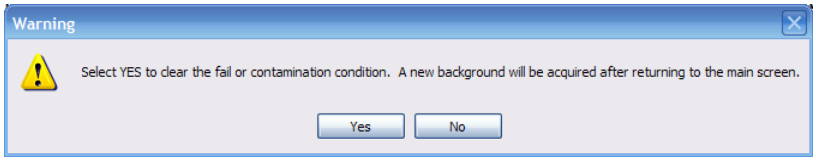


Set the desired count time in seconds and click the Start button. Click the Cancel button to stop a count that is in progress.

If the Gamma Personnel Portal is in a fail condition caused either by a background alarm or contamination, a fourth column will be displayed showing the last good background for comparison along with a button that will be used to clear the fail condition.


Scaler
Count Time (seconds)
60
Detector
Gross Count
Count Rate (cps)
Background (cps)
1 300 100 0
2 300 100 0
3 300 100 0
4 300 100 0
5 300 100 0
6 300 100 0
7 300 100 0
8 300 100 0
Press the Clear Fail button to clear a fail or contamination condition. For reference, the last known good background is displayed.
Start
Clear Fail
Close
Scaler count was cancelled by user.

Once the contamination has been cleaned off the detectors or the cause of the fail has been corrected, take a scaler count to verify that the background values have returned to normal. If the background has returned to normal for all detectors, click Clear Fail to clear the fail condition and exit back to the main screen. A residual contamination check will be automatically performed followed by a background update if no contamination is detected.



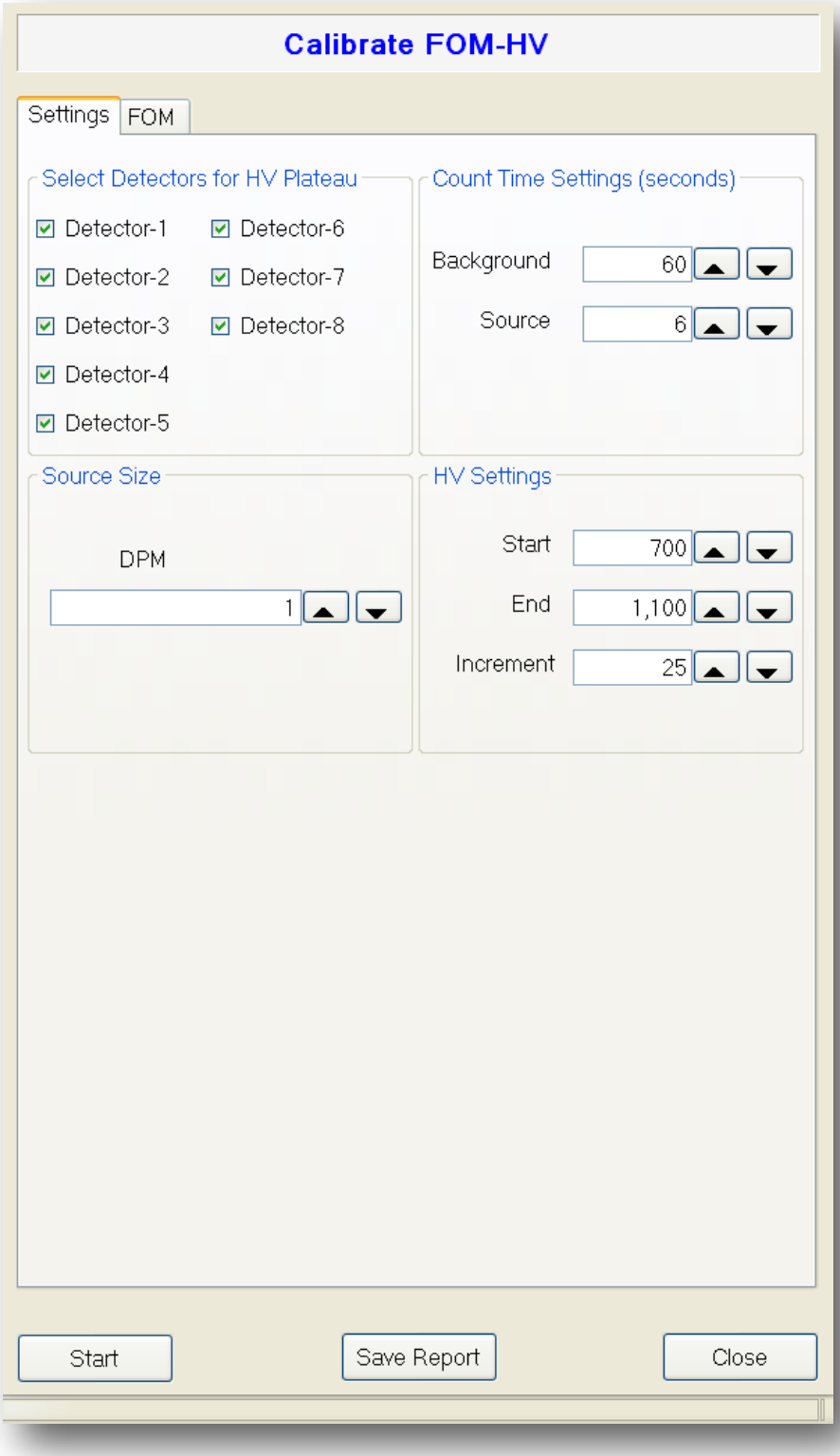
Section

15

FOM-HV

The FOM-HV screen is used to calculate a Figure of Merit to find the optimum high voltage operating point for each detector. A background count and source count are taken at various high-voltage set points, and the best high voltage is chosen.

The Settings tab (see following page) allows choosing of the detectors that are calibrated, along with the count time for background and source counts.


Calibrate FOM-HV
Settings
FOM
Select Detectors for HV Plateau
Detector-1
Detector-2
Detector-3
Detector-4
Detector-5
Detector-6
Detector-7
Detector-8
Count Time Settings (seconds)
Background
60
Source
6
Source Size
DPM
1
HV Settings
Start
700
End
1,100
Increment
25
Start
Save Report
Close

Select Detectors for HV Plateau

Select which detectors will be included in the calibration. The FOM-HV calibration can be run on multiple detectors or just a single detector.

Count Time Settings

The background and source count times can be set individually and are adjustable from 1 to 300 seconds.

Source Size

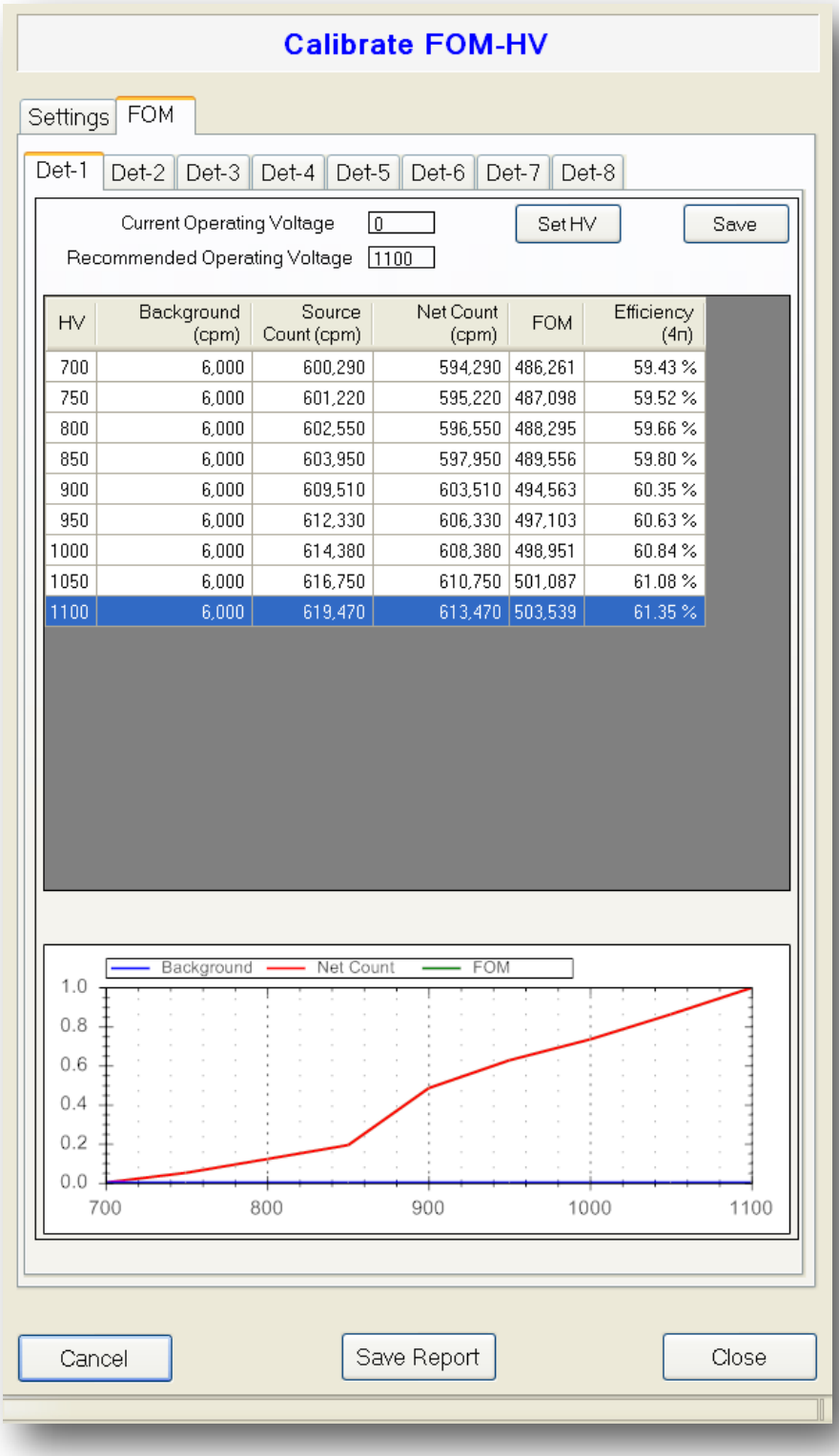
The source size in DPM is used to calculate the detector efficiency.

HV Settings

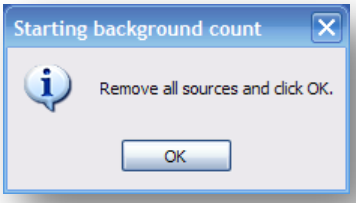
The start and end of the high-voltage plateau are defined. The default start high voltage is 700 V, and the default end high voltage is 1100 V. The high-voltage increment defaults to 25 V and can be adjusted from 1 to 500 V.

Running the FOM-HV

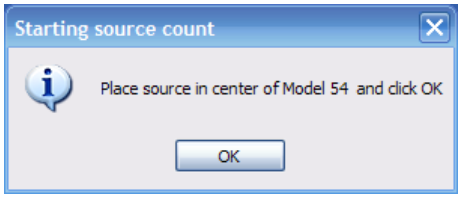
Click the Start button to begin the FOM process (see screen shot on the following page). The FOM tab will automatically be selected if necessary. This tab shows a grid that displays the background, source, and net counts, as well as the FOM and efficiency at each high voltage step.


Calibrate FOM-HV
Settings
FOM
Det-1
Det-2
Det-3
Det-4
Det-5
Det-6
Det-7
Det-8
Current Operating Voltage
0
Set HV
Save
Recommended Operating Voltage
1100
HV
Background (cpm)
Source Count (cpm)
Net Count (cpm)
FOM
Efficiency (4π)
700 6,000 600,290 594,290 486,261 59.43 %
750 6,000 601,220 595,220 487,098 59.52 %
800 6,000 602,550 596,550 488,295 59.66 %
850 6,000 603,950 597,950 489,556 59.80 %
900 6,000 609,510 603,510 494,563 60.35 %
950 6,000 612,330 606,330 497,103 60.63 %
1000 6,000 614,380 608,380 498,951 60.84 %
1050 6,000 616,750 610,750 501,087 61.08 %
1100 6,000 619,470 613,470 503,539 61.35 %
Background
Net Count
FOM
1.0
0.8
0.6
0.4
0.2
0.0
700
800
900
1000
1100
Cancel
Save Report
Close

A prompt will be displayed indicating that all sources should be removed from the chamber. After acknowledging this prompt, background counts will be taken at each high-voltage step.



When all background counts are complete, a prompt will be displayed indicating that the source must be placed in the center of the Gamma Personnel Portal chamber. Open the door, place the source inside, and close the door. Click the OK button when done.



The Gamma Personnel Portal will begin taking source counts at each high-voltage step until completed. Once the current detector is complete, the process will begin for any remaining detectors.

When the FOM is complete, the recommended voltage will be displayed. Click the Set HV button to set the detector's high voltage to the recommended set point.

The Figure of Merit is calculated using the following equation:

$$FOM = \frac{S^2}{\left(\sqrt{B} + \sqrt{S+B}\right)^2}$$

Where:

S = Net (background subtracted) source count rate

B = Background count rate

Click the Save button to save an FOM report. The FOM-HV results are also displayed as a graph of the three curves. The curves are normalized, i.e., each

one peaking at 1, since the scales of the curves can vary dramatically from one another. The background curve is displayed as blue, the net source curve is displayed as red, and the FOM curve is displayed as green.

Section

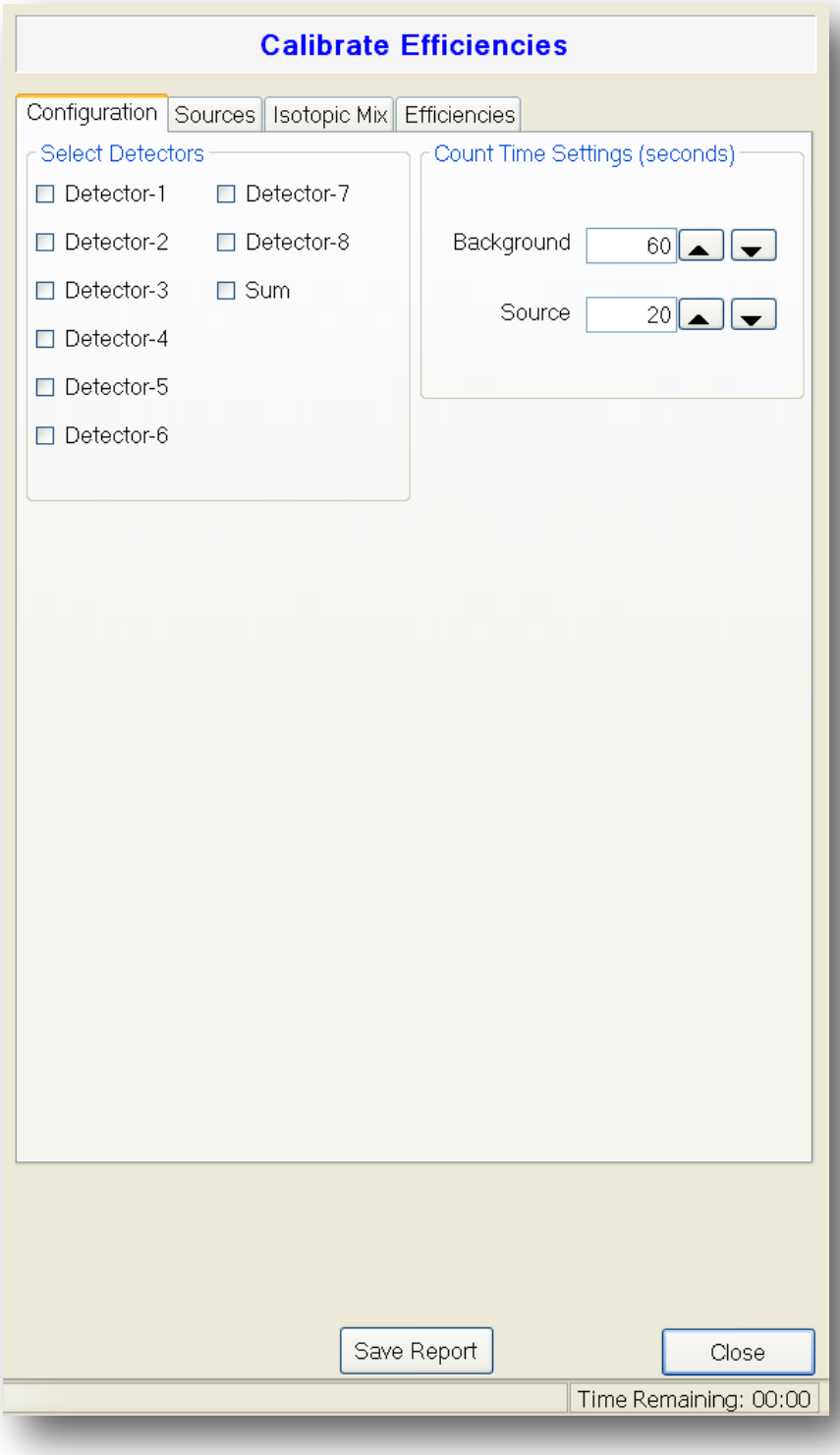
16

Efficiencies

The Efficiency screen is used to configure the efficiencies for each detector. These efficiencies are used in calculating alarm points and determining the specific activity if the weight option is enabled.

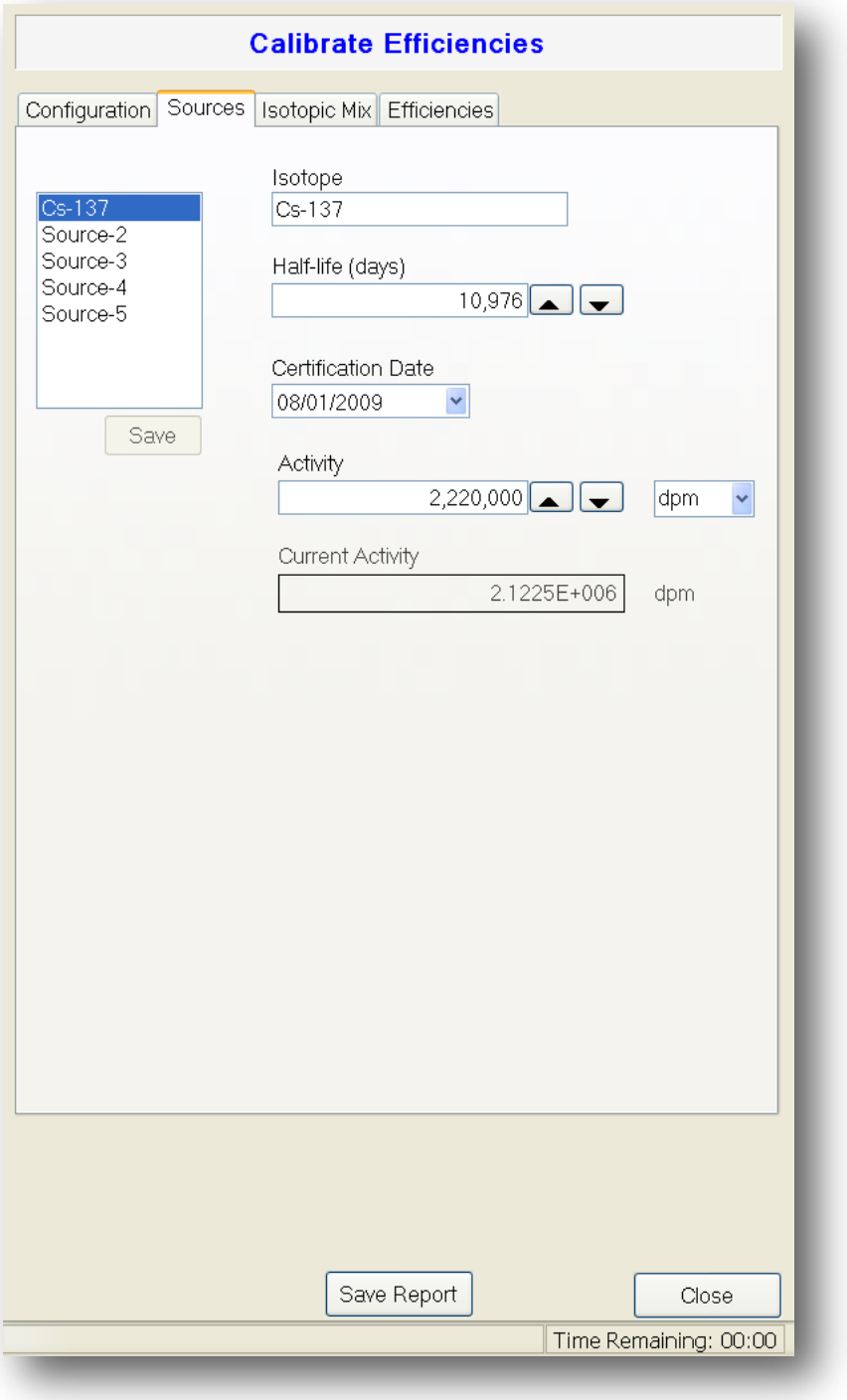
The Configuration tab (see the following page) is where the count times and detectors are selected. In addition to the individual detectors, the Sum channel can also be selected. The count times are adjustable from 1 to 300 seconds.

Configuration



The Sources tab is used to configure up to five sources that will be used in determining the efficiencies.

Sources



Up to five sources can be used in determining the efficiency. For each source, the half-life, certification date, and activity can be set. The current activity is automatically determined based on the data entered for the source.

To edit a source, select it from the list. The default names for the sources are Source-1, Source-2, Source-3, Source-4, and Source-5. After selecting a source, its parameters can be changed. After changing the parameters, click the Save button to save the changes.

The current activity is calculated using the following equation:

$$A_F = A_O e^{-KT}$$

Where:

A_F = Current activity

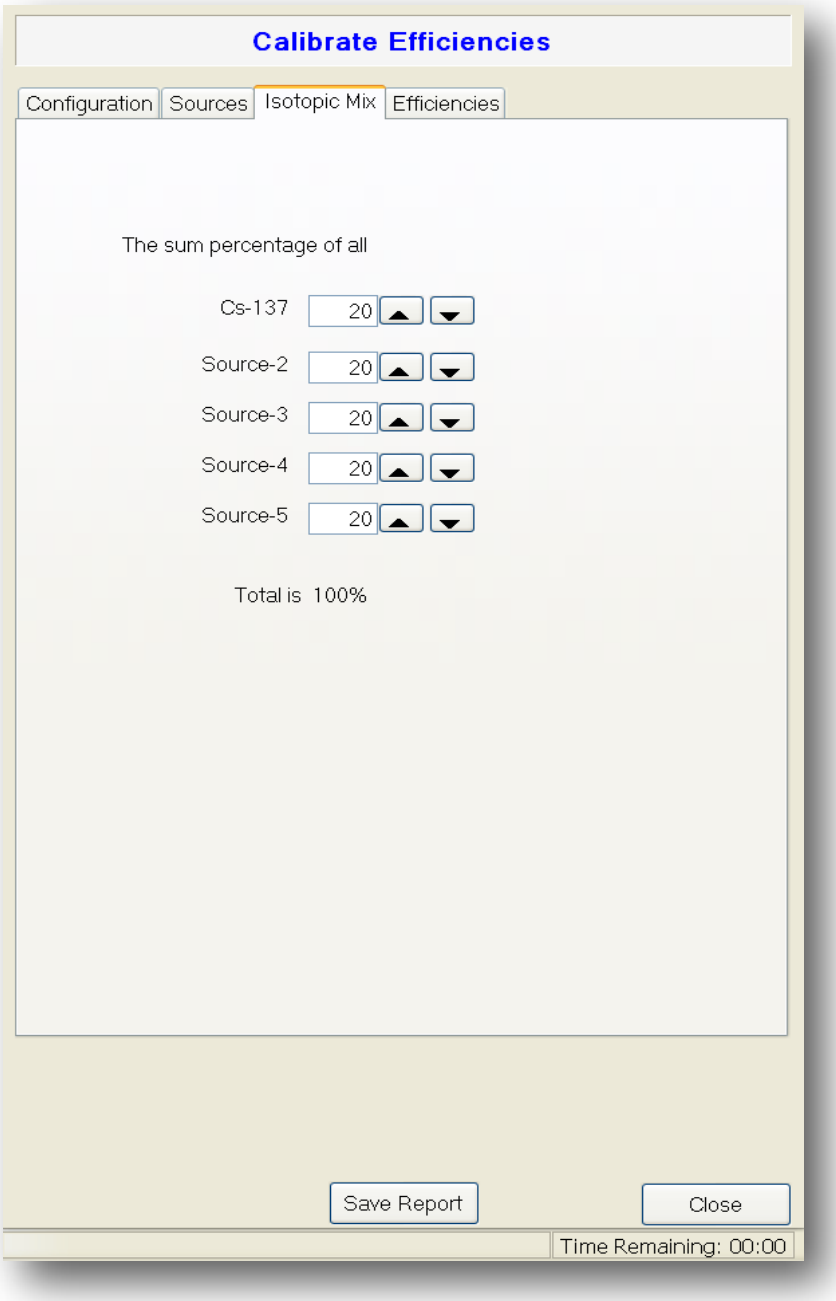
A_O = Original activity

K = 0.693 / half-life in days

T = Elapsed time in days from certification date

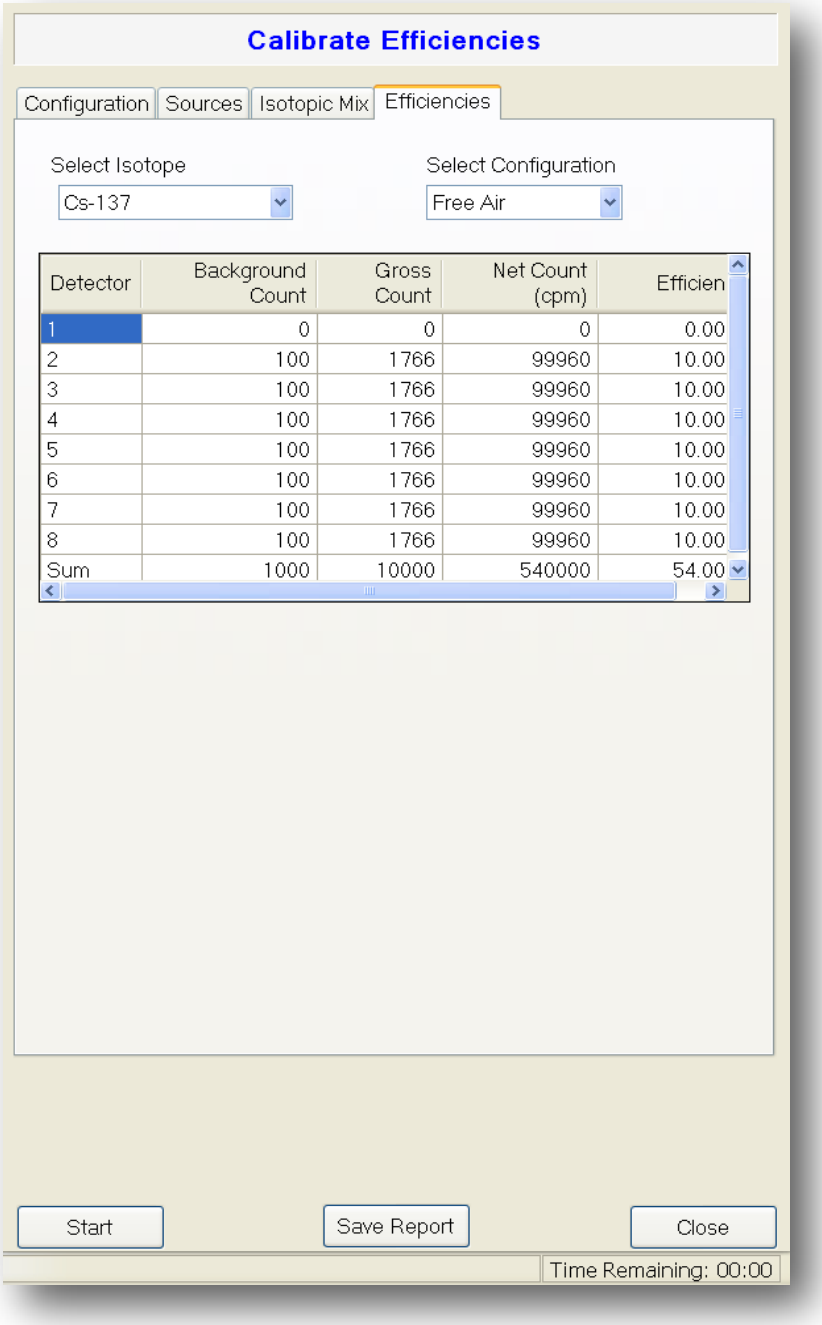
Click on the Efficiencies tab to view efficiencies for the detectors.

Isotopic Mix



The isotopic mix is used to create a weighted average efficiency during monitoring cycles. Up to five isotopes may be used which are defined in the Sources tab. The percentages must add up to 100%. The isotope names default to Source-1, Source-2, Source-3, Source-4, and Source-5 but will be updated to reflect the isotope names defined in the Sources tab.

Efficiencies



A grid displays the count and efficiency data for all detectors. Each detector and the Sum channel have efficiency data for five isotopes and three configurations, for a total of 15 separate efficiencies.

The configurations are:

- Free Air
- User-defined weight 1 (default 50 lbs)
- User-defined weight 2 (default 100 lbs)

The efficiency is updated only for the selected combination of detector(s), isotope, and configuration. After selecting the detectors, isotope and configuration, click the Start button to begin. A background will be taken for all selected detectors. After the background count is complete, place the source in the appropriate location in the chamber. The efficiency will be calculated after the source count is taken and is the net count divided by the source size. For proper operation, the free air efficiency must be determined for all detectors, including the sum channel.

If the weight option is disabled, then the isotope efficiency is simply the free air efficiency. When the weight option is enabled, the efficiency is calculated using the following equation:

$$Eff_x = Eff_0 e^{-Bx^C}$$

Where:

Eff_x = Efficiency associated with a weight of x

Eff_0 = Free air efficiency

B = Derived constant that is affected by the material of the spheres, the unit of measure used for the weight and the isotope of interest

x = Weight of the object being monitored

C = Primarily derives the equivalent linear distance through which the gamma rays pass, as well as any other contributing factors such as dose build-up, etc. It is isotope specific.

Two weighted spheres are used when determining efficiencies with the weigh scale option enabled. The weights of the two spheres are user definable and default to 50 and 100 lb. These values are only used to distinguish the two weight configurations from the free air configuration. The actual weights of the spheres will be measured for use in calculating B and C_x.

The A and B coefficients are calculated using the following:

Eff_0 = Efficiency measured in free air

Eff_1 = Efficiency measured with sphere 1

Eff_2 = Efficiency measured with sphere 2

C is calculated using the equation below:

$$C = ln\left[\frac{2ln\left(\frac{Eff_0}{Eff_1}\right)}{ln\left(\frac{Eff_0}{Eff_2}\right)}\right]$$

B is calculated using the equations for the two different weights:

$$B = \frac{\ln\left(\frac{Eff_0}{Eff_1}\right)}{x^C}$$

$$B = \frac{\ln\left(\frac{Eff_0}{Eff_2}\right)}{x^C}$$

Both computations of B should be almost identical. The larger of the two values is used for B.

Composite Efficiency

If the weight option is disabled, then the composite efficiency is the sum of the isotopic efficiencies multiplied by their isotopic mix percentages.

Section 17

View Logs

The View Log screen is used to view various log files and reports. Log files and reports are saved in the Data Directory specified in the Logging tab of the Operational screen. The Gamma Personnel Portal creates several log files automatically. These are:

- System Log
- Background Log
- Scan Log

Log files are named with a prefix of the date and time in the format of YYYYMMDD and have a file extension of .log. These files are ASCII text files and are viewable in any program that can read text files. New log files are created for each day.

The system log file records events relating to the status of the Gamma Personnel Portal such as:

- Starting and stopping the Supervisor application
- Commands sent to the host board
- Current status
- Door and push button events
- Alarms and failures

The background log file records the current background and detector status at an interval specified in the logging tab of the Operational screen.

The scan log file records information about the results of the monitoring of personnel, including:

- Date/Time

- Employee ID, if required
- Status and which detector alarmed, if any
- Count time
- Detector readings

Most setup screens have an option to save a report. These reports can be viewed here as well.

Section

18

Changes

Firmware Compatibility
Version 1.0.0 –53001n02
Version 0.9.5 –53001n02
Version 0.9.4 –53001n02
Version 0.9.3 –53001n02
Version 0.9.2 –53001n01
Version 0.9.1 –53001n01

Version 1.0.0
-First full release.
-Incorporated customer feedback.

Version 0.9.5
-Beta release.
-Incorporated customer feedback.

Version 0.9.4
-Beta release.
-Incorporated customer feedback.

Version 0.9.3
-Beta release.

Version 0.9.2
-Beta release.

Version 0.9.1
-Beta release.

Section 19

Recycling

Ludlum Measurements, Inc. supports the recycling of the electronic products it produces for the purpose of protecting the environment and to comply with all regional, national, and international agencies that promote economically and environmentally sustainable recycling systems.To this end, Ludlum Measurements, Inc. strives to supply the consumer of its goods with information regarding reuse and recycling of the many different types of materials used in its products. With many different agencies – public and private – involved in this pursuit, it becomes evident that a myriad of methods can be used in the process of recycling. Therefore, Ludlum Measurements, Inc. does not suggest one particular method over another, but simply desires to inform its consumers of the range of recyclable materials present in its products, so that the user will have flexibility in following all local and federal laws.

The following types of recyclable materials are present in Ludlum Measurements, Inc. electronic products, and should be recycled separately. The list is not all-inclusive, nor does it suggest that all materials are present in each piece of equipment:

- Batteries
- Glass
- Aluminum and Stainless Steel
- Circuit Boards
- Plastics
- Liquid Crystal Display (LCD)

Ludlum Measurements, Inc. products, which have been placed on the market after August 13, 2005, have been labeled with a symbol recognized internationally as the "crossed-out wheelie bin." This notifies the consumer that the product is not to be mixed with unsorted municipal waste when discarding; each material must be separated. The symbol will be placed near the AC

receptacle, except for portable equipment where it will be placed on the battery lid.