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## Calibration and Testing Procedure

**Model: 4906AB**

**Dial: none**

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**Revision 1**

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**Date:** *12-20-12*

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**Date:** *12/20/12*

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# Model 4906AB Calibration and Testing

## 1. Prerequisites

- a. Functional Model 4906AB
  - i. The procedure presented here is for the calibration of gas proportional detectors installed in the Model 4906AB Hand and Foot Monitor. Before this procedure is performed, ensure the unit is functional and connected to the required power supply.
- b. Detector Board Voltage Calibration
  - i. All detectors under calibration must have successfully completed a detector board voltage calibration before completing this procedure. This calibration is performed at the factory and does not need to be repeated unless detector board malfunction is suspected or detector board voltage calibration data is cleared.

## 2. Calibration Frequency

- a. Model 4906AB detector calibration is recommended annually. Detector board voltage calibration is not required at each annual calibration, only FOM-HV (Figure of Merit-High Voltage) and efficiency calibrations should be performed annually. Detector board voltage calibration is performed at the factory and does not need to be repeated unless detector board malfunction is suspected or detector voltage calibration data is cleared.

## Model 4906AB Calibration and Testing

### 3. Needed Equipment

#### a. Calibration Sources

- i. Source size is recommended in the 5X-20X background range minimum. Generally alpha and beta sources in the 10,000–40,000 dpm range are sufficient. This places the alpha source a bit higher than the 5X–20X range generally; however, this is not a problem.
- ii. Factory calibration is performed using  $^{239}\text{Pu}$  and  $^{90}\text{SrY}$  sources; however, the calibrator may choose any desired isotope. This calibration procedure is primarily focused on  $^{239}\text{Pu}$  and  $^{90}\text{SrY}$  sources.

#### b. Calibration Fixtures

- i. Source positioning is done several different ways for the hand, foot, and frisker probes. For hand probes, generally either tape or an item that can apply a slight pressure to keep the source close to the proactive screen and vertical is used to hold sources in place during calibration. Ideally the source used for calibration is centered in the hand probe detection area. For foot probes, sources are simply laid on top of the foot probe detection area and centered. When calibrating the frisker, all calibrations are on the detector surface, and thus the source may be held to the center of the detection area with any means desired.

#### c. Keyboard

- i. To perform the Model 4906AB Hand and Foot Monitor calibration procedure, a USB keyboard is recommended for software interface and data entry.

## Model 4906AB Calibration and Testing

### 4. Discriminator Level Setup

- a. The recommended LLD (Lower Level Discriminator) setting for the Model 4906AB detectors is 75 mV. The discriminator level can be set by navigating to the Setup menu (click the setup button and enter the password, default = 2222). Next, open the Detectors screen by clicking the Detectors button. Now select the LLD tab and enter the desired default value in the Set Point box for each detector. Click the Save button to save the entered values (Close to discard them). Once the save is complete, click the Refresh button to get updated Readback data from the detectors and verify the desired level has been set.
- b. Set the ULD and LLD2 values in the same manner as the LLD value set above. The recommended ULD value is 1200 mV, and the recommended LLD2 value is 1800 mV.

	Set Point	Readback	Actual CC
RHB	75	73	+0.0
RHP	75	74	+0.0
RF	75	74	+0.0
LF	75	74	+0.0
LHP	75	73	-1.3
LHB	75	74	+0.0

Refresh      Voltage Cal      Save      Close

## Model 4906AB Calibration and Testing

### 5. Calibration Source Data Entry

- a. Calibration sources must be entered into the source library for use in collecting efficiency data and setting the isotopic mix percentages. This can be done from the Sources tab of the of the Calibrate Efficiencies screen. To get there, go to the Setup menu (click the Setup button and enter the password, default = 2222). Next, open the Calibrate Efficiencies screen by clicking the Efficiencies button. Now select the Sources tab.

The screenshot shows the 'Calibrate Efficiencies' software interface. The title bar reads 'Calibrate Efficiencies'. Below the title bar are four tabs: 'Configuration', 'Sources', 'Isotopic Mix', and 'Efficiencies'. The 'Sources' tab is selected. On the left side, there is a list of sources: 'Source1', 'Source2', 'Source3', 'Source4', and 'Source5'. Below this list are two buttons: a '+' button and a '-' button, and a 'Save' button. The main area of the 'Sources' tab contains the following fields and controls:

- Isotope:** A dropdown menu showing 'Isotope1', with '+' and '-' buttons and a 'Save' button to its right.
- Half-life:** A text input field containing '10', followed by up and down arrow buttons, and a dropdown menu showing 'days'.
- Certification Date:** A dropdown menu showing '05/08/2012'.
- Certification Activity:** A text input field containing '100', followed by up and down arrow buttons, and a dropdown menu showing 'Bq'.
- Current Activity:** A text input field containing '100', followed by a dropdown menu showing 'Bq'.

At the bottom right of the interface is a 'Close' button. At the bottom of the window, there is a status bar that reads 'Time Remaining: 00:00'.

## Model 4906AB Calibration and Testing

- b. If the desired isotope is not listed in the isotope drop-down list at the top of the screen, it will need to be entered. To do this, click on the button labeled with a “+” sign to the right of the isotope drop-down list box. This will bring up the Add Isotope screen used to enter the Name and Half-life for a new isotope. Once the new isotope data is entered, click the Add Isotope button to add it to the isotope library. If the desired isotope is available, proceed directly to the entry of the new source data.
- c. If the desired source is not in the Sources list on the left side of the screen, new source data will have to be entered. Addition of a new source to the source library can be performed by clicking the “+” button directly below the Sources list. This brings up the Add Source page and allows the selection of the Source Name, Isotope (from the isotope library), Half-life (determined by isotope), Certification Date, Certification Activity, and units. The calculated Current Activity based on the system time is displayed at the bottom of the screen. Once all desired data is entered, click the Add Source button to add the source to the source library.
- d. If the desired source is in the library but requires editing, this can be done by selecting the source to edit, editing the desired values directly on the Sources tab, and clicking the Save button under the Sources list to save the modified source data.
- e. Select one of the sources from the source list on the left of the screen, for example, Source1. Enter the appropriate data in the boxes, such as in the previous example. Each calibration source must be entered into the source library in this manner.

## Model 4906AB Calibration and Testing

### 6. FOM-HV

- a. The FOM-HV (Figure of Merit – High Voltage) tool is intended to allow gathering of high-voltage plateau data for detectors installed in the Model 4906AB, as well as to give estimates on an appropriate high-voltage setting for each detector. The actual selection of high-voltage values is completely up to the calibrator setting the high-voltage values. FOM-HV recommended values do not have to be used, as they are just an additional information tool for the user. The FOM-HV step of the calibration process only needs to be performed once with a selected isotope for each channel (once for the alpha channel and once for the beta channel). If multiple isotopes will be targeted with the Model 4906AB, the procedure can be completed multiple times for each channel; however, only the last FOM-HV test data set for each channel is retained, so be sure to save a report between each source test when performing FOM-HV tests on multiple sources per channel.
- b. To perform an FOM-HV test, first determine the current activity of the calibration source in dpm (disintegrations per minute). Next, navigate to the FOM-HV screen by first opening the Setup menu (click the Setup button from the Operate screen and enter in the pass code, default = 2222). Next, click the FOM-HV button to open the FOM-HV screen. Select all detectors for which you would like to perform an FOM-HV test from the detectors check-box list. Select the desired channel to use for the FOM-HV test, either alpha or beta. Now enter the current source activity in dpm in the source size input box. Enter the Background and Source count times in the Count Time Settings area. Recommended values are listed below.
  - i. Background = 60 seconds
  - ii. Source = 12-24 seconds, depending on source size relative to background (larger sources compared to background require shorter count times); generally this comes out to 12 seconds for alpha sources and 24 for beta sources
- c. Next enter the HV Start, End, and Increment values. Recommended values are listed below.
  - i. Start = 1550
  - ii. End = 1750
  - iii. Increment = 50

## Model 4906AB Calibration and Testing

**Calibrate FOM-HV**

Settings **Plateau**

**Select Detectors for HV Plateau**

Right Hand Back     Left Foot  
 Right Hand Palm     Left Hand Palm  
 Right Foot     Left Hand Back

**Count Time Settings (seconds)**

Background  ▲ ▼  
Source  ▲ ▼

**Select Channel**

Alpha Channel     Beta Channel

**Source Size**

DPM  
 ▲ ▼

**HV Settings**

Start  ▲ ▼  
End  ▲ ▼  
Increment  ▲ ▼

**Start**    **Save Report**    **Close**

- d. Now select the Plateau tab and click the Start button to begin the test. Acknowledge the warning that all previous FOM-HV data will be lost and ensure all sources have been removed from the Model 4906AB as prompted, and then allow the background count to be taken for each HV level. Once the background counts are complete, place the source in the appropriate position for the detector under calibration, as prompted, and click the OK button to proceed to the source count portion of the FOM-HV test. Once the source counts are complete, repeat this process until all detectors have collected FOM-HV data.
- e. Once all data is collected, review the data and select an appropriate HV level of each detector based on the Recommended Operating Voltage presented by the Model 4906AB Supervisor or your own HV selection criteria. To set the HV level for a detector, highlight the line in the chart of the desired HV level and click the Set HV button.

## Model 4906AB Calibration and Testing

### Calibrate FOM-HV

SettingsPlateau

RHBRHPRFLFLHPLHB

**α** Current Operating Voltage  Set HV Save Graph

Recommended Operating Voltage

HV	Background (cpm)	Source Count (cpm)	Net Count (cpm)	FOM	Efficiency (4n)
1450	0	2625	2,625.00	2,625.00	7.38 %
1500	2	3860	3,858.00	3,686.27	10.84 %
1550	2	5130	5,128.00	4,929.42	14.41 %
1600	1	6325	6,324.00	6,166.94	17.77 %
1650	2	7120	7,118.00	6,883.34	20.00 %
1700	12	8075	8,063.00	7,464.42	22.65 %
1750	119	8390	8,271.00	6,510.59	23.24 %

Select Row and click "Set HV" button to change HV

StartSave ReportClose

- f. Save the collected data by clicking the Save Report button and entering a descriptive file name for referencing the collected FOM-HV data at a later time.

## Model 4906AB Calibration and Testing

### 7. Efficiency Calibration Procedure

- a. Ensure the source data for all calibration sources being used has been entered into the isotope library, according to the Calibration Source Data Entry section of this procedure.
- b. Navigate to the Calibrate Efficiencies screen in order to perform an efficiency calibration. To get there, go to the Setup menu (click the Setup button and enter the password, default = 2222). Next, open the Calibrate Efficiencies screen by clicking the Efficiencies button.
- c. Select the Configuration tab, then select the check box next to all detectors for which an efficiency calibration is to be performed from the Select Detectors area. Select the appropriate channel for the efficiency test being performed, either the alpha or beta channel. Set the Count Time Settings Background and Source count time values. Recommended values are listed below.
  - i. Background = 60 seconds
  - ii. Source = 60 seconds

**Calibrate Efficiencies**

Configuration Sources Isotopic Mix Efficiencies

**Select Detectors**

Right Hand Back  Left Hand Palm

Right Hand Palm  Left Hand Back

Right Foot

Left Foot

**Count Time Settings (seconds)**

Background 60 ▲ ▼

Source 60 ▲ ▼

**Select Channel**

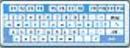
Alpha Channel  Beta Channel

Close

Time Remaining: 00:00

## Model 4906AB Calibration and Testing

- d. Next, select the Efficiencies tab. Choose the calibration source that will be used for the efficiency calibration from the Select Isotope drop-down list box. Select Free Air from the Select Configuration drop-down list box. Now click the Start button and follow the on-screen prompts to ensure the unit is clear of sources, and heed the warning regarding the loss of previous data for the selected source. Background counting then begins.
- e. Once the background count is complete, position the calibration source on the specified detector when prompted and click OK to proceed with the source count. For more detail on how to position the source, refer to the Calibration Fixtures portion of the Needed Equipment section in this procedure.
- f. Move the calibration source between positions as prompted until all source counts are complete.

**α**
Calibrate Efficiencies


Configuration

Sources

Isotopic Mix

Efficiencies

Select Source

E425C

▼

Collected Data

Enable Direct Input

Detector	Background Count	Gross Count	Net Count (cpm)	Efficiency
Right Hand Back	3	2934	7332.0	20.60 %
Right Hand Palm	0	2864	7160.0	20.12 %
Right Foot	3	1617	4039.5	11.35 %
Left Foot	8	1707	4259.5	11.97 %
Left Hand Palm	8	2678	6687.0	18.79 %
Left Hand Back	3	2865	7159.5	20.12 %

Start

Save Report

Close

Time Remaining: 00:00

## Model 4906AB Calibration and Testing

- g. Save the collected efficiency data in a report by clicking the Save Report button at the bottom of the Efficiencies tab. If performing more than one efficiency calibration for multiple sources, wait until all data has been collected to save the efficiency report.

### 8. Isotopic Mix

- a. With all efficiency data collected, the isotopic mix percentage must be set up to use the newly collected values for both the alpha and beta channels. In order to do this, navigate to the Calibrate Efficiencies screen and select the Isotopic Mix tab.

**Calibrate Efficiencies**

Configuration Sources **Isotopic Mix** Efficiencies

**Source Library**

- E210C
- E225C
- L194C
- L200C
- L246C
- E425C
- E240

**Isotopic Mix Sources**

- E425C

Selected Source Mix Percentage: 100%

Apply Selected Source %

Save Isotopic Mix

Current Mix Percentage: 100%

Save Report Close

Time Remaining: 00:00

## Model 4906AB Calibration and Testing

- b. Then, currently selected channel is shown in the upper, left-hand corner by displaying the Greek letter for alpha or beta. Note that this setup must be performed for each channel.
- c. For the alpha channel, select the calibration sources with efficiency data intended for use as the unit's normal alpha operating efficiency one at a time from the Source Library list on the left and move them over into the Isotopic Mix Sources box on the right with the ">" button.
- d. Remove any unwanted sources from the Isotopic Mix Sources by selecting them and clicking the "<" button.
- e. Set the source mix percentage by selecting each source and editing the value in the Selected Source Mix Percentage box to the desired value and clicking the Apply Selected Source % button. The current mix percentage total is displayed in the bottom, right corner and must add up to 100%.
- f. Once all sources have mix percentages set, click the Save Isotopic Mix button to save the new configuration. For a single alpha channel source, place it in the Isotopic Mix Sources list alone and edit the mix percentage to 100%.
- g. Repeat this process for the beta channel.

### 9. Source Check

- a. Once efficiency data has been taken, it is important to verify that the Model 4906AB is operating as expected. One way this is done is by performing a source check. The source check should always be used following a calibration or efficiency update and can be used on a regular basis to provide monthly, weekly, or daily tests of basic unit functionality.
- b. Before performing a source check, it is recommended that the Model 4906AB be set up in the desired normal operating configuration, as this will affect the background count time used before the source check and source count time used during the source check. The recommended source size for performing a source check is in a range similar to that of the intended alarm activity level (MDA). If the desired normal operating configuration is not known, the below setting can be used.

## Model 4906AB Calibration and Testing

- i. Counting Mode = Mode 2 – Fixed MDA
- ii. Fast Alarm = Disabled
- iii. Fast Clean = Disabled
- iv. Background Count Time = 2 minutes
- v. Weighting Factor = 240
- vi. Beta Sigma Limit = 6
- vii. Beta Sigma OK = 4
- viii. Alpha Hands MDA = 500+ dpm (high enough to prevent a failure upon background count)
- ix. Alpha Feet MDA = 1000+ dpm (high enough to prevent a failure upon background count)
- x. Alpha Count Time = 10 seconds
- xi. Alpha Detection Probability = 95%
- xii. Alpha False Alarm Probability = 0.1%
- xiii. Alpha Alarm Time Extension Factor = 0
- xiv. Beta Hands MDA = 2000+ dpm (high enough to prevent a failure upon background count)
- xv. Beta Feet MDA = 4000+ dpm (high enough to prevent a failure upon background count)
- xvi. Beta Count Time = 10 seconds
- xvii. Beta Detection Probability = 95%
- xviii. Beta False Alarm Probability = 0.1%
- xix. Beta Alarm Time Extension Factor = 0

## Model 4906AB Calibration and Testing

- c. Once the desired settings have been applied, begin a new background count by selecting the Update button in the Background area of the Setup menu, then closing the Setup menu and waiting for background completion. Once the background measurement has been completed, the current activity for the source to be used should be determined. This is a bit easier if using a source already entered into the Sources tab of the Efficiency screen, as the current activity will be displayed there.
- d. To begin the source check, navigate to the Setup menu by clicking the Setup button, then enter the password and click the Enter button (default high-level password is 2222). Once in the Setup menu, open the Source Check Screen by selecting the Source Check button in the Test portion of the Setup Menu.
- e. Enter the current activity of the source in the Source Size box in dpm.
- f. Enter the desired pass percentage (recommend value is 10%, but larger values are acceptable if required).
- g. Select the channel for which the source check is to be performed, either alpha or beta.
- h. Click the Start button to begin the test and position the source at the surface calibration position of each detector until all detectors have passed. Passing is indicated by the appearance of a large green “PASS” test in the detector Status column.
- i. Once the test is complete, click the Save Report button to save a text file with the results of the test. This step is only required if a saved report is desired; however, it should be noted that the source check data will not be saved once the Source Check screen is closed.

## Model 4906AB Calibration and Testing

**Source Check**

Source Size (dpm)  ▲ ▼

Percent  ▲ ▼

**Test -  $\alpha$**

Detector	Count (dpm)	Status
RHB	<input type="text" value="0"/>	
RHP	<input type="text" value="0"/>	
RF	<input type="text" value="0"/>	
LF	<input type="text" value="0"/>	
LHP	<input type="text" value="0"/>	
LHB	<input type="text" value="0"/>	

**Select Channel**

Alpha    Beta

Instructions:

1. Click the start button. This will start a continuous count cycle.
2. Place the source at each detector. Hold it there long enough for a complete count cycle.

Once all detectors have passed the system is operational. If any detector can not pass the test, service is required.

### 10. Frisker Calibration

- a. For Model 4906AB units equipped with a frisker, the frisker must be calibrated separately from the primary unit detectors. At the time of this writing, the Model 4906AB has two frisker options, a Model 44-9 GM probe or a Model 43-143 Gas Proportional probe. Each probe is calibrated according to the procedures below.
- b. Model 44-9 GM Frisker
  - i. Ensure the Frisker Type is set to GM and that the GM frisker lower-level discriminator (LLD2) is set to the recommended value of 75 mV.
  - ii. This can be done by first navigating to the Setup menu and selecting the Frisker button to open the Frisker Setup screen. If the Frisker button is not visible, ensure the Frisker Enabled option in the Operational Setup screen on the Options tab is set to Yes.
  - iii. Select the General tab and verify the Frisker Type is set to GM. If this is not the case, select the GM option and click the Apply button to apply the new setting.

## Model 4906AB Calibration and Testing

**Frisker Setup**

General | **Detector**

**Alarm Level**  
Count Rate Alarm Level  
600 ▲ ▼ cpm

**Audio Level**  
5  
4  
3  
2  
1  
0

**Time**  
Minimum Frisk Time (secs)  
10 ▲ ▼  
Maximum Frisk Time (secs)  
300 ▲ ▼

**Frisker Type**  
 Gas  
 GM

**Rate Indicator Bar Range**  
Bar Full Scale  
1,000 ▲ ▼ cpm

Apply OK Cancel

- iv. Select the Detector tab and set the Lower Level Discriminator 2 value to 75.

# Model 4906AB Calibration and Testing

**Frisker Setup**



General Detector

**Serial Number**

FRS

**Firmware Number**

FRS

**High Voltage**

FRS▲▼

**Lower Level Discriminator 2**

FRS▲▼

Refresh

Save

Close

## Model 4906AB Calibration and Testing

- v. Click the Save button to put the new setting into effect. Once applied, click the Refresh button to get fresh readback data and verify the new discriminator setting has been applied.
- vi. Next, set the high-voltage value for 900 V using the same Detector tab in the Frisker Setup screen.
- vii. Enter 900 in the High Voltage setpoint box and click the Save button to apply the new setting.
- viii. Once saved, give a few seconds delay to allow high voltage to stabilize and click the Refresh button to verify the new voltage setting has been reached with a fresh readback value.
- ix. Next, navigate to the Scaler screen by clicking the Scaler button in the Setup menu.
- x. Set the Count Time for 60 seconds and ensure the Include Frisker check box is selected.
- xi. Remove the frisker from the frisker cradle and allow it to set in a position for acquiring an unshielded background reading.
- xii. Click the Start button to begin the scaler count.
- xiii. Once the count is complete, note the Count Rate Beta in cpm as the background count rate and ignore the alpha channel data if any displays, as this channel is not used for the GM frisker.

## Model 4906AB Calibration and Testing

Scaler

Count Time (seconds)

60

▲ ▼

Include Frisker

Detector	Gross Count α	Count Rate α (cpm)	Gross Count β	Count Rate β (cpm)
Right Foot	0	0	0	0
Left Foot	0	0	0	0
Frisker	1921	1,954	113	115
Left Hand Palm	0	0	0	0
Left Hand Back	0	0	0	0

Start

Close

Scaler count complete

- xiv. Next, place the calibration source on the face of the frisker. The factory recommended source is one of <sup>99</sup>Tc in a range well above background (approximately 5X background or more).
- xv. Click the Start button to take a second 60-second scaler count. Once complete note the Count Rate Beta in cpm.
- xvi. Next, determine the current source activity in dpm.
- xvii. Calculate the efficiency using the equation below:
  - $Efficiency = ((Source\ Count\ Rate - Background\ Count\ Rate) / Source\ Activity) * 100\%$
- xviii. For <sup>99</sup>Tc on the 44-9 GM probe, an efficiency of approximately 19% is expected. Verify the calculated efficiency matches this expectation.
- xix. Record test data as desired for field calibration, for factory calibration data must be recorded according to the Model 4906 Factory Documentation List.

## Model 4906AB Calibration and Testing

- c. Model 43-143 Gas Proportional Frisker
  - i. Ensure the Frisker Type is set to Gas and that the various discriminator levels are set to the recommended values.
  - ii. This can be done by navigating to the Setup menu and selecting the Frisker button to open the Frisker Setup screen. If the Frisker button is not visible, ensure the Frisker Enabled option on the Options tab of the Operational Setup screen is set to Yes.
  - iii. Select the General tab and verify the Frisker Type is set to Gas. If this is not the case, set the Frisker Type to Gas and click the Apply button to apply the new setting.

The screenshot shows the 'Frisker Setup' window with the 'General' tab selected. The window contains several sections for configuration:

- Alarm Level:** Includes 'Count Rate Alarm Level Alpha' set to 100 cpm and 'Count Rate Alarm Level Beta' set to 500 cpm.
- Time:** Includes 'Minimum Frisk Time (secs)' set to 10 and 'Maximum Frisk Time (secs)' set to 300.
- Frisker Type:** Includes radio buttons for 'Gas' (selected) and 'GM'.
- Audio Level:** A vertical slider set to level 5.
- Rate Indicator Bar Range:** Includes 'Alpha Bar Full Scale' set to 100 cpm and 'Beta Bar Full Scale' set to 500 cpm.

At the bottom of the window are three buttons: 'Apply', 'OK', and 'Cancel'.

- iv. Select the Detector tab in order to set the discriminator levels are required. Set the LLD to 75 mV, set the ULD to 1200 mV, and set the LLD2 to 1800 mV.

## Model 4906AB Calibration and Testing

**Frisker Setup**

Serial Number  
Firmware Number  
High Voltage  
Lower Level Discriminator  
Upper Level Discriminator  
Lower Level Discriminator 2

**General** | **Detector**

**Serial Number**  
FRS PR307519

**Firmware Number**  
FRS 420427R02N01

**High Voltage**  
FRS 1,600 ▲ ▼ 1596 +0.0 -0.9

**Lower Level Discriminator**  
FRS 75 ▲ ▼ 72 +0.0

**Upper Level Discriminator**  
FRS 1,200 ▲ ▼ 1200 +0.0

**Lower Level Discriminator 2**  
FRS 1,800 ▲ ▼ 1800 +0.0

- v. Click the Save button to apply the new settings, then click the Refresh button to verify the readback indicates the discriminator levels were set as specified.
- vi. Using the Frisker screen Detector tab, increment the HV level from 1600 V to 1700 V in 50-volt increments. At each level use the Scaler function according to the following instructions to acquire background counts, alpha source counts, and beta source counts. Additionally, the efficiency must be calculated at each voltage level.
- vii. Once the voltage level is saved and verified to be stabilized by a refresh, navigate to the Scaler screen.
- viii. Set the Count Time to 60 seconds and ensure the Include Frisker box is checked.

## Model 4906AB Calibration and Testing

Scaler

Count Time (seconds)  

▲
▼

Include Frisker

Detector	Gross Count α	Count Rate α (cpm)	Gross Count β	Count Rate β (cpm)
Right Foot	0	0	0	0
Left Foot	0	0	0	0
Frisker	1921	1,954	113	115
Left Hand Palm	0	0	0	0
Left Hand Back	0	0	0	0

Start

Close

Scaler count complete

- ix. Remove the frisker from the cradle and allow it to set in a position to acquire an unshielded background reading.
- x. Click the Start button to begin a scaler count.
- xi. Once the count is complete, note the Count Rate Alpha and Count Rate Beta values in cpm as the background count rates at the current voltage level.
- xii. Next, place the <sup>239</sup>Pu source on the detector screen surface and click Start to perform a second scaler count.
- xiii. Once complete, note the Count Rate Alpha and Count Rate Beta values in cpm as the alpha source count values.
- xiv. Remove the alpha source and place the <sup>90</sup>SrY source on the detector screen surface and click the Start button to perform a third scaler count at the current voltage level.
- xv. Once the count is complete, note the Count Rate Alpha and Count Rate Beta values in cpm as the beta source count values.
- xvi. Calculate the alpha and beta efficiencies using the below equation:

- $$\text{Efficiency} = ((\text{Source Count Rate} - \text{Background Count Rate}) / \text{Source Activity}) * 100\%$$

## Model 4906AB Calibration and Testing

- xvii. Proceed to the next HV level and repeat the process for each HV level.
- xviii. Once all scaler counts and efficiency calculations on all levels are complete, use the efficiency data along with background and cross talk information to select an appropriate HV level. This level is generally expected to be 1650 V.
- xix. Efficiency values should be approximately 17.5% for  $^{239}\text{Pu}$  and 20% for  $^{90}\text{SrY}$ .
- xx. Cross talk values should be no more than 10% alpha counts into the beta channel and no more than 1% beta counts in the alpha channel.
- xxi. Record the test data as desired for field calibration, for factory calibration data must be recorded according to the Model 4906 Factory Documentation List.

### 11. Operational Check

- a. An operational check is performed upon calibration completion to verify the system is operating as expected. Before performing an operational test, ensure the system is set up on the desired normal operating configuration. The factory defaults for Radiological settings are listed below.
  - i. Counting Mode = Mode 2 – Fixed MDA
  - ii. Fast Alarm = Disabled
  - iii. Fast Clean = Disabled
  - iv. Background Count Time = 2 minutes
  - v. Weighting Factor = 240
  - vi. Beta Sigma Limit = 6
  - vii. Beta Sigma OK = 4
  - viii. Alpha Hands MDA = 500+ dpm (high enough to prevent a failure upon background count)
  - ix. Alpha Feet MDA = 1000+ dpm (high enough to prevent a failure upon background count)
  - x. Alpha Count Time = 10 seconds
  - xi. Alpha Detection Probability = 95%
  - xii. Alpha False Alarm Probability = 0.1%
  - xiii. Alpha Alarm Time Extension Factor = 0
  - xiv. Beta Hands MDA = 2000+ dpm (high enough to prevent a failure upon background count)
  - xv. Beta Feet MDA = 4000+ dpm (high enough to prevent a failure upon background count)
  - xvi. Beta Count Time = 10 seconds
  - xvii. Beta Detection Probability = 95%
  - xviii. Beta False Alarm Probability = 0.1%
  - xix. Beta Alarm Time Extension Factor = 0

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- b. The isotopic mix percentage must also be set to the desired operational value. The factory default is 100%  $^{239}\text{Pu}$  alpha channel efficiency and 100%  $^{90}\text{SrY}$  beta channel efficiency. These values are set on the Efficiencies screen under the Isotopic Mix tab.
- c. Once all settings have been set as desired (either to factory defaults or user specific values), initiate a background by selecting the Update button under the Background area on the Setup menu. Then close the Setup menu and wait for the background average to be acquired.
- d. Once the background count is complete, perform a minimum of 3-6 tests with and without selected test sources to ensure expected test results (alarm with source and clean without source).
- e. If the operational tests are successfully performed, as well as other tests mentioned above, the calibration is complete.

### 12. Saving Calibration Data

- a. Once the calibration process is complete, LMI recommends calibration data and system setup information be saved for future reference and ease of setup restoration if required.
- b. Create Backup Utility
  - i. As of Model 4906 Supervisor Software Version 1.2.6, a Create Backup utility is available to make backing up important system data easier. The Create Backup utility is found in the Setup Menu in the bottom right corner.
  - ii. Click the Create Backup button and a dialog inquiring what should be saved in the backup is displayed.
  - iii. Select all the optional check boxes and new Calibration, Efficiency, Isotopic Mix, and FOM-HV reports will be generated with the current system data and saved in a backup folder location along with the current settings.config configuration file and FOM data from the latest plateau run. This does not save the required Source Check reports to the backup unless they have been created in the last day. In fact, the Save Only New Reports option saves all reports in the Data folder created within the last day.
  - iv. If you find your Source Check reports are not located in your backup, copy them over manually.
  - v. The backup folder created by this process should be saved on the desktop for easy access when performing a factory calibration with an appropriate name such as "Ludlum Factory Backup."
  - vi. This data can be used by the customer later to restore factory settings with the Restore utility if desired.

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### c. Calibration and Setup Report

- i. To save a copy of the Model 4906AB calibration report, navigate to the Setup menu and select the Save Report button. Name the report as desired or allow the use of the default name.

### d. Efficiency and Isotopic Mix Report

- i. To save a copy of the Model 4906AB efficiencies report, navigate to the Setup menu and select the Efficiencies button. Go to the Efficiencies tab and select the Save Report button located at the bottom of the screen. Name the report as desired or allow the use of the default name.

### e. Source Check Report

- i. Source check reports must be saved after completing a source check and before the Source Check screen is closed or another source check is run. Refer to the Source Check section for more information on performing a source check and saving the related report.

### f. FOM-HV Report

- i. To save a copy of the Model 4906AB FOM-HV report, navigate to the Setup menu and select the FOM-HV button. Next, select the Save Report button at the bottom of the screen. Name the report as desired or allow the use of the default name.