

**K. LEG-1**

**Section 1 - Calibration in CPS, CPM - Gross Counting** (for PHA calibration skip to section 2.)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	8
Probe Area (cm <sup>2</sup> )	5
Max. High Voltage	1500
Overrange (cps)	40000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Upper	
High Voltage	460	
Window Param's	Lower	Upper
Threshold (mV)	2.00	2.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date"

parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	450
Ending Voltage	725
Voltage Step	25
Max. Count Rate (cps)	5000*
Graph Name	LEG-1
File Name	LEG1.GRF

\* Depends on source activity.

5. Expose the probe to an  $^{241}\text{Am}$  plated source, of  $\approx 300\text{k cpm}$  ( $\approx 600\text{k dpm}$ ). Position the source disc with the active side facing the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% crossover. The black vertical bar turns red when the window crossover exceeds 1%. Move the bar back one position when it turns red to obtain the optimum operating voltage. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.
7. Next select *Calibration* then *Determine Calibration Constant*. Verify *Channel 1*, *Upper Window*, and *Background* buttons are selected with the count time set to 300 seconds. Place the probe in a low background area, preferably in a lead shield, then click on the *Start* button to begin the background count. Note the background reading.
8. Check the  $^{241}\text{Am}$  60 keV gamma efficiency. Expose the detector to an  $^{241}\text{Am}$  source of  $\approx 600\text{k dpm}$ , preferably s/n 6025 and place in a shield. Use the *Background* mode to acquire a count by watching the countdown in the lower right corner, note the cpm when it is below 2%. Subtract the previously determined background from this count. Use the following formula to determine efficiency. Note the calculated efficiency to record later on the calibration report.

$$60\text{keV } \gamma \text{ eff.} = \frac{E600 \text{ reading} - \text{Bkg} \times 100}{0.357 \times \text{Source DPM}}$$

NOTE: Gamma per minute based on 0.357 abundance of 60 keV gamma from <sup>241</sup>Am. Ref: ICRP Publication 38, 1983.

- Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined 60 keV efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph*.

## Section 2 - PHA Calibration

- Load the LEG-1 PHA probe parameters (*leg1pha.\** file), by selecting *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters.

Probe Parameters	
Dead Time (µsec.)	8
Probe Area (cm <sup>2</sup> )	5
Max. High Voltage	1500
Overrange (cps)	40000
Radon Alarm (cps)	0

Channel Parameters	
Channel Number	1
Channel Type	PHA
Units	cpm
Selected Window	Lower
High Voltage	460

Window Param's	Lower	Upper
Threshold (mV)	4.00	5.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

11. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.
12. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	700*
Ending Voltage	900*
Voltage Step	10
Max. Count Rate (cps)	20,000**
Graph Name	LEG-1, PHA
File Name	LEG1.GRF

\* Plateau starting and ending voltages will vary with isotope.

\*\* Depends on source activity.

13. Place a  $^{241}\text{Am}$  or  $^{239}\text{Pu}$  source (or other isotope of interest) against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
14. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is on the peak of the lower window plot. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the correct desired value.
15. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button if the Print Linearity Data dialog box appears. Print

the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

**L. NRD, HP-280**

Calibration in Rem/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

<b>Probe Parameters</b>	
Dead Time (μsec.)	10
Probe Area (cm <sup>2</sup> )	1
Max. High Voltage	2300
Overrange (cps)	10,000-NRD 25,000-HP280
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Neutron	
Units	Rem/h	
Selected Window	Lower	
High Voltage	1500	
Window Param's	Lower	Upper
Threshold (mV)	2.00	60.00
counts/rem	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Temporarily edit the units of measure to cpm in channel 1 by selecting *Edit, Smart or Conventional Probe* then *Channel Parameters*. Place the NRD in a 10 R/h <sup>137</sup>Cs field. Select *Edit, Smart or Conventional Probe* then *Channel Parameters* and adjust the HV for approximately 50 cpm as read on the E-600 in Ratemeter mode. Changing the high voltage setting in the channel parameters and clicking on the *Down Load* button, will allow changes to the HV while observing the effect on count rate in Ratemeter mode. When the reading is approximately 50 cpm in a 10 R/h field, decrease the HV by 50V and verify no counts.
4. Edit the units of measure back to Rem/h, by selecting *Edit, Smart or Conventional Probe* then *Channel Parameters*. Next select *Calibration*, then *Determine Calibration Constant*. Verify Channel 1, Lower Window, and Cal. Const. are selected. Enter the calibration constant field, 0.027 Rem/h. Place the NRD in a 27 mRem/h field (0.027 Rem/h) then click on the *Start* button to begin calibration constant determination. Actual count time is determined by the program. When the count is complete, click on *Save* to store the new calibration constant.
5. Select *Calibrate*, then *Run Linearity Check*. Enter the following linearity fields in the box that appears: 0.027 Rem/h (27 mRem/h) and 0.2 Rem/h (200 mRem/h). Note the field entered must be in the same units (Rem/h), as the detector set up.
6. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.
7. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted.

**M. PG-2**

**Section 1 - Calibration in CPS, CPM - Gross Counting** (for PHA calibration skip to section 2.)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

<b>Probe Parameters</b>	
Dead Time (μsec.)	12
Probe Area (cm <sup>2</sup> )	12
Max. High Voltage	1300
Overrange (cps)	20000
Radon Alarm (cps)	0

<b>Channel Parameters</b>		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Lower	
High Voltage	560	
<b>Window Param's</b>	<b>Lower</b>	<b>Upper</b>
Threshold (mV)	3.00	45.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date"



parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	560
Ending Voltage	1060
Voltage Step	20
Max. Count Rate (cps)	25,000*
Graph Name	PG-2
File Name	PG2.GRF

\* Depends on source activity.

5. Expose the probe to a  $^{239}\text{Pu}$  plated source (preferably one of the Meg cpm sources). Position the source disc with the active side facing the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% alpha (upper window) to gamma (lower window) crossover. The black vertical bar turns red when the alpha to gamma crossover exceeds 1%. Move the bar back one position when it turns red to obtain the optimum operating voltage. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.
7. Determine efficiency next by selecting *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Lower Window, and Background buttons are selected with the count time set to 300 seconds. Place the probe in a low background area, preferably in a lead shield, then click on the *Start* button to begin the background count. The background should be less than 60 cpm in a lead shield.
8. Expose the detector to a plated  $^{239}\text{Pu}$  source, preferably s/n 1071 or s/n P1646 and place in a shield. Use the *Background* mode to acquire a count by watching the countdown in the lower right corner, note the cpm when it is below 2%. Subtract the previously determined background from this count. Use the following formula to determine efficiency. Note the calculated efficiency to record later on the calibration report.

$$\gamma \text{ eff.} = \frac{E600 \text{ reading} - \text{Bkg} \times 100}{\text{Source CPM}}$$

9. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined gamma efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph*.

## Section 2 - PHA Calibration

10. Load the PG-2 PHA probe parameters (*pg2pha.\** file), by selecting *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters.

Probe Parameters	
Dead Time (μsec.)	12
Probe Area (cm <sup>2</sup> )	12
Max. High Voltage	1300
Overrange (cps)	20000
Radon Alarm (cps)	0

Channel Parameters	
Channel Number	1
Channel Type	PHA
Units	cpm
Selected Window	Lower
High Voltage	700

Window Param's	Lower	Upper
Threshold (mV)	4.00	5.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

11. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.
12. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	700*
Ending Voltage	900*
Voltage Step	10
Max. Count Rate (cps)	20,000**
Graph Name	PG-2, PHA
File Name	PG2.GRF

\* Plateau starting and ending voltages will vary with isotope.

\*\* Depends on source activity.

13. Place a  $^{241}\text{Am}$  or  $^{239}\text{Pu}$  source (or other isotope of interest) against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
14. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is on the peak of the lower window plot. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the correct desired value.

15. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

## N. HP/SHP-340, HP/SHP-380AB

Calibration in dps, dpm, cps, cpm, Bq, dps/100cm<sup>2</sup>, dpm/100cm<sup>2</sup>, Bq/100cm<sup>2</sup>

**NOTE:** The probe must have been closed up for at least 8 hours before attempting to calibrate. Exposing the scintillator or PM tube to light will cause the probe to be noisy.

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters*, whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored and won't require downloading from the computer.

Probe Parameters			
Dead Time (µsec.)	8		
Probe Area (cm <sup>2</sup> )	73 (100 for HP/SHP-380AB)		
Max. High Voltage	1000		
Overrange (cps)	80,000		
Radon Alarm (cps)	0		

  

Channel Parameters			
Channel Number	1	2	3
Channel Type	Alpha	Beta	A/B
Units	cpm	cpm	cpm
Selected Window	Upper	Lower	Both
High Voltage	654	654	654
Scaler Time(secs)	20	20	20

Window Parameters	Lower	Upper
Threshold (mV)	1.50(1.60 for HP/SHP380AB)	30.1 (22.1 for HP/SHP380AB)
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.
4. Select *Calibrate*, then *Run Plateau* from the sub-menu. Click on the *Channel 1* button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	684 (550 for HP/SHP380AB)
Ending Voltage	889
Voltage Step	10
Max. Count Rate (cps)	5000*
Graph Name	SHP340, SHP380AB, etc.
File Name	340XXX.GRF, 380ABXXX.GRF, etc. where XXX = serial no.

\* Depends on source activity.

5. Expose the probe to a <sup>99</sup>Tc 10K to 200K cpm (or ~20K to 400K dpm) plated source. Position the source disc near the center of the probe face, with the active side facing the probe. Click on the *Start* button. There may be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If there are no counts in the upper window, extend the plateau ending voltage, but no higher than 1000 volts.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the desired HV set point. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% beta (lower THLD cts.) to alpha (upper THLD cts.) crossover. The black vertical bar turns red when the beta to alpha crossover exceeds 1%. Once it turns red, move the bar back until the alpha counts (upper window) is ≤0.1 cps to obtain the optimum operating voltage. Save the desired high voltage setting for channel 1 by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the

plateau. Click on the *Channel 2* button on top and then the *Set HV* button to set the same HV for channel 2. Repeat the same for Channel 3.

7. Perform a quick check on the beta background. Remove the source from the probe and select channel 2 (Beta), Ratemeter mode. The beta background count rate should be between 150 and 300 cpm (250 to 450 cpm on HP/SHP380). If not, adjust the high voltage as necessary. Note: Ensure the HV is set the same on all three channels before proceeding.
8. Both alpha and beta backgrounds must be established prior to determining the calibration constant and crossover correction factor for each window. Begin by selecting *Calibration*, then *Determine Calibration Constant*. Verify Channel 3, Upper Window, and Background buttons are selected with the count time set to 180 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background reading. The alpha background should not exceed 5 cpm. While *Background* is still selected, click on the Lower Window button to display the beta background. The beta background should be less than 300 cpm (450 cpm for HP/SHP380). If either background is too high, try decreasing the high voltage.
9. Next determine the calibration constant and crossover factor for the Beta (lower) window. Select Channel 3, Lower Window, Cal. Const. and the Do XOver box. Enter the calibration field, which should be a 47mm <sup>99</sup>Tc source of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.
10. Verify the determined Beta Cal.  $2\pi$  efficiency or counts/count parameter) is greater than 0.10 for <sup>99</sup>Tc. If within tolerance, answer Yes to the save prompt. Note the efficiency ( $CC \times 100 = \% \text{ eff.}$ ) to record later on the calibration report. The new crossover factor is also stored into the channel parameters.
11. Now determine the calibration constant and crossover factor for the Alpha (upper) window. Select Channel 3, Upper Window, Cal. Const., and Do XOver. Enter the calibration field, which should be a 47mm <sup>239</sup>Pu source of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. Actual count time is determined by the WinE600 program.
12. Upon completion, verify the determined Alpha Cal. Constant (ie.  $2\pi$  efficiency or counts/count parameter) is greater than 0.36 for <sup>239</sup>Pu. If within tolerance, answer Yes to the save prompt. Note the efficiency ( $CC \times 100 = \% \text{ eff.}$ ) to record later on the calibration report. The new crossover factor is also stored into the channel parameters. The Alpha to Beta crossover factor must be less than 0.2500.
13. Unless calibration other than cpm or cps is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 3. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 16.
14. If calibration is to source count rate ( $2\pi$  emissions) then jump to step 16. Do not edit the cal constants to 1.00, the previously determined values are correct for  $2\pi$  emissions.
15. If units of dps, dpm or Bq, dps/100cm<sup>2</sup>, dpm/100cm<sup>2</sup>, or Bq/100cm<sup>2</sup> are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 3. Then divide the previously determined cal constant by two, and enter the new cal constant. This must be done for both upper and lower windows of channel 3.

For example: If the previously determined cal constant was 0.24 counts/count. Change the units to dpm, then edit the cal constant to 0.12 counts/disint. ( $0.24 \div 2$ ).

16. Verify correct units of measure are set in the instrument. Copy the new parameters from channel 3 to channels 1 and 2 by selecting *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Click on the *Copy* button and when prompted enter "1" as the channel to copy to. Repeat the same for channel 2. Copying channel parameters will require restoring the *Channel Type* and *Selected Window* for each channel. Channel 1 should be set to Alpha channel type, with the Upper window selected. Channel 2 should be set to Beta channel type, with the Lower window selected. Refer to the *Channel Parameters* table.
  
8. Calibration is complete. To print cal report, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button if the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed cal report. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.



## O. SHP-400

### Calibration in R/h

Handling precautions: The plastic ion chamber inside the SHP-400 is conductive and is charged to about 30 Volts above chassis ground. While the current available from the chamber's bias batteries is limited and presents no hazard, shorting the chamber to any other parts of the instruments will quickly run down the battery as well as invalidating any readings taken.

Note: This procedure REQUIRES an E-600 with a firmware version of 3.02 or later. Prior versions of the E-600 program DO NOT automatically recognize the SHP-400 and WILL NOT support this procedure as written.

The first section of this procedure is intended to initialize a newly assembled SHP-400 probe and to prepare it for calibration. These steps are equally appropriate for a probe which has been repaired and/or rebuilt and which does not appear to be interacting correctly with an E-600. Simple calibration of a probe which is already functioning properly is covered later in the document.

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Switch the E-600 to *Check* mode, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Connect a digital voltmeter between pin 1 of the 1000:1 voltage divider (R12) and pin 2 of potentiometer R11 (or the end of R1 which is tied to this point in etch). With the voltmeter on its lowest scale, adjust R11 until the displayed voltage is  $24.5 \pm 0.5$  millivolts.
3. If the probe being calibrated is new, use the *Init Smart Probe* function under the *Utility* heading to initialize the probe's memory. At this point, if the E-600 is displaying *Probe Fail*, install Probe Parameters, turn the E-600 OFF then ON to initialize the SHP-400. Set the Autoranging command to "NO" in the Instrument Parameters.
4. Next load the probe parameters (previously calibrated smart probes will have parameters stored and will not require downloading from the computer). Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters*. From the list presented, select the SHP-400 file. Click on the *OK* button to transfer the parameters from the disk file to the instrument.
5. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe*, then the *Probe* and *Channel* parameters. Values not listed, such as alarm setpoints and scaler count times, may be set as desired, however a response time setting of approximately 10 seconds will be called for later in this calibration procedure.

Probe Parameters	
Dead Time (μsec.)	0
Probe Area (cm <sup>2</sup> )	42
Max. High Voltage	0
Overrange (cps)	18000
Radon Alarm (cps)	0
Control Line Function	Slide Position - Auto Channel
Probe Type	Ion Chamber -- Pulsed

Channel Parameters			
Channel Number	1	2	3
Channel Type	Gamma	None	None
Units	R/h	R/h	cps
Selected Window	Upper	Upper	Upper
High Voltage	0	0	0

Window Parameters Channels 1 & 2	Lower Window	Upper Window
Threshold (mV)	1.00	60.0
counts/R	1	7.00E+06
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	10

6. Select *Edit, Smart Probe, Probe Parameters*, then enter the SHP-400 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration; the "Next Cal. Date" parameter should be set to one year after this cal date. Store all changes to the probe's memory.
7. In a negligible background field, advance the E-600 control knob to *Check* mode, then press the *Channel* key several times until a screen is displayed with the label 'CAL0' in the lower-right corner. Press and hold

the *Star* key for five seconds; the instrument will then beep four times and begin counting the probe's 'zero' frequency. Do not move or touch the probe during this count. After a thirty second count, the E-600 will again beep four times and display the zero frequency in Hertz. If necessary, potentiometer R10 on the bottom of the SHP-400's V-F board should be adjusted and the frequency measurement repeated until the zero frequency is  $20 \pm 2$  Hertz. After CAL0 has been done, SHP 400 should be dropped  $\sim 1/4''$  from Table Top while re-running CAL0 change should not be greater than 0.25 Hz. If it changes; it is indicative of a loose connection or foreign matter which is moving inside the chamber, and should be investigated.

8. Turn the E-600 *Off*, re-connect the ribbon cable to the battery board, and re-assemble the probe completely.

This concludes the initialization and checkout segments of this procedure; the remaining steps will calibrate the probe. It is assumed that the person performing this calibration is familiar with basic operation of the SHP-400 and E-600. If necessary, refer to the technical manuals for these products for normal operating instructions.

#### Calibration Procedure

9. In a negligible (ie. background) field area, connect the SHP-400 and E-600 and switch the instrument to *Check* mode. Press the *Chnl* key several times until the screen labeled 'CAL0' is displayed. Press and hold the *Star* key for five seconds to initiate a 30-second count of the probe's zero frequency. After this count is completed, the E-600 will automatically subtract this frequency from all subsequent readings.
10. Take readings in gamma fields (normally provided by  $^{137}\text{Cesium}$  source wells) at a minimum of three values. For Normal use, fields of 25, 250 and 2500 mR/hour are recommended. If the probe is to be used primarily in a specific range of field intensities, values in the desired range may be substituted for the above or additional points may be taken. Likewise, if the probe is to be used principally for measuring a different isotope, that source may be used for calibration.
11. Compute the response of the probe in each field measured (indicated value divided by nominal field intensity). Average these ratios to obtain a single value, which should be close to unity.
12. Connect the probe and E-600 to a personal computer on which the E-600 interface program is running. Retrieve the calibration constant (expressed in *Counts/R*) which was in use during these measurements and multiply this value by the response ratio obtained in the previous step. Enter the result as the probe's new calibration constant and click *OK* to save it to the probe's memory.  
  
Note: The same calibration constant is normally entered into both channel 1 and channel 2. This entry must be made manually in both windows before saving to probe memory. If desired, a second set of measurements may be made with the shield open and/or using a different isotope as a source for channel 2. If channel 2 is to be calibrated, its *Channel Type* must be set to something other than 'None'. The normal type for channel 2, if used, is 'Beta'.
13. Measure and save a new background value using the updated calibration constant. Repeat the measurements used as calibration points and verify that all are now within 5% of nominal (ie. the ratios obtained are between 0.95 and 1.05). Additional points may be checked if desired; all values between 10 and 5000 mR/h should fall within  $\pm 5\%$  of nominal.
14. Calibration is complete. To print cal report, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and calibration constant on the printed cal report.

## P. SPA-1A

Calibration in CPS, CPM, DPS, DPM, Bq to  $^{230}\text{Th}$

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time ( $\mu\text{sec.}$ )	10
Probe Area ( $\text{cm}^2$ )	2
Max. High Voltage	1400
Overrange (cps)	15000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Alpha	
Units	cpm	
Selected Window	Upper	
High Voltage	430	
Window Param's	Lower	Upper
Threshold (mV)	2.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date"

parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	30
Starting Voltage	425
Ending Voltage	725
Voltage Step	25
Max. Count Rate (cps)	2500*
Graph Name	SPA-1A
File Name	SPA1A.GRF

\* Depends on source activity.

5. Expose the probe to a  $^{230}\text{Th}$  plated source of around 10K cpm. If available  $^{239}\text{Pu}$  may also be used. Position the source disc with the active side facing the detector. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached extend the ending voltage as necessary to complete the plateau.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. Adjust up and down from this point noting the ratio of the upper window counts versus the lower window counts shown in the lower left corner. Select the point where the upper window (alpha) counts are highest and the lower window (beta) counts are lowest while still on the plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.
7. Determine background and calibration constant next by selecting *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 300 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background count. The background should be less than 30 cpm.
8. Upon completion of the background count, click on the *Cal. Const.* button. Enter the calibration field, which should be a  $^{230}\text{Th}$  source of around 8K cpm ( $\approx 16\text{K dpm}$ ), such as s/n 10001. The units have to be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.
9. Upon completion, verify the determined cal constant (ie.  $2\pi$  efficiency or counts/count parameter) is greater than 0.60. If within tolerance, answer Yes to the save prompt. Note the efficiency ( $\text{CC} \times 100 = \% \text{ eff.}$ ) to record later on the calibration report.

10. Select *Calibrate*, then *Run Linearity Check*. Click on the *Efficiency Based Linearity Check* box on top of the dialog box that appears. Enter the  $^{230}\text{Th}$  source count rate for the linearity fields. Sources should be 1 inch, plated  $^{230}\text{Th}$  of less than 2K cpm and another of more than 7K cpm, such as s/n 10170 and 10001. Note the field entered must be in the same units (cpm) as the probe set up.
11. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it.
12. Unless calibration other than cpm is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 1. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 15.
13. If calibration is to source count rate ( $2\pi$  emissions) then jump to step 15. Do not edit the cal constants to 1.00, the previously determined values are correct for  $2\pi$  emissions.
14. If units of dps, dpm or Bq are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 1 and divide the previously determined cal constant by two.

For example: If the previously determined cal constant was 0.28 counts/count. Change the units to dpm, then edit the cal constant to 0.14 counts/disint. ( $0.28 \div 2$ ).

15. Calibration is now complete. Verify correct units of measure are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph*.

Q. SPA-3

Section 1 - Calibration in CPS, CPM, R/h (for PHA calibration skip to section 2)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (µsec.)	20
Probe Area (cm <sup>2</sup> )	20
Max. High Voltage	1600
Overrange (cps)	48000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	410	
Window Param's	Lower	Upper
Threshold (mV)	2.00	2.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.

- Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	400
Ending Voltage	840
Voltage Step	20
Max. Count Rate (cps)	20,000*
Graph Name	SPA-3
File Name	SPA3.GRF

\* Depends on source activity.

- Place a CS-7B,  $^{137}\text{Cs}$  ( $\approx 1\mu\text{Ci}$ ) check source against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
- When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. At this point the lower window counts should be at their lowest also. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.
- Next select *Calibration*, then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 120 seconds. Calibration should be performed in an area with less than  $30\ \mu\text{R/h}$  background. Place the probe in a low background area, then click on the *Start* button to begin background count.
- After the background has been determined, click on *Cal. Const.* Enter the calibration field,  $0.0004\ \text{R/h}$ . Place the probe in a  $0.4\ \text{mR/h}$  ( $0.0004\ \text{R/h}$ )  $^{137}\text{Cs}$  field, face on. Probe must be in free air, suspended on non-metallic objects at least 3 feet off the floor with no other objects within 6 feet. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within  $5.0\text{E}+10$  to  $9.0\text{E}+10$ .
- Click on *Dead Time* and enter the dead time field,  $0.002\ \text{R/h}$ . Place the probe in a  $2\ \text{mR/h}$  ( $0.002\ \text{R/h}$ )  $^{137}\text{Cs}$  field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 16 to 26  $\mu\text{sec.}$ , click on *Save* when prompted, to store new value in the instrument.
- Calibration is now complete. Verify correct units of measure are set in the instrument. If calibration is to **R/h**, jump to step 11. Otherwise, edit the units of measure to cpm or cps, and cal constant (counts/count parameter) to 1.00 in both the upper and lower windows of channel 1. To edit the units and cal constant, select *Edit*,



*Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 12 to print calibration report.

11. Select *Calibrate*, then *Run Linearity Check*. Enter the following  $^{137}\text{Cs}$  linearity fields in the dialog box that appears: 0.0005 R/h (0.5 mR/h) and 0.001 R/h (1 mR/h). Note the field entered must be in the same units (R/h), as the probe set up. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions that appear in the dialog box. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.
12. Print cal report by selecting *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. If linearity data was taken, click on the *YES* button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

### Section 2 - PHA Calibration

13. Load the SPA-3 PHA probe parameters, by selecting *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the *spa3pha.\** file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters.

Probe Parameters	
Dead Time ( $\mu\text{sec.}$ )	20
Probe Area ( $\text{cm}^2$ )	20
Max. High Voltage	1600
Overrange (cps)	48,000
Radon Alarm (cps)	0

Channel Parameters	
Channel Number	1
Channel Type	PHA
Units	cpm
Selected Window	Lower
High Voltage	400

Window Param's	Lower	Upper
Threshold (mV)	4.00	5.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

- Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.
- Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	440*
Ending Voltage	500*
Voltage Step	10
Max. Count Rate (cps)	20,000**
Graph Name	SPA-3, PHA
File Name	SPA3.GRF

\* Plateau starting and ending voltages will vary with isotope. Approximate plateau voltages are 440V to 500V for  $^{137}\text{Cs}$ ; 670V to 710V for  $^{241}\text{Am}$  and 400V to 450V for  $^{60}\text{Co}$ .

\*\* Depends on source activity.

- Place a CS-7B,  $^{137}\text{Cs}$  ( $\approx 1\mu\text{Ci}$ ) check source or other isotope of interest, against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high

voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

17. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is on the peak of the lower window. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the correct desired value.
18. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

## R. SPA-6

### Calibration in CPS, CPM

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time ( $\mu$ sec.)	15
Probe Area ( $\text{cm}^2$ )	20
Max. High Voltage	1600
Overrange (cps)	50,000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Upper	
High Voltage	750	
Window Param's	Lower	Upper
Threshold (mV)	3.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date"

parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	750
Ending Voltage	1500
Voltage Step	50
Max. Count Rate (cps)	6.70E+04
Graph Name	SPA-6
File Name	SPA6.GRF

5. Place a CS-7B,  $^{137}\text{Cs}$  ( $\approx 1\mu\text{Ci}$ ) check source against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.
7. Next select *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 60 seconds. Calibration should be performed in an area with less than  $30\ \mu\text{R/h}$  background. Place the probe in a low background area, then click on the *Start* button to begin the background count. Note the reading upon completion of the background count. Switch to *Background* mode on the E-600.
8. Place the probe in a  $0.5\ \text{mR/h}$  ( $0.0005\ \text{R/h}$ )  $^{137}\text{Cs}$  field, face on. Probe must be in free air, at least 3 feet off the ground with no large objects within 6 feet. Acquire a count in the *Background* mode by watching the countdown in the lower right corner. Note the CPM value when it is below 2%. Subtract the previously determined background from this value. Multiply the net cpm value by 8 and use this number as the dead time field.
9. Click on *Dead Time* and enter the dead time field, determined in step 8. Place the probe, in a  $4\ \text{mR/h}$  ( $0.004\ \text{R/h}$ )  $^{137}\text{Cs}$  field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 16 to 26  $\mu\text{sec.}$ , click on *Save* when prompted, to store the new value.
10. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated.

Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

## S. SPA-8

### Calibration in CPM, CPS, R/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (µsec.)	36
Probe Area (cm <sup>2</sup> )	5
Max. High Voltage	1500
Overrange (cps)	45000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Upper	
High Voltage	525	
Window Param's	Lower	Upper
Threshold (mV)	2.00	2.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	500
Ending Voltage	1100
Voltage Step	50
Max. Count Rate (cps)	15,000*
Graph Name	SPA-8
File Name	SPA8.GRF

\* Depends on source activity

5. Expose the probe to a CS-7B,  $^{137}\text{Cs}$  ( $\approx 1\mu\text{Ci}$ ) check source, preferably in a lead shield. Position the source disc with the active side facing the end of the probe. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau. If calibration is to  $\mu\text{R/h}$  then jump to step 11.
7. Select *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 300 seconds. Calibration should be performed in an area with less than  $30\mu\text{R/h}$  background. Place the probe in a low background area, then click on the *Start* button to begin the background count.
8. Place the probe in a  $0.5\text{ mR/h}$  ( $0.0005\text{ R/h}$ )  $^{137}\text{Cs}$  field, face on. Probe must be in free air, at least 3 feet off the ground with no large objects within 6 feet. Acquire a count in the *Background* mode by watching the countdown in the lower right corner. Note the CPM value when it is below 2%. Subtract the previously determined background from this value. Multiply the net cpm value by 15 and use this number as the dead time field.
9. Click on *Dead Time* and enter the dead time field, determined in step 8. Place the probe, in a  $7.5\text{ mR/h}$   $^{137}\text{Cs}$  field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 20 to 65  $\mu\text{sec.}$ , click on *Save* when prompted, to store the new Dead Time parameter.
10. Calibration is now complete. To print cal report, select *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration, Display*



*Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph*.

## R/h Calibration

11. Edit the units to R/h by selecting *Edit, Smart Probe* or *Conventional Probe* as applicable, then *Channel* parameters. Change channel 1 units from cpm to R/h. Place the probe in a low background area. Calibration should be performed in an area with less than 30  $\mu$ R/h background. Select *Calibration*, then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background are selected with the count time set to 120 seconds. Click on the *Start* button to begin background count.
12. After the background has been determined, click on *Cal. Const.* Enter the calibration field, 0.0005 R/h. Place the probe in a 0.5 mR/h (0.0005 R/h)  $^{137}\text{Cs}$  field, face on. Probe must be in free air, at least 3 feet off the ground with no large objects within 6 feet. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 1.00E+10 to 2.00E+10.
13. Next, click on *Dead Time*. Enter the dead time field, 0.0075 R/h. Place the probe in a 7.5 mR/h (0.0075R/h)  $^{137}\text{Cs}$  field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 20 to 65  $\mu$ sec., click on *Save* when prompted, to store new value in the instrument.
14. Select *Calibrate*, then *Run Linearity Check*. Enter the following  $^{137}\text{Cs}$  linearity fields in the dialog box that appears: 0.0005 R/h (0.5 mR/h), 0.002 R/h (2 mR/h), and 0.010 R/h (10 mR/h). Note the field entered must be in the same units (R/h), as the detector set up.
15. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.
16. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. When the Graph Window is displayed, select *File* then *Print Graph*.

## T. SPA-9, RD-19

### Calibration in CPS, CPM

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.
2. Next load the probe parameters. Select *Edit, Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit, Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (µsec.)	31
Probe Area (cm <sup>2</sup> )	20
Max. High Voltage	1600
Overrange (cps)	50000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	575	
Window Param's	Lower	Upper
Threshold (mV)	3.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date"

parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

<b>Plateau Parameters</b>	
Count Time (sec.)	10
Starting Voltage	550
Ending Voltage	1300
Voltage Step	50
Max. Count Rate (cps)	67000
Graph Name	SPA-9
File Name	SPA9.GRF

5. Place a CS-7B,  $^{137}\text{Cs}$  ( $\approx 1\mu\text{Ci}$ ) check source against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.
6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.
7. Next select *Calibration*, then *Determine Calibration Constant*. Verify *Channel 1*, Upper Window, and *Background* buttons are selected with the count time set to 120 seconds. Calibration should be performed in an area with less than 30  $\mu\text{R/h}$  background. Place the probe in a low background area, then click on the *Start* button to begin the background count. Upon completion of the background count, click on the *Cal. Const.* button.
8. After the background has been determined, click on *Cal. Const.* Enter the calibration field, 0.0005 R/h. Place the probe in a 0.5 mR/h (0.0005 R/h)  $^{137}\text{Cs}$  field, face on. Probe must be in free air, suspended on non-metallic objects at least 3 feet off the floor with no other objects within 6 feet. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 2.0E+10 to 4.0E+10.
9. Click on *Dead Time* and enter the dead time field, 0.005 R/h. Place the probe in a 5 mR/h (0.005 R/h)  $^{137}\text{Cs}$  field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 25 to 38  $\mu\text{sec.}$ , click on *Save* when prompted, to store new value in the instrument.
10. Calibration is now complete. Verify correct units of measure are set in the instrument. If calibration is to R/h, jump to step 11. Otherwise, edit the units of measure to cpm or cps, and cal constant (counts/count parameter)

to 1.00 in both the upper and lower windows of channel 1. To edit the units and cal constant, select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 12 to print calibration report.

11. Select *Calibrate*, then *Run Linearity Check*. Enter the following  $^{137}\text{Cs}$  linearity fields in the dialog box that appears: 0.0005 R/h (0.5 mR/h) and 0.005 R/h (5 mR/h). Note the field entered must be in the same units (R/h), as the probe set up. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions that appear in the dialog box. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.
12. Print cal report by selecting *Calibration*, and *Print Calibration Report*, while still connected to the E-600 just calibrated. If linearity data was taken, click on the *YES* button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration, Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.