SECTION 13

Section 13

E-600 Calibration

This procedure is designed to calibrate an E-600 with the many hand probes available from Eberline. Select a probe from the list below then go to the corresponding page.

EQUIPMENT REQUIRED:

IBM PC/AT 386 Compatible Computer, Windows 3.1 capable.
Windows program for E-600 (part of E600OPT7 or E600OPT17)
CA-104-60 Data Cable and appropriate detector cable, CA-XXX-60 unless otherwise specified.
Graphics capable printer.
Calibration standard sources, isotope and type vary with probe.

REFERENCE:

E-600 PC Windows Technical Manual (MA-WINE600)

A. ABP-100, SABP-100

Calibration in dps, dpm, cps, cpm, Bq, dps/100cm^2, dpm/100cm^2, Bq/100cm^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 and won't require downloading from the computer.

Probe Parameters	
Dead Time (µsec.)	5
Probe Area (cm^2)	100
Max. High Voltage	1100
Overrange (cps)	75000
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	752	752	752

Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	20.0
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	752
Ending Voltage	1055
Voltage Step	10
Max. Count Rate (cps)	5000*
Graph Name	ABP-100
File Name	ABP100.GRF

* Depends on source activity.

5. Expose the probe to a ^{99}Tc 10K to 200K cpm (or ≈20K to 400K dpm) plated source. Position the source disc with the active side facing 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 plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% beta to alpha 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. 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 count. The Alpha background should be less than 10 cpm. If the background is too high, try decreasing the high voltage, (refer to the previously run plateau). Click on the Lower Window button to display the beta background. The beta background should be less than 500 cpm.

8. 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 ^{99}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.

9. Verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.10 for ^{99}Tc. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

10. 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 ^{230}Th source (or ^{239}Pu if available) 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.

11. Upon completion, verify the determined Alpha Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.10 for ^{230}Th, and greater than 0.18 for ^{239}Pu. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

12. 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 15.

13. If calibration is to source count rate (2π emissions) then jump to step 15. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

14. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 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 ÷ 2).

15. 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.

16. 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 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*.

B. AC-3-7, AC-3-8, HP/SHP-350, HP/SHP-380A

Calibration in CPS, CPM, DPS, DPM, Bq

Calibration to ^{239}Pu (or ^{230}Th if necessary) in S94 type source holders when possible, except for HP/SHP-380A.

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^2)	73 (100 for HP/SHP-380A)
Max. High Voltage	1500 (1300 for HP/SHP-380A)
Overrange (cps)	90000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Alpha	
Units	cpm	
Selected Window	Upper	
High Voltage	700	
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.)	10
Starting Voltage	700 (500 for HP-380)
Ending Voltage	1250
Voltage Step	25
Max. Count Rate (cps)	2500*
Graph Name	AC-3, HP-380, etc.
File Name	AC3.GRF (example)

* Depends on source activity.

5. Expose the probe to a ^{239}Pu (or ^{230}Th) 40K to 200K cpm (or ≈80K to 400K dpm) plated source. Position the source disc with the active side facing 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, but no higher than 1300 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 center of the upper window 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 10 cpm.

8. Upon completion of the background count, click on the *Cal. Const.* button. Enter the calibration field, which should be a ^{239}Pu source (or ^{230}Th), of around 50K cpm (≈ 100K dpm). 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. 2π efficiency or counts/count parameter) for ^{239}Pu is greater than 0.28 for the AC-3-7, greater than 0.18 for the AC-3-8, and greater than 0.36 for the HP/SHP-350 and HP/SHP-380A. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

10. 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 13.

11. If calibration is to source count rate (2π emissions) then jump to step 13. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

12. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 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 ÷ 2).

13. 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*.

C. HP-100A, HP-100B, HP-100AGS, HP-100BGS, SHP-100BGS

Calibration in CPS, CPM, Bq, DPS, DPM, DPS/100cm^2, DPM/100cm^2, Bq/100cm^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 and won't require downloading from the computer.

Probe Parameters	
Dead Time (µsec.)	7.5
Probe Area (cm^2)	100
Max. High Voltage	1900
Overrange (cps)	80000
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	1360	1360	1360

Window Param's	**Lower**	**Upper**
Threshold (mV)	1.00	27.00
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. Flush the probe with P10 gas for one hour (minimum) at a flow rate of 50 cc/min. During the actual plateau and counting operations, flow must be maintained at 40 cc/min or more.

4. 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.

5. Select *Calibrate*, then *Run Plateau* from the sub-menu. Click on the *Channel 3* 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	1360
Ending Voltage	1660
Voltage Step	20
Max. Count Rate (cps)	2500*
Graph Name	SHP-100BGS
File Name	SHP100.GRF

* Depends on source activity.

6. Expose the probe to a ^{99}Tc* 40K to 200K cpm (or ≈80K to 400K dpm) plated source. Position the source with the active side facing 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.

7. 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% beta to alpha crossover. The black vertical bar turns red when the beta to alpha crossover exceeds 1%. Move the bar back one position when it turns red to obtain the optimum operating voltage. Save the desired 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.

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. If the background is too high, try decreasing the high voltage. While *Background* is still selected, click on the Lower Window button to display the beta background. The beta background should be less than 600 cpm.

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 100cm^2, ^{137}Cs source. 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. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.52 for ^{137}Cs. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

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 100cm^2, ^{241}Am source. 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. 2π efficiency or counts/count parameter) is greater than 0.45 for ^{241}Am. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

13. Unless calibration other than cpm is specified, edit the cal constant to 1.00 in both 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 to source count rate (2π emissions) is specified, then jump to step 16. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

15. If units of dpm, dps, Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 are desired, change the activity units and cal constant. 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 and divide the previously determined cal constant by two.

    For example: If the previously determined cal constant was 0.54 counts/count. Change the units to dpm, then edit the cal constant to 0.27 counts/disint. (0.54 ÷ 2).

16. Verify correct units of measure are set in the instrument. Copy the new parameters from channel 3 to channels 1 and 2. Select *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Click on the *Copy* button, then 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.

17. 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. After printing the report, enter the Alpha and Beta isotope and efficiency on the 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.*

18. The gas should now be disconnected from the probe. For **Gas Seal (GS) versions** of the probe perform the following:

    a. Seal the probe by disconnecting the inlet and then the outlet.

    b. Wait 4 hours. Measure the Beta 2π efficiency. It should be less than 5% decrease from the original value from step 10. Calculate the percent decrease with the following equation. This value should be less than 5.0 (5%):

$$\frac{Eff\ step\ 10\ -\ Eff\ step\ 18b}{Eff\ step\ 10} \times 100$$

* $100cm^2$ source is preferred, but any size may be used for the plateau. If necessary, the following isotopes may also be used for the plateau: ^{137}Cs, ^{90}Sr, ^{60}Co. A $100cm^2$ ^{137}Cs source is the only type that should be used to measure beta efficiency.

D. HP-190A

Section 1 - Calibration in CPM

(for R/h 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 and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	250
Probe Area (cm^2)	6
Max. High Voltage	900
Overrange (cps)	12500
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Beta	
Units	cpm	
Selected Window	Upper	
High Voltage	900	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/count	1.0	1.0
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. If R/h calibration is specified, then jump to step 10, otherwise calibration should be in CPM.

4. Place the probe in a low background area. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and Background are selected with the count time set to 180 seconds. Click on the *Start* button to begin background count.

5. After the background has been determined, click on *Cal. Const.* Expose the probe, screen on a 1 inch plated ^{90}SrY source of less than 20k cpm. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and source activity. Upon completion, verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.12. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC $\times$ 100 = % eff.) to record later on the calibration report.

6. Select *Calibrate*, then *Run Linearity Check.* Click on the *Efficiency Based Linearity Check* box on top of the dialog box that appears. Enter the ^{90}SrY source count rate for the linearity fields. Sources should be 1 inch, plated ^{90}SrY of about 2K to 20K cpm and another of $\approx$75K to 100K cpm. Note the field entered must be in the same units (cpm) as the probe set up.

7. 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.

8. If linearity checks ok, 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.*

9. 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, prior to printing. Record the isotope and previously determined efficiency on the cal report.

Section 2 - R/h Calibration

10. Select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters.* Change the units from cpm to R/h in channel 1and the channel type to gamma.

11. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and *Cal. Const.*are selected. Enter the cal constant field of 0.0075R/h. Place the probe in a 0.0075 R/h (7.5 mR/h) ^{137}Cs field, side on. 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 1.15E+08 to 1.95E+08.

12. Next, click on *Dead Time.* Enter the dead time field of 0.75R/h. Place the probe, in a 0.75R/h (750 mR/h) ^{137}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 230 to 330 µsec., then click on *Save* when prompted, to store the new Dead Time value in the instrument.

13. Select *Calibrate*, then *Run Linearity Check.* Enter the following ^{137}Cs linearity fields in the box that appears: 0.005 R/h (5 mR/h), 0.05 R/h (50 mR/h), and 0.25 R/h (250 mR/h). Note the field entered must be in the same units (R/h), as the probe set up.

14. 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.

15. 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, prior to printing.

E. HP-210, HP-260, SHP-360

Section 1 - Calibration in CPM (for R/h 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.)	100
Probe Area (cm^2)	15
Max. High Voltage	900
Overrange (cps)	58000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Beta	
Units	cpm	
Selected Window	Upper	
High Voltage	900	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/count	1	1
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. If R/h calibration is specified, then jump to step 9, otherwise calibration should be in CPM.

4. Place the probe in a low background area. 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.

5. After the background has been determined, click on *Cal. Const.* Expose the probe to a 47mm ^{99}Tc source of 18k to 35k cpm. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and source activity. Upon completion, verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.25. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

6. Select *Calibrate*, then *Run Linearity Check.* Click on the *Efficiency Based Linearity Check* box on top of the dialog box that appears. Enter the ^{99}Tc source count rate for the linearity fields. Sources should be 47mm, ^{99}Tc of about 15k to 40k cpm (this may be the same source used in Step 5.) and another of ≈75K to 100K cpm. Note the field entered must be in the same units (cpm) as the probe set up.

7. 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.

8. If linearity checks ok, 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.*

9. 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, prior to printing. Record the isotope and previously determined efficiency on the cal report.

Section 2 - R/h calibration

10. Select *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters.* Change the units from cpm to R/h in channel 1and the channel type to gamma.

11. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and *Cal. Const.* are selected. Enter the cal constant field of 0.0075 R/h.

NOTE

Use 1/4" plastic (plexiglas) between source and detector, placed in contact with detector, for the following readings.

12. Place the probe in a 0.0075 R/h (7.5 mR/h) ^{137}Cs field, face on. 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 1.8E+08 to 2.4E+08.

13. Next, click on *Dead Time.* Enter the dead time field of 0.75R/h. Place the probe, in a 0.75R/h (750 mR/h) ^{137}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 80 to 125 µsec., click on *Save* when prompted, to store the new Dead Time value in the instrument.

14. Select *Calibrate*, then *Run Linearity Check.* Enter the following ^{137}Cs linearity fields in the box that appears: 0.005 R/h (5 mR/h), 0.05 R/h (50 mR/h), and 0.5 R/h (500 mR/h). Note the field entered must be in the same units (R/h), as the probe 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.

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, prior to printing. Record the isotope and previously determined efficiency on the printed cal report.

F. HP-220A
Calibration in 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.)	60
Probe Area (cm^2)	1
Max. High Voltage	600
Overrange (cps)	67000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	600	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	1.50E+06
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Place the probe in a low background area. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and *Cal. Const.* are selected.

4. Enter the cal constant field, 0.075 R/h. Place the probe in a 75 mR/h (0.075 R/h) ^{137}Cs field. 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 4.9E+07 to 9.1E+07.

5. Next, click on *Dead Time*. Enter the dead time field, 75 R/h. Place the probe in a 75 R/h ^{137}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 70 to 100 µsec., click on *Save* when prompted, to store new value in the instrument.

6. Change the linearity tolerance to 15% by selecting *Edit*, then *System Parameters*. Next perform the linearity check by selecting *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.750 R/h (750 mR/h), 7.5R/h, and 75R/h. Note the field entered must be in the same units (R/h), as the detector set up.

7. 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. 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.

8. 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.

G. HP-270, SHP-270
Calibration in R/h

9. 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*.

10. 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.)	90
Probe Area (cm^2)	3
Max. High Voltage	900
Overrange (cps)	60000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	900	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	7.00E+07
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

11. Select *Calibration,* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Cal. Const. are selected. Enter the calibration constant field, 0.0075 R/h. Place the probe in a 7.5 mR/h (0.0075 R/h) ^{137}Cs field, side on, shield closed. 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 4.9E+07 to 9.1E+07.

12. Next, click on *Dead Time*. Enter the dead time field, 0.75 R/h. Place the probe, shield closed, in a 750 mR/h (0.75R/h) ^{137}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 60 to 120 µsec., click on *Save* when prompted, to store new value in the instrument.

13. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.005 R/h (5 mR/h), 0.5R/h (500mR/h), and 2R/h. Note the field entered must be in the same units (R/h), as the detector set up.

14. 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.

15. 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.

H. HP-290, SHP-290

Calibration in 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.)	24
Probe Area (cm^2)	2
Max. High Voltage	550
Overrange (cps)	75000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	550	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	5.50E+06
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Select *Calibrate,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and Cal. Const. are selected. Enter the calibration constant field, 0.75 R/h. Place the probe in a 0.75 R/h (750 mR/h) ^{137}Cs

field, side on. Click on the *Start* button to begin count. 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 4.50E+06 to 7.0E+06.

4. Next, click on *Dead Time*. Enter the dead time field, 25 R/h. Place the probe in a 25R/h ^{137}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 22-35 µsec., click on *Save* when prompted to store new value in the instrument.

5. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.075 R/h (75 mR/h), 7.5R/h, and 40R/h. Note the field entered must be in the same units (R/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.

I. HP-300, SHP-300

Calibration in 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 Dis*k, 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.)	100
Probe Area (cm^2)	53
Max. High Voltage	500
Overrange (cps)	16,000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	449	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	5.00E+08
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Select *Calibration,* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Cal. Const. are selected. Enter the calibration constant field, 0.001 R/h. Using the free air calibrator setup, place the probe in a 1 mR/h (0.001 R/h) ^{137}Cs field, side on. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. Repeat until determined cal constant is

consistent. When count is complete, click on *Save* to store the new calibration constant if within 4.7E+08 to 7.0E+08.

4. Next, click on *Dead Time*. Enter the dead time field, 0.05 R/h. Follow the instructions for HP-300 probes located in the source room for source well s/n EI-152. Place the probe in the special holder above the well, and set up for a 50 mR/h (0.05R/h) ^{137}Cs field per the HP-300 instructions. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 90 to 200 µsec., click on *Save* when prompted to store the new value in the instrument.

5. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.02 R/h (20 mR/h), 0.05R/h (50mR/h), and .1R/h (100mR/h). Note the field entered must be in the same units (R/h), as the detector set up. Follow the instructions for the HP-300 probes when setting up these fields.

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 printed calibration report when prompted.

J. HP-320, SHP-330

Calibration in CPM, CPS, DPM, DPS, Bq

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.)	8.5
Probe Area (cm^2)	15
Max. High Voltage	1800
Overrange (cps)	48000
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	1450	1450	1450

Window Param's	**Lower**	**Upper**
Threshold (mV)	1.00	30.00
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* from the sub-menu. Click on the *Channel 3* 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	1450
Ending Voltage	1650
Voltage Step	10
Max. Count Rate (cps)	2500*
Graph Name	SHP-330
File Name	SHP330.GRF

* Depends on source activity.

5. Expose the probe to a ^{99}Tc 20K to 200K cpm (or ≈40K to 400K dpm) 47mm plated source. Position the source disc with the active side facing 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 plateau. Adjust up and down from this point noting the ratio of the upper window counts versus the lower window counts. Select the point where the lower window counts are highest and the upper window 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. 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 2 cpm. While *Background* is still selected, click on the Lower Window button to display the beta background. The beta background should be less than 50 cpm.

8. 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 ^{99}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.

9. Verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.18 for ^{99}Tc. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

10. 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 ^{239}Pu 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.

11. Upon completion, verify the determined Alpha Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.20 for ^{239}Pu. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record later.

12. Unless calibration other than cpm 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 15.

13. If calibration is to source count rate (2π emissions) then jump to step 15. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

14. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 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 and divide the previously determined cal constant by two.

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

15. Verify correct units of measure are set in the instrument. Copy the new Cal. Constant and other parameters 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.

16. 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 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. When the Graph Window is displayed, select *File* then *Print Graph*.

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^2)	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}Am plated source, of ≈300k cpm (≈600k 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}Am 60 keV gamma efficiency. Expose the detector to an ^{241}Am source of ≈600k 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.

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