ITEM 10

CALIBRATION OF INSTRUMENTS

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CALIBRATION OF SURVEY INSTRUMENTS

1. Survey instruments will be calibrated at least annually and following repair.

2. Calibration will be performed at two points on each scale. The two points will be approximately 1/3 and 2/3 of full scale. A survey instrument may be considered properly calibrated when the instrument readings are within ± 10% of the calculated or known values for each point checked. Readings within ± 20 are considered acceptable if a calibration chart or graph is prepared and attached to the instrument.

3. Survey instruments will be calibrated by:

   Radiation Management Corporation
   Science Center Building #2
   ATTN: Mr. Stephen M. Kim
   3508 Market Street
   Philadelphia, PA 19104

4. Procedures and sources have been approved by NRC and are on file in License No. 37-13129-01.

DOSE CALIBRATOR QUALITY CONTROL

Daily Checks:

Place the calibration stick source (Amersham/Searle serial #1121 with 15.5 microcuries of ^{226}Ra as of 4/1/74) and take readings at the following settings: ^{226}Ra, ^{131}I, ^{99m}Tc, ^{75}Se, and ^{133}Xe. Remove the stick source and take background readings at the same settings. NOTE: Take extra care in placing all unshielded sources of radioactivity behind lead before taking the above readings. A small source of unshielded activity will give elevated readings.

Record all readings in the Mediac Dose Calibration log book under the proper section. Subtract all background readings from the source readings to determine net activity. If the net readings fall outside of the values listed below, re-check the following areas:

1. The serial number of the calibration source.
2. The dial setting on the dose calibrator.
3. Look for unshielded sources of radioactivity.

If the net readings still fall outside of the $\pm$ 2 SD, notify the laboratory supervisor or chief technologist and do not use the dose calibrator to determine activity on any patient dose.

Dose Calibrator #1: #028555 FSN 6720 G030005 (Comp. part)

^{226}Ra	15.01 to 16.27	($\pm$ 2 SD)	$\bar{x}$ = 15.64
^{131}I	62.06 to 65.86	($\pm$ 2 SD)	$\bar{x}$ = 63.96
^{99m}Tc	13.51 to 14.29	($\pm$ 2 SD)	$\bar{x}$ = 13.90
^{75}Se	48.23 to 53.13	($\pm$ 2 SD)	$\bar{x}$ = 50.68
^{133}Xe	0.5711 to 0.5879	($\pm$ 2 SD)	$\bar{x}$ = 0.5795

Dose Calibrator #2:

^{226}Ra	15.48 to 16.08	($\pm$ 2 SD)	$\bar{x}$ = 15.78
^{131}I	62.04 to 63.40	($\pm$ 2 SD)	$\bar{x}$ = 62.72
^{99m}Tc	13.68 to 14.44	($\pm$ 2 SD)	$\bar{x}$ = 14.06
^{75}Se	48.94 to 50.42	($\pm$ 2 SD)	$\bar{x}$ = 49.68
^{133}Xe	0.550 to 0.597	($\pm$ 2 SD)	$\bar{x}$ = 0.570

LINEARITY CHECK FOR DOSE CALIBRATORS

PRINCIPLE:

An important aspect of "Quality Control" in the radiopharmacy or Nuclear Medicine installation is the preparation and dispensing of accurately measured doses to the patients. One important aspect for proper calibration of all dose calibrators is to determine the need to apply corrections for saturation losses to measurements of high activity sources.

To determine these correction factors, a linearity should be performed on all dose calibrators at installation and at a regular interval thereafter.

PROCEDURE:

1. Linearity checks for all dose calibrators will be checked at installation and semi-annually by tracking the decay of TcO4 99m of substantial activity.

2. Milk the "oncall" generator on Wednesday. Note the exact time of the elution and the net mean TcO4 99m activity ($\bar{X}$ of three (3) separate readings).

3. At intervals of 3, 6, 24, 27, 30 and 48 hrs. after elution, reassay the TcO4 99m vial and record the actual net mean activity.

4. Using the 24 hr. reading as a reference point, calculate the expected net activity for the readings taken at 0, 3, 6, 27, 30 and 48 hrs.

ASSAY TIME (Hours $\bar{p}$ elution)	CORRECTION FACTOR
0	16.0
3	11.363
6	8.000
24	1.000
27	0.707
30	0.500
48	0.062

5. Plot the net expected activity vs the net actual activity on Log-Log graph paper.

6. Record and save all data.

7. If the net actual activity curve exceeds ± 5% of the net expected activity, the Laboratory Supervisor or the Chief Technologist should be notified immediately. The dose calibrator is not to be used until proper maintenance has been obtained.

8. Repeat linearity check after repairs have been completed.

DOSE CALIBRATOR CALIBRATION
FOR GEOMETRY VARIATION

PRINCIPLE:

Large variances in activity can occur when the volume of the sample, container shape and volume or gamma energy level changes for different radionuclides used in diagnostic evaluations. To minimize this effect, correction factors should be established to determine the true activity administered to patients.

To ascertain these correction factors, a check for geometry variation should be performed at the time of installation even though manufacturer guidelines may have been already established.

PROCEDURE:

1. Prepare two (2) stock solutions as follows:

   a. I-131 stock solution - Prepare a solution of I-131 with a final concentration of approximately 1.0 millicurie per ml and with a final volume of <u>at least</u> 5.0 ml (use tap water as a dilutent).

   b. TcO_4 99m stock solution - Prepare a solution of TcO_4 99m with a final concentration of approximately 10.0 millicuries per ml and with a final volume of at least 5.0 ml (use tap water as a diluent).

2. Weigh a 1.0, 3.0, 5.0 and 10.0 ml syringe with a 25 gauge (5/8") needle in place on the Mettler.

3. Withdraw, as accurately as possible, 1.0 ml into each of the four syringes from the I-131 stock solution vial.

4. Weigh each syringe on the Mettler after adding the 1.0 ml.

5. Obtain activity reading from each syringe by taking the mean of three (3) separate readings.

6. By using the 3.0 ml syringe as a standard reference point, correct the volume that was added to the 1.0, 5.0 and 10.0 ml syringes to equal that of the 3.0 syringe.

Example:

Syringe Volume	Tare Weight	Weight after Addition of 1.0 ml
1.0	13.0	14.27
3.0	15.0	16.18
5.0	20.0	21.35
10.0	30.0	31.87

Net Weight Added	$\bar{X}$ Activity from Dose Calibrator (Three Separate Readings)
1.07	1.02 mCi
1.18	1.07 mCi
1.35	1.20 mCi
1.87	1.42 mCi

$$\text{Correction Factor (CF)} = \frac{\text{Net weight added to 3.0 ml syringe (reference standard point)}}{\text{Net weight added to 1.0, 5.0 and 10.0 ml syringe}}$$

CF for 1.0 ml syringe = $\frac{1.18}{1.07}$ = 1.1; CF for 5.0 ml syringe = $\frac{1.18}{1.35}$ = 0.89;
CF for 10.0 ml syringe = $\frac{1.18}{1.87}$ = 0.63

CF · $\bar{X}$ activity from the 1.0, 5.0 and 10.0 ml syringe = relative activity added

Relative activity added:	1.0 ml syringe	5.0 ml syringe	10.0 ml syringe
	1.1x1.02=1.12 mCi	0.87·1.20-1.04 mCi	0.63·1.42=0.89 mCi

7. Once the activities for all syringes have been corrected for the difference in volumes added and the relative activity added has been calculated, prepare a graph to correct for syringe size in the following manner:

   a. Find the correction factor for each syringe by dividing the mean activity from the dose for the 1.0 ml syringe by each relative activity added for the 1.0, 5.0 and 10.0 ml syringe.

Example:

	1.0 ml syringe	5.0 ml syringe	10.0 ml syringe
Correction Factors for Different Syringe sizes	$\frac{1.07 \text{ mCi}}{1.12 \text{ mCi}} = 0.95$	$\frac{1.07 \text{ mCi}}{1.04 \text{ mCi}} = 1.02$	$\frac{1.07 \text{ mCi}}{0.89 \text{ mCi}} = 1.20$

(CF for 3.0 ml syringe = $\frac{1.0}{}$)

b. Plot the correction factors for different syringe sizes vs syringe size on linear graph paper and keep graph at dose calibrator.

8. Repeat steps 2-7 from above using the TcO_4 99m stock vial (*Note: be sure to correct all activity readings for decay)

9. Place 1.0 ml from the I-131 stock vial into a 30.0 ml elution vial.

10. Assay the elution vial and record the net mean reading (the $\bar{X}$ of three (3) separate readings).

11. Add an appropriate amount of water to the elution vial to bring the total volume of solution to 2.0, 4.0, 8.0, 10.0, 15.0 and 20.0 ml's. After each addition of water (mix well), record the net mean reading for each volume ($\bar{X}$ of three (3) separate readings).

12. Select the net mean reading from the 8.0 ml volume as a reference standard, from which all other values will be compared.

13. Correction factors (CF) for differences in activity encountered for the various volumes are calculated as follows:

$$CF = \frac{\text{Net } \bar{X} \text{ activity of reference standard}}{\text{Net } \bar{X} \text{ activity of other volumes}}$$

14. Plot the correction factors vs volumes on linear graph paper. Use this graph to determine appropriate CF needed to acquire an accurate activity measurement in elution vials.

15. Repeat the above procedure (Steps 9-14) using 1.0 ml from the TcO_4 99m stock solution vial (*Note: Be sure to correct all activity readings for decay).

16. Draw, as accurately as possible, 1.0 ml from the I-131 stock solution vial into a 3.0, 5.0 and 10.0 ml syringe.

17. Record the net mean activity for each syringe ($\bar{X}$ of three (3) separate readings).

18. Add water in 1.0 ml increments to each syringe until the maximum volume for that particular syringe has been reached.

19. Take and record the net mean activity after every addition of water (X of three (3) separate readings for each volume).

20. Select the 1.0 ml reading from the 3.0 ml syringe; the 3.0 ml reading from the 5.0 ml syringe and the 5.0 ml reading from the 10.0 ml syringe as reference standards from which all correction factors will be calculated.

21. Correction factors for the different volumes will be calculated as follows:

$$\text{Correction Factors} = \frac{\text{Mean activity of reference standard}}{\text{Mean activity from other volumes}}$$

22. Plot the correction factors vs volumes for each syringe size on linear graph paper. Use this graph to determine accurate activity measurements for various syringe volumes.

23. Repeat steps 16-22 using 1.0 ml of TcO_4 99m from the stock solution vial.

ACCURACY TEST FOR DOSE CALIBRATORS

RATIONALE:

By obtaining an accurate activity value, we are more certain to administer a quantity of radioactive material that is optimal for the planned study or treatment and that does not result in excessive dose to the patient. Small overdoses probably do not measurably harm the recipient, however, these exposure doses do accumulate and thus contribute to the overall population radiation exposure. Underdoses result in less than optimal information and prolonged imaging time. This increases patient discomfort and decreases the efficiency of the department.

PROCEDURE:

1. Assay each reference standard (Cs-137; Co-60; Co-57; and Ba-133) and subtract the appropriate amount of background to determine the net activity.

2. Repeat step #1 for a total of three determinations for each standard source.

3. Determine the mean for each standard from the three activity readings.

4. The net mean activity for each standard should be less than $\pm$ 5.0% of the certified activity after decay corrections have been made.

5. Record all results in the appropriate log book.

6. Perform accuracy checks annually or whenever repairs have been made on the instrument..

7. If at any time the net mean activity for any of the standard reference sources is greater than 5.0% of the certified activity (after correction for decay), notify the Laboratory Supervisor or Chief Technologist and do not use the instrument for determining dose activity.