Effective Date: Revised: January 20, 1994	St. Francis Central Hospital	Number: 17.02/56
Approved: Barbara A. Ball	OPERATING INSTRUCTIONS	Subject: Testing Procedures of the Dose Calibrator

PURPOSE: To provide methods and frequencies of test procedures to ascertain accuracy, constancy, linearity and geometrical variation of the dose calibrator.

BACKGROUND: All radiopharmaceutical doses must be assayed for activity to an accuracy of 10%. The most common instrument for accomplishing this is an ionization-type dose calibrator. The instrument must be checked for accurate operation at the time of installation and periodically thereafter, as directed below.

PROCEDURE: The instrument is to be tested as follows:

RESPONSIBLE PARTY	TEST	FREQUENCY
1. Nuclear Med Tech	Instrument Constancy	Daily
2. Consultant Radiological Physicist	Instrument Accuracy	At Installation & quarterly thereafter
3. Consultant Radiological Physicist	Instrument Linearity	At installation and quarterly thereafter, after any repair, adjustment or relocation
4. Nuclear Med Tech	Geometrical Variation	At installation, after any repair, adjustment or relocation

Note: Nuclear Medicine Technologists may perform actual testing, however, results are to be verified by consultant radiological physicist. The Radiation Safety Officer will review and sign the records of all geometry, linearity and accuracy tests.

METHODS:

Constancy means that there is a reproducibility, within a stated acceptable degree of precision, in measuring a constant net activity over time.

1. Assay each of three reference sources, daily prior to assay of patient doses.

   Cs-137 (100uCi to 200uCi)

   Ba-133 (100uCi to 200uCi)

   Co-57 (50uCi to 6.0mCi)

2. The constancy check is to be performed using the sealed reference sources and if the ratio of the calculated net activity to the measured net activity is not within .95 to 1.05, a "multiplying factor" will be established. Future constancy readings are to be checked using the "multiplying factor."

3. The constancy value should be within ± 5% of the calculated net activity of the reference sources.

4. Using the Cs-137 source, record readings daily for all of the commonly used radionuclide settings. eg; Tc99m, I-123, Ga-67, Tl-201 and In-111.

5. If the constancy value is not within ± 5% of the calculated net activity of each reference source, the results should be reported to the Radiation Safety Officer and the Consultant Radiological Physicist and the instrument is not to be used for the assay of patient doses.

Accuracy of the dose calibrator is to be checked for three radionuclides, Cs-137, Co-57 and Ba-133 in the activity ranges noted above (constancy). The reference sources' activities must be calibrated by comparisons with standard sources that have been assayed by the Nation Bureau of Standards (NBS) and documented.

1. The measurement chamber liner and the "zero" will be checked quarterly according to manufacturers instructions.

2. Assay the reference standard in the dose calibrator at the appropriate setting, and subtract the background level to obtain the net activity.

3. Repeat step 1 for a total of 3 determinations, and average results.

4. The average activity determined in step 2 should agree with the certified activity of the reference source within ± 5% after decay corrections.

5. Repeat the above steps for the other 2 reference sources.

6. Maintain documentation of these quarterly accuracy checks.

7. Accuracy calculations which do not agree within ± 5% indicate that the instrument should be repaired or adjusted.

8. If repair or adjustment is not readily available, a calibration factor must be established for use during routine radionuclide assays.

9. Accuracy test results are to be reported to the radiation safety officer for his review and signature.

Linearity of a dose calibrator must be ascertained over the entire range of activities used. This test will use a vial of Tc99m whose activity is equivalent to the maximum anticipated activity to be assayed, (eg. 100mCi).

1. Assay the Tc99m vial in the dose calibrator and subtract background level to obtain net activity in millicuries.

2. Repeat step 1 at the time intervals of 6, 24, 30 and 48 hours after the initial assay.

3. Using the 30 hour activity measurement as a starting point, calculate the predicted activities at 0, 6, 24 and 48 hours using the following table:

Assay Time (Hr)	Correction Factor
0	31.633
6	15.853
24	1.995
30	1.0
48	0.126

Example: If the new activity measured at 30 hours was 15.625mCi, the calculated activities for 6 and 48 hours would be 15.625mCi X 15.853 = 247.7mCi and 15.625mCi X 0.126 = 1.97mCi, respectively.

4. Record and compare the measured net activity (for each time interval) versus the calculated activity (for the same time interval).

5. The activities recorded should be within ± 5% of the calculated activity if the instrument is linear and functioning properly. Readings greater than ± 5% indicate the need for repair or adjustment to the instrument.

6. Linearity tests will be performed quarterly, after any repair or adjustment, and any time the dose calibrator is relocated by using either a decay method or the filtration system, such as the Calichek System (see Policy #17.02/59). If the filter system is used, the linearity must first be established using the decay method and calibration factors obtained at the same time using the filters. If the linearity is within ± 5% by the decay method then the subsequent linearity check may be done using the filter system.

7. Linearity test results are to be reviewed and signed by the radiation safety officer and kept on file in the dose calibrator log book.

Geometrical variation testing is necessary to be performed as there may be significant variation in activity measured as a function of sample volume or configuration, depending on the volume and size of the ionization chamber used in the dose calibrator. The extent of geometrical variation should be ascertained for Tc99m and appropriate correction factors computed when significant, ie., greater than ± 5%. When available from the manufacturer, certified data on geometrical variations may be used in lieu of these measurements.

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To measure variation with a volume of liquid a 5cc plastic syringe containing 0.5cc of 35mCi of Tc99m will be used.

1. Assay syringe at the appropriate instrument setting and subtract background level to obtain net activity.

2. Increase volume of liquid in the syringe to 1, 1.5, 2, 2.5, 3.0, 3.5, 4, 4.5, and 5cc by adding the appropriate amount of water or saline. After each addition, gently shake syringe to mix the contents and assay as in step 1. (follow good radiation safety practices to avoid contamination and to minimize radiation exposure).

3. Select 2cc as the standard reading and calculate the ratio of measured activities for each volume to the reference volume activity. Normalize the activity to the 2cc reading to be called the normalized volume. If all normalized values fall between 0.9 and 1.05, no correction factor is necessary. If any of the readings for a particular volume fall outside of the 0.95 and 1.05 ranged a correction factor must be used for those volumes.

4. The geometrical variation calculation test report must be kept in the dose calibrator log book. The report is to be verified by the consultant radiological physicist and the radiation safety officer.

5. The geometrical variation calculation MUST be performed at installation, after any repair or adjustment, and any time the dose calibrator is relocated.

   a. To further assure that item #5 is completed as required, the Administrative Director must be notified by one of the Nuclear Technologists at the time of installation, all repairs or adjustments, and any relocation of the dose calibrator.

NOTE: A reminder label has been placed on the dose calibrator and at the electrical outlet where it is plugged in, stating the linearity and geometrical variation frequency directive.

This policy was approved by the Radiation Safety Committee on

REVISED: January 20, 1994 to reflect current practices and as recommended by the NRC inspectors December, 1993.
June 29, 1988 to conform to recommendations made by the consultant Radiological Physicist.