1. **Purpose:** The purpose of this SOP is to provide guidance for performing Quality Assurance (QA) tests of Nuclear Medicine equipment.

2. **Scope:** MU Health Care Nuclear Medicine staff should use this SOP as a guide for developing, maintaining, and implementing procedures for performing routine performance tests of department equipment.

3. **Definitions:**

   3.1 Acceptance Test – the ICRP defines acceptance test as a "test carried out at the request and with the participation of the user or their representative to ascertain by determination of proper performance parameters that the instrument meets the specifications claimed by the vendor" and recommends that an acceptance test be carried out at the time of installation and when appropriate after major service.

   3.2 Accuracy – a measure of the dose calibrator response to traceable standards of radioactivity.

   3.3 Constancy – a relative response test used to track the stability of the dose calibrator performance, typically from day to day.

   3.4 Geometry – a test of the dose calibrator response to differing volumes for the same activity.

   3.5 Linearity – a measure of the dose calibrator response over a range of activities.

4. **Procedure Details:**

   4.1 The manufacturer's operating manual (or nationally recognized standards) shall be followed for all equipment maintenance. Only authorized personnel shall operate department equipment, and up-to-date instructions on the maintenance of equipment shall be readily available for reference and use (Reference 5.1).

   4.2 Records of QA tests will be reviewed by EHS Radiation Safety Staff during semi-annual audits of radioactive material permits.

   4.3 Accuracy

   4.3.1 Typically, two standard sources (e.g., Co-57, Ba-133, Cs-137) in a solid plastic matrix in a vial format are assayed and the measured activity compared with the decay-corrected activity provided with the standard. The two standard sources should be within the energy range of common radionuclides used in the dose calibrator.

4.3.2 If the measurements agree with the standard activity, it is assumed that the dose calibrator is functioning correctly over the range of energies and radionuclides that will be assayed clinically.

4.3.3 Investigate causes if deviation is greater than 5%. Repair or replace calibrator if deviation is greater than 10%.

4.3.4 Frequency of testing dose calibrator accuracy is during acceptance testing, at least annually thereafter, and after repair or relocation.

4.4 Constancy

4.4.1 A long half-life solid check source is placed in the source holder in the measurement position and assayed. The check source should be within the energy range of common radionuclides used in the dose calibrator.

4.4.1.1 The source should be measured on its own setting (e.g., Cs-137 on Cs-137 or Co-60 on Co-60). Using the same procedure, the source is also assayed on all commonly used settings (e.g., Cs-137 on Tc-99m, Cs-137 on I-131, Cs-137 on F-18, etc.). This is referred to as a "relative response test" and is a measure of the constancy of the calibrator response for commonly used settings.

4.4.2 The measurements are compared to the initial measurements performed at acceptance testing and the results kept for the life of the chamber. Measurements should be within 5% of the decay-corrected initial values.

4.4.3 Investigate causes if deviation is greater than 5%. Repair or replace calibrator if deviation is greater than 10%.

4.4.4 Frequency of testing dose calibrator constancy is at least once each day (prior to assay of patient dosages) and after repair or relocation.

4.5 Geometry

4.5.1 An assay is performed of a small volume of activity (similar to what is commonly used in the dose calibrator) in a syringe and/or vial commonly used clinically by the licensee.

4.5.2 Subsequent assays are performed after drawing up fixed quantities of a non-radioactive solution, e.g., water, until the syringe and/or vial contains the maximum volume that might be used.

4.5.3 Performance of the system is determined by comparing the measurements to determine the maximum deviation, e.g., from the initial measurement.

4.5.4 Investigate causes if deviation is greater than 5%. Repair or replace calibrator if deviation is greater than 10%.

4.5.5 Frequency of testing dose calibrator geometry is during acceptance testing and after repair or relocation.

4.6 Linearity

4.6.1 The decaying source method:

4.6.1.1 Take repeated measurements of a source while its activity decays over an extended period of time. The start and end activity points should represent the highest and lowest activities that may be measured on the dose calibrator.

4.6.1.2 It is typically performed using a vial or syringe of Tc-99m and takes several days to decay through the clinical operating range of a dose calibrator.

4.6.1.3 The measured activities and measurement times are then to determine the deviation of each point from the expected exponential decay.

4.6.2 The shield method:

4.6.2.1 This method uses a set of lead shields or sleeves that attenuate the source to simulate several time points in the decaying source method.

4.6.2.2 The calculations typically involve a comparison to baseline measurements. The baseline measurements need to be performed when it is known that the dose calibrator is working in a linear manner. These baseline measurements are specific to a particular dose calibrator and set of sleeves.

4.6.2.3 If a new set of lead sleeves is obtained, it is necessary to perform the decaying source method at the time of baseline calibration of the sleeves. The manufacturers of linearity sleeves provide guidance on performing sleeve calibration, as well as on the recommended use and analysis of the sleeve measurements.

4.6.3 Investigate causes if deviation is greater than 5%. If deviation is greater than 10%, correct mathematically or repair/replace the calibrator.

4.6.4 Frequency of testing dose calibrator linearity is during acceptance testing, quarterly thereafter (or annual if not ACR accredited), and after repair or relocation.

5. References:

5.1 10 CFR 35.60 - Possession, use, and calibration of instruments used to measure the activity of unsealed byproduct material.

5.2 AAPM Report No. 181 – The Selection, Use, Calibration, and Quality Assurance of Radionuclide Calibrators Used in Nuclear Medicine.

5.3 ACR-AAPM Radiation Safety Officer Resources, 2021 Revision.

6. Revisions

6.1 Rev 01 – 2024-7-1 – New SOP.