AAPM REPORT No. 6

SCINTILLATION CAMERA ACCEPTANCE TESTING AND PERFORMANCE EVALUATION

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Nuclear Medicine Committee

Audrey V. Wegst, Chairperson

Alan Ashare
John A. Correia
James C. Ehrhardt
Ann L. Forsaith
L. Stephen Graham
William A. Roventine
James A. Sorenson
David A. Weber
Richard L. Witcofski
Robert E. Zimmerman

Ralph Adams, Consultant

Members of the Committee during
the preparation of this document

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F O R E W O R D

This report, "Scintillation Camera Acceptance Testing and Performance Evaluation," is the sixth in a series of AAPM Reports. It is designed to provide users of the scintillation cameras with test procedures for performance evaluation.

This report was prepared by the Nuclear Medicine Committee of the AAPM, under the chairmanship of Audrey V. Wegst. It was reviewed for the Publications Committee by Adrian LeBlanc to whom we are indebted for his careful review and comments.

Issuance of such reports is one of the means that the AAPM employs to carry out its responsibility to prepare and disseminate technical information in medical physics and related fields. Its reports cover topics which may be scientific, educational or professional in nature, and final approval is given by the Council of the Association charged with responsibility for the particular concerns of each report.

John S. Laughlin, Ph.D., FACR
Chairman, Publications Committee

TABLE OF CONTENTS

SCINTILLATION CAMERA ACCEPTANCE TESTING AND PERFORMANCE EVALUATION

Introduction:

Acceptance testing of an Anger-Type scintillation camera by the user under known conditions is an important step towards the acquiring of images of the highest possible quality over the operating life of the instrument, and should be performed after the camera is installed, carefully tuned, clinically operative, and before patient studies are initiated.

The major purpose of acceptance testing is to assure the user that the scintillation camera is performing in accordance with the specifications for that system as quoted by the manufacturer. This is extremly difficult to do in a rigorous manner. For the most part, the camera's performance has been measured by the manufacturer under test conditions impossible for the average user to duplicate. The manufacturers use specialized equipment and test procedures which are not openly documented and which vary from manufacturer to manufacturer. After the camera has been shipped, performance measurements as initially done in the factory are impossible to repeat as the specialized equipment is not available to field service representatives. Further, many manufacturer's specifications are class standards, indicating that they are not measured on each and every camera, and therefore may never have been measured on a given camera.

In an effort to encourage more complete and uniform performance specifications, the National Electrical Manufacturer's Association (NEMA) has prepared a protocol "Performance Measurement of Scintillation Cameras"[31] detailing test conditions to be used by manufacturers. These standards detail the equipment and techniques to be used in measuring a set of performance parameters. If adopted by manufacturers of scintillation cameras, they will assist the user in several ways. First, the test procedures are well documented so that the user will be aware of the methods and techniques used to determine the performance parameters. Second, comparison of performance specifications from manufacturer to manufacturer will be possible as the measurement will have been made under similar conditions.

The verification of the performance of the instrument by the user in the clinical setting is not addressed or answered by the NEMA protocol as the test procedures directed to manufacturers require specialized equipment and phantoms not generally available to the user. This document is an attempt to provide the user with specific protocols to allow him to measure the same set of performance parameters and thus provide tracability from manufacturer to user. The test procedures outlined here can be followed using equipment and radionuclides which are available in most nuclear medicine laboratories with a scintillation camera equipped with a standard image recorder. (One optional section does require a multi-channel analyzer.) A later document will be designed for a camera-computer system. Some of the recommended tests will yield a numerical value closely comparable to a NEMA specification. Such tests are indicated by two stars (**) placed beside the outline number and as such

yield acceptance criteria. Other performance parameters such as uniformity cannot be quantitated without the aid of a digital system. Methods of subjectively evaluating non-quantifiable performance parameters are provided which cannot be used to confirm a NEMA standard. Instead, the results will provide important initial performance information on the system, establishing a baseline for quality control measurements performed at regular intervals thereafter.

The time devoted to assessing the performance of a scintillation camera initially will be a worthwhile investment over the operating life of the instrument. Though the tests suggested are lengthy, the Committee recommends the user perform all that are appropriate to his instrument, or clinical situation.

Pre-Test Conditions:

When performing the acceptance tests, sources of radioactivity should be handled in accordance with proper techniques. All unsealed sources should be kept on absorbant pads and handled by gloved personnel wearing appropriate dosimeters. In all cases the measurements should be performed with the room background as low as achievable and other sources (such as injected patients) carefully excluded from the area. During the period of time the crystal is not protected by the collimator for intrinsic studies, extreme care must be taken not to damage the crystal by mechanical or thermal insult.

If x-ray film is used, the processor should be checked to assure it is in proper working order.

Log Book:

At the time of acceptance testing of a new system a permanent record book should be initiated for that system. The results of the performance testing should be recorded including the labeled images and all information necessary to duplicate the procedures at some later date. Parameters recorded should include the date and time, radionuclide, source activity, configuration of source, console and system parameters, source-detector distance, collimator, counting time, number of counts, and scatter material. Console parameters may change if adjustments are made on the camera.

Subsequent quality control, component failure and maintance records should be recorded in the same book.

The user should request of the manufacturer all performance data available on his system and the protocols under which they were measured. This information should be recorded in the log book.

PROTOCOL

1.0 Physical Inspection for Shipping Damages, Production and Design Flaws

1.1 Detector Housing and Support Assembly:

Inspect the aluminum can surrounding the NaI (Tl) detector, for identations or punctures and the support stand for loose parts, or mechanical difficulties.

1.2 Electronics Console:

Inspect the dials, switches and other controls for loose knobs. Check for dials that are difficult to turn or noisy, and switches that do not throw securely.

1.3 Image Display Modules:

Inspect the display screen for scratches, dust or other debris.

1.4 Image Recording Module:

Inspect the mechanical operation of rollers or film transfer mechanism, if possible, making certain the movement is smooth and positive. Clean the rollers and check camera lenses for scratches, dust or other debris.

1.5 Hand Switches:

Inspect the hand switches for proper mechanical operation and confirm that the cabling has acceptable strain relief at maximum extension.

I.6 Collimators:

Inspect the collimators for damage. The integrity of the collimator channels can be checked by inspecting the image of an x-ray of each collimator taken at a long tube to film distance. More than one view per collimator will be necessary.

1.7 Electrical Connections, Fuses, Cables:

Inspect for any loose or broken cable connectors, and pinched or damaged cables. Obtain from the manufacturer the locations of all fuses or circuit breakers necessary to check equipment failure.

1.8 Optional Accessories, e.g. Scan Table, Data Storage and Display Devices:

Scan Table - Inspect the bed alignment, vertically and horizontally, and all cables, switches or other controls. Record any limitations such as weight or maximum movement for loading and unloading patients. Any restrictions should be posted on the console.

Data Storage and Display Devices - Follow procedures in sections 1.2, 1.3 and 1.4.

2.0 Temporal Resolution:

The measurement of the dead time is sensitive to many factors such as:

1) thickness of scattering material about the source
2) pulse-height analyzer width
3) photopeak centering
4) counting rate
5) presence of correction circuitry
6) presence of peripheral electronic equipment
7) location of sources on detector face

Therefore it is important to carefully standardize all these factors so that the measurement can be repeated.

2.1 Measurement of paralyzing dead time with scatter.

2.1.1 Center a 20% (15%) window symmetrically about the Tc-99m photopeak and place a high sensitivity collimator on the camera.

2.1.2 Prepare two sources of Tc-99m:

The sources must be of sufficient activity to produce 20,000 cps each (± 10%) when placed in a scatter phantom similar to that shown in Figure #1.

The activities needed vary between 2 and 7 mCi but do not require accurate calibration. With the Anger camera directed horizontally, position the scatter phantom with the surface nearest the tubes on the face of the collimator with the test tubes vertical at the center of the field-of-view. Each source volume should be approximately 5 ml.

2.1.3 Follow the following counting procedure using a counting time of 100 seconds for each step. Maintain the same elapsed time between source measurements in order to cancel the effect of radioactive de cay.

1. Place source #1 in the scatter phantom and record count.
   Calculate cps.

2. Add source #2 and measure the combined sources.
   Calculate cps

3. Remove source #1 and measure source #2 only.
   Calculate cps.

4. Repeat the above set of measurements in reverse or&r as a control procedure.

5. Determine the background counting rate.
   Calculate cps.

2.1.4 Calculate the paralyzable dead time, τ (usec)=

$$[2R_{12}/(R_1 + R_2)^2 \ln (R_1 + R_2)/R_{12}] \times 10^6$$

where R_1, R_2 and R_{12} are the measured net counting rates from sources 1, 2 and 1 and 2 combined.

2.1.5 If more than one count rate mode is available, 2.1.3 to 2.1.5 should be repeated for each condition.

2.2 Intrinsic Paralyzable Dead Time:

2.2.1 Remove collimator from the camera and center a 20% window symetrically about the Tc-99m photo-peak at a low count rate.

Mask the outer 10% of the crystal area (or 5% of the diameter! with a circular lead mask, at least 3mm thick, carefully centered to ensure that the edge packing is covered. The manufacturer's stated useful field of view should outline the same area. In certain cases, an electronic field limiting device can be used.

2.2.2 Repeat steps 2.1.3 and 2.1.4 with the sources suspended near the axis of the crystal at a distance greater than one meter so that the required count rate is achieved.

** 2.2.3 Compare the measured value to the manufacturer's specifications.

2.3 Maximum Count Rate of Camera:

2.3.1 Remove collimator and replace circular ring mask. Prepare a Tc-99m source of approximately 500 uCi. Center a 20% window symmetrically about the photopeak, at a low count rate and not readjusted during the test.

2.3.2 With the camera directed horizontally and the source suspended from a cart at the level of the central crystal axis, move the source toward the crystal. The count rate will increase to a maximum value and then fall as the source nears the crystal. Determine the peak count rate. This maximum count rate will decrease if camera system performance degrades.

2.4 Input Count Rate For A 20% Count Loss:

**2.4.1 Calculate the input count rate for a 20% loss.

$$R_{-20\%} = 1/T \ln(10/8)$$

$$= 0.2231/T$$

Using the dead time determined in section 2.2.2.

3.0 Uniformity Testing:

(All manufacturer's specifications are performed with digital equipment.)

3.1 Intrinsic Uniformity (collimator removed):

Mask the outer 10% of the crystal area (or 5% of the diameter) with a circular lead mask, at least 3mm thick, carefully centered to ensure that the edge packing is covered. The manufacturer's stated useful field of view should outline the same area. In certain cases, an electronic field limiting device can be used.

3.1.1 On Peak Uniformity:

3.1.1.1 Obtain approximately 100 uCi of Tc-99m in a point source configuration (activity in a volume of ICC or less is acceptable). Carefully assay the source, in a calibrated dose calibrator recording the activity and the time of calibration.

3.1.1.2 Suspend the source at least five crystal diameters from the detector and on the detector central axis. Measure the distance carefully and record.

3.1.1.3 Center the photopeak in a 15% or 20% window, whichever is to be used clinically. (Most manufacturer's specifications are measured with a 20% window).

In some camera systems, this can be accomplished using a multichannel analyzer. In others, it is possible to center with a 10% window and then open to the 20% (15%) window. If an automatic peak centering device is available, and is to be used clinically, these tests should be performed with and without the circuit enabled, if possible.

3.1.1.4 Obtain a Field Flood Image:

If automatic field uniformity correction circuitry is available, it should be disabled. (If the correction circuitry cannot be disabled, continue with it in operation and omit sections 3.1.1.5 and 3.1.1.8.)

Use the imaging device which will be employed clinically. If a multi-format imager is used, the film image should be no larger than 7.5 cm.

Collect 4500 counts/cm^2 of exposed crystal area, with a count rate not to exceed 10K cps.

Record the orientation, window setting, time of day, time to accumulate the counts. Calculate cps/uCi corrected for decay of source, as an index of intrinsic sensitivity.

Inspect the image for non-uniformity.

3.1.1.5 If uniformity correction circuitry is available, repeat 3.1.1.4 with it enabled. The image obtained with the correction circuitry operating should not contain any areas of non-uniformity and should be free of artifacts.

3.1.1.6 Field uniformity at a high count rate.

Repeat 3.1.1.4 and 3.1.1.5 with a count rate of approximately that determined in section 2.2.2, or 75000 cps (observed) which ever is least. Use the high count rate mode, if available.

3.1.1.7 Obtain field floods with varying window widths.

Maintaining a centered window position with the correction circuitry disabled, obtain field floods at 35%, 30%, 25%, 15% (20%), and 5% windows.

Note if uniformity is maintained from narrow to wide window width setting.

If the field flood uniformity becomes unacceptable, provide the technologists with a minimum usable window width.

3.1.1.8 If uniformity correction circuitry is available, repeat 3.1.1.7 with it enabled.

3.1.2 Off-Peak Uniformity:

3.1.2.1 Using a 20% (15%) window, adjust the window position above the photopeak until the count rate falls to 90% of that obtained in section 3.1.1.4, after correcting for decay of the source. Record if possible the dial setting necessary to obtain the drop in count rate.

With the correction circuitry disabled, obtain an image as in section 3.1.1.4. (If the correction circuitry cannot be disabled, skip to section 3.1.2.5.)

3.1.2.2 Repeat section 3.1.2.1 with the window below the photopeak.

3.1.2.3 Inspect the images. They may not be uniform.

However, any change in the appearance of these floods with time is a sensitive indicator of the change in performance of the phototubes. Secondly, if the photopeak widens because of crystal damage or &tuning, the dial change necessary to obtain the count rate change will increase.

3.1.2.4 The user should especially be aware of the rate at which the uniformity degrades with an off-set window on the lower side of the photopeak if an auto peaking circuit is to be employed continually during a clinical study. This circuit will down-shift the window because of the presence of scatter. Therefore step 3.1.2.2 should be repeated with a 95% count-rate drop. The use of a continually adjusting auto peak circuit is not recommended.

3.1.2.5 If correction circuitry is available, repeat sections 3.1.2.1 and 3.1.2.2 using a 5% decrease in count rate with the correction circuitry enabled. This will stress the uniformity correction capabilities of the camera, however it should produce uniform images.

3.1.3 Field Uniformity at Other Than 140 keV:

Repeat sections 3.1.1.1 - 3.1.1.4 with point sources of I-131, and Xe-133 or Tl-201 with the 20% (15%) window centered around the appropriate photopeak. The lead mask will be ineffective for I-131 and should be removed.

If a correction matrix acquired with Tc-99m is used to correct the uniformity of images acquired at energies other than 140 keV, the following step should be done:

Repeat section 3.1.1.5 using a Tc-99m source to produce the reference flood to correct flood images obtained with radionuclides at energies different than Tc-99m, unless otherwise specified by the manufacturer. Inspect the images for uniformity.

3.2 Uniformity Studies With Collimator in Place:

3.2.1 Remove lead mask and place a collimator on the detector. Place a technetium filled flood phantom on the protected surface of the collimator. Obtain an image as in 3.1.1.4 or 3.1.1.5. If correction circuitry is to be used clinically, it should be enabled.

3.2.2 Repeat 3.2.1 with flood phantom rotated by 90°.

Inspect the image for any uniformity difference not seen on the intrinsic study which would indicate collimator imperfection. If the non-uniformities rotate 90° on the second image (3.2.2), the artifact is due to a non-uniform distribution of activity in the source.

3.2.3 Repeat the above steps for each multihole collimator. High energy collimators may show non-uniformities due to the collimator hole pattern.

4.0 Spatial Resolution and Distortion:

4.1 Instrinsic Resolution:

4.1.1 Resolution at 140 keV:

4.1.1.1 Mask the outer 10% of the crystal area (or 5% of the diameter) with a circular lead mask, at least 3mm thick, carefully centered to ensure that the edge packing is covered. The manufacturer's stated useful field of view should outline the same area. In certain cases, an electronic field limiting device can be used.

4.1.1.2 Position the point source of Tc-99m as in 3.1.1.

4.1.1.3 Center the 20% (15%) window symmetrically about the photopeak, and enable the uniformity correction circuit.

4.1.1.4 Place a transmission pattern of equally spaced lead (thickness at least 3 mm) and Lucite strips in a quadrant or parallel bar design carefully aligned with the X and Y axes of the crystal on the surface of the crystal.

The transmission pattern should be matched to the resolution of the camera so that at least one set of bars is not resolved. The increment of bar width from one bar size to the next should be small so that the intrinsic resolution can be measured with reasonable accuracy.

4.1.1.5 Obtain an image of the transmissionpattern with the count rate less than l0,000cps, the image size less than 7.5cm, and a total of 1.5 million counts collected for a small field-of-view crystal and 3.0 million for a large field-of-view- crystal.

** 4.1.1.6 Determine the bar width just resolved by visual inspection. This distance times 1.75 approximates the full-width at half-maximum intrinsic resolution, and can be compared to the appropriate manufacturer's specifications.

4.1.1.7 Repeat above 3 steps with the bars turned at angle 90° to the original direction. If a four quadrant transmission pattern is used, continue to rotate the transmission pattern until the smallest bar width resolved has been imaged in all quadrants in both X and Y directions. The quadrant transmission pattern will need to be inverted to accomplish this.

4.1.1.8 Observe any spatial distortion of the bar images in both directions. Determine if the resolution is maintained across the camera face and if it is equal in the X and Y directions.

4.1.1.9 Calculate magnification factor, M_f, in the X and Y directions:

$$\frac{\text{image bar width}}{\text{actual bar width}} = M_f$$

A different magnification factor can be calculated for each clinically used image size.

**4.1.2 Repeat steps 4.1.1.1 through 4.1.1.8 using the maximum observable count rate determined in 2.2.2 or 75000 cps (observed), which ever is least. Use a high count rate mode, if available.

4.1.3 Resolution at Lower Energies:

Repeat steps 4.1.1.2 through 4.1.1.6 using a point source of Xe-133 or Tl-201. Determine the bar width just resolved by visual inspection.

4.2 Spatial Resolution with Collimator in Place:

4.2.1 Place collimator on detector head. Position a parallel or quadrant bar transmission pattern and Tc-99m filled flood source on the surface of the collimator. This pattern can be that used in 4.1.1.4.

**4.2.2 Repeat steps 4.1.1.5 and 4.1.1.6 for the bar pattern-flood source combination at the surface of the collimator. NOTE: in step 4.1.1.6 change intrinsic to system resolution.

4.2.3 Repeat 4.2.1 and 4.2.2 for each collimator except the pinhole.

Observe any spatial distortion of the image not evident in intrinsic resolution images. Artifacts may appear due to the lead strip, collimator configuration.

** 4.2.4 Repeat above steps with a parallel bar transmission pattern and source located at a distance of 10cm from the collimator surface without scatter material interspersed. If the manufacturer specifies resolution at depth, vary the distance to correspond to the specification. The bar pattern used for this test will need to have wider spacings than that used in 4.2.1. At least one set of bars should remain unresolved.

** 4.2.5 Repeat with scatter material (Lucite Tm) inserted between transmission pattern and collimator surface.

5.0 Energy Resolution (optional):

This measurement requires interfacing the camera Z pulse before it is processed by the camera analyzer system to an external multichannel analyzer or single channel analyzer. The manufacturer's assistance should be obtained so the-camera's warranty is not compromised.

5.1 Full Width at Half-Maximum of the Photopeak:

5.1.1 These measurements should be made with an uncollimated detector, the count rate 8K cps, and a small source (less than 2 cm in diameter) placed at a distance of at least 2 crystal diameters on central axis.

Mask the outer 10% of the crystal area (or 5% of the diameter) with a circular lead mask, at least 3mm thick, carefully centered to ensure that the edge packing is covered. The manufacturer's stated useful field of view should outline the same area. In certain cases, an electronic field limiting device can be used.

5.1.2 Using a Tc-99m source, adjust the gain on the pulse height analyzer so that there are 10 or more sampling channels in the energy range corresponding to the full width at half maximum (FWHM) of the photopeak (140 keV). Determine the channel position of the center of the photopeak (140 keV).

5.1.3 Replace Tc-99m with a source of Co-57 and then In-111. Determine the center of the 122 keV photopeak of Co-57 and the 172 keV photopeak of In-Ill. Note: other sources may be used to calibrate the pulse height analyzer at 2 energies other than the energy of interest. Their energies should be on each side of the photopeak and not differ from the photopeak energy by more than 50%.

Calculate keV/channel.

5.1.4 Acquire the spectra of Tc-99m in counts/channel, obtaining a minimum of 50,000 counts in the center channel and acquiring the other channels of interest for the same period of time.

5.1.5 Acquire a background spectra over the same channels as in 5.1.4 with all sources of radioactivity removed.

5.1.6 Subtract the background spectra from the Tc-99m spectra normalized for equal counting times.

5.1.7 Determine the channel numbers for the upper and lower FWHM points, using linear interpolation between points. Subtract the lower from the upper channel number. Multiply this difference by the keV/channel to determine the FWHM in energy units.

Calculate: $\frac{\Delta E \times 100}{140 \text{ keV}} = \%$ FWHM

This determined value is sensitive to the camera tuning, the count rate and the photon energy.

5.1.8 Calculate the photopeak efficiency by determining the ratio:

$$\frac{\text{net counts in the photopeak}}{\text{net counts in the entire spectrum}}$$

Note: the true photopeak counts may be obtained by fitting the photopeak curve to a Gaussian distribution and determining the area under the curve. This will correct for scattered events near the photopeak.

The photopeak efficiency is sensitive to count rate and gamma ray energy.

5.2 Window Width Calibration (can be performed only if multichannel analyzer with coincidence mode is available).

The sensitivity of a given camera measurement is particularily dependent upon the accuracy of the window width calibration. For example, the comparison of sensitivities of two cameras, each with a 20% window if the cameras actually have windows of 19% and 21% respectively, the sensitivity data will be inaccurate. The window width may be measured with a multichannel analyzer calibrated and operated as discussed above for energy resolution and measurement. In addition, the camera unblanking pulse, i.e. the output of the camera single channel analyzer shall be input to the coincidence circuitry of the multichannel analyzer. Operating the multichannel analyzer in the coincidence mode will thus yield the energy spectrum which is accepted by the gamma camera single channel analyzer.

5.2.1 Use Tc-99m source as described in 5.1.2, and a 20% (15%) window to acquire a spectrum through the multichannel analyzer operating in the coincidence mode.

5.2.2 The width of the window shall be measured at the width where the counts are reduced to one-half of their value, linearily interpolated between those points in the spectrum. This width shall be expressed as the percent of the gamma ray energy.

5.2.3 Repeat 5.2.1 and 5.2.2 for all window widths used and all single channel analyzers.

6.0 Multiple Window Spatial Registration:

If more than one pulse height analyzer can be used simultaneously for multi energic gamma emitters, it is important that the X Y gain from each analyzer be adjusted so that the image of a source acquired at one energy directly superimpose on an image of the same source acquired through a different pulse height analyzer adjusted for a second energy. This can be tested using a collimated source emitting gamma rays of several energies.

6.1.1 Collimate a Ga-67 source with a single hole 3mm in diameter in a lead container 6mm thick.

6.1.2 If two windows are available, center a 20% (15%) window on the 93 keV photopeak and on the 296 keV photopeak. If three windows are available, center an additional 20% window on the 184 keV photopeak. Enable the uniformity correction circuitry.

6.1.3 Direct the uncollimated camera horizontally. Place a table adjacent to the crystal to support the source.

6.1.4 Adjust the source strength so that no more than 10 K cps are detected through each window at the surface of the uncollimated detector.

6.1.5 Carefully place the source on the +X axis, 75% of the distance from the center of the field of view as defined by the circular mask. Obtain a separate image through each of the available windows acquiring 100,000 counts for each.

6.1.6 Reposition the source on the -X axis, and repeat 6.1.5.

6.1.7 Observe if the images from 6.1.5 superimpose. Repeat for 6.1.6. If they do not the displacement in the X direction can be determined in mm knowing the distance between the two source positions.

6.1.8 Repeat 6.1.5 to 6.1.7 for the Y axis displacement by placing the source on the Y axis.

7.0 Relative Point Source Sensitivity Over the Field Of View:

This is a useful measure to quantitatively check the uniformity response of the system. Enable the uniformity correction circuit.

7.1 Collimate a Tc-99m source with a single hole 3 mm in diameter in a lead container 6 mm thick.

7.2 Center a 20% (15%) window about the I40 keV photopeak.

7.3 Direct the camera head horizontally and place the source on a table at the surface of the crystal.

7.4 Adjust the source strength so that no more than 10 K cps are detected at the surface of the uncollimated detector head.

7.5 Carefully place the source on the +X axis 75% of the distance from the center of the field of view as defined by the circular mask.

7.6 Record the count rate for a 30 second period.

7.7 Repeat 7.4 and 7.5 at 50% and 25% of the distance from the center of the field of view and at the same point along the -X axis.

7.8 Repeat steps 7.4 through 7.6 for the Y axis.

7.9 It is suggested these measurements be repeated at 45° to the X axis.

7.10 Correct all counts for decay of the radionuclide.

7.11 Average the count rate. Record the standard deviation, and the maximum deviation from the average.

** 7.12 Calculate sensitivity variations (31):

$$\text{Sensitivity Variation} = \pm\ 100\ \left(\frac{\text{max}-\text{min}}{\text{max}+\text{min}}\right)$$

8.0 Collimator Testing:

8.1 Relative Collimator Sensitivity:

8.1.1 Place a multihole collimator on camera.

8.1.2 Prepare a flat disc source of Tc-99m with a surface area of approximately 75-100 cm (a flat tissue culture flask provides a convenient fluid holder). Adjust the activity to yield 8K-10K cps with a 20% (15%) window symmetrically centered over the photo-peak, Carefully assay activity in a calibrated dose calibrator. Record count, count rate with source, time of count and source activity.

8.1.3 Remove source and record background count rate, calculate net c/sec per uCi.

8.1.4 Repeat steps 8.1.2 and 8.1.3 for each multihole collimator. Correct each net counting rate for source decay to the time of the first count.

8.1.5 Calculate relative collimator sensitivities.

8.1.6 Note an acceptable background counting rate for each collimator.

9.0 Camera Head Shielding Leakage:

9.1 Prepare a syringe to contain 5 to 7 mCi of Tc-99m.

9.2 Position syringe about the detector head with collimator in place at a distance of approximately 0.5 meters.

Record count rate every 45°.

9.3 Note integrity and uniformity of shielding.

9.4 Repeat 9.2 and 9.3.3 with approximately 200 uCi of I-131.

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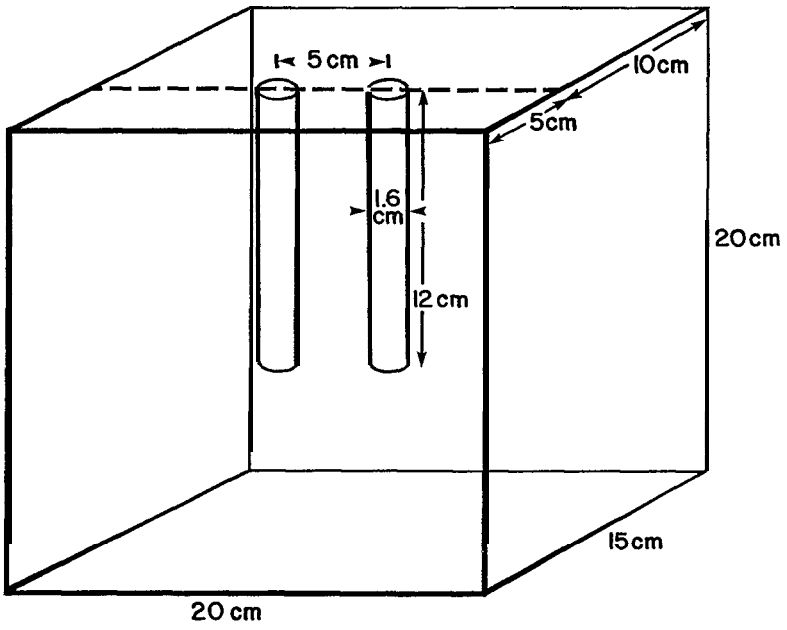
FIGURE I



Reference (1)

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