Accuracy

• Done on installation and annually thereafter
• Usually $^{57}$Co and $^{137}$Cs
• Should document Zero and BKG
• Test reading needs to exceed 140 mV
• Also evaluate other channels
• National Bureau of Standards (NBS)

Accuracy Results

• All accuracy measurements are repeated three times to obtain an average value and assess the unit's reproducibility.
• A percent error of ± 5.0% may indicate a need for repair or adjustment.
• A percent error of ± 10.0% requires repair or replacement of the unit.

Geometry

• Done at installation or after repair
• Use a syringe that is normally used for injections
• Use a vial similar in size, shape, and construction to the radiopharmaceutical kit vials
Geometry - Results

- If any correction factors are greater than 1.1 or less than 0.9 or if any data points lie outside the 10 percent error lines, it will be necessary to make a correction table or graph that will allow you to convert from "indicated activity" to "true activity."

Geo Variance Plot

Linearity

- At installation and quarterly thereafter.
- **Linearity** means that the calibrator is able to indicate the correct activity over the range of use of that calibrator.
- This test is done using a vial or syringe of activity which is at least as large as the highest dosage that will be administered to a patient, in a unit dosage syringe, or a therapeutic radiopharmaceutical (whichever is largest).

Linearity Test

- Decay Method
- Shield Method
- If the worst deviation is more than ± 0.10, the dose calibrator should be repaired or adjusted. If this cannot be done, it will be necessary to make a correction table or graph that will allow you to convert from activity indicated by the dose calibrator to "true activity."

Constancy

- Daily
  - Assay the reference source(s) using a frequently used setting (i.e., Tc-99m may be the most frequently used setting).
  - Measure background at the same setting, and subtract or confirm the proper operation of the automatic background subtract circuit if it is used.
Constancy

<table>
<thead>
<tr>
<th>Date</th>
<th>Lower</th>
<th>Upper</th>
<th>Measured BKG</th>
<th>Source Used</th>
<th>Co-57 E-Vial</th>
<th>Z凸</th>
<th>S凸</th>
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</table>

Weekly Constancy

- Test for the following at the indicated frequency and for the suggested tolerance:
  - Constancy at least once each day prior to assay of patient dosages (±10 percent).
  - Linearity at installation and at least quarterly thereafter (±10 percent).
  - Geometry dependence at installation (±10 percent).
  - Accuracy at installation and at least annually thereafter (±10 percent).
- After repair, relocation or adjustment, repeat the above tests as appropriate.

Frequency

- Weekly
  - Weekly, using one of the sources, repeat the above procedure for all commonly used radioisotope settings.
  - If the value does not agree, within ±10%, the dose calibrator must be repaired or replaced.
- Daily and Weekly tests must be documented

NaI Well Counter

- Assess accuracy at installation and annually.
- Evaluate Resolution FWHM
- Estimate MDA for swipe methods
  - Package Receipts
  - Daily & Weekly swipes
  - Therapy room clearance surveys
- Chi Square Test semi-annually

Reporting Results

Rs < Lc reported as
\[
Rs < Lc \text{ reported as } Rs + 1.65 \left[ \frac{R_{\text{gross}}}{t_{\text{gross}}} + \frac{R_{\text{bkg}}}{t_{\text{bkg}}} \right]^{1/2}
\]

Rs > Lc reported as
\[
Rs > Lc \text{ reported as } Rs + 1.96 \left[ \frac{R_{\text{gross}}}{t_{\text{gross}}} + \frac{R_{\text{bkg}}}{t_{\text{bkg}}} \right]^{1/2}
\]

Lc = 1.65 \left[ \frac{ct_{\text{bkg}}}{t_{\text{bkg}}} \right]^{2} \left[ 1 + t_{\text{bkg}}/t_{\text{gross}} \right]^{1/2}

MDA = 2.72/t_{\text{gross}} + 3.30 \left[ \frac{R_{\text{bkg}}}{t_{\text{bkg}}} \right] \left[ 1 + t_{\text{bkg}}/t_{\text{gross}} \right]^{1/2}
Chi Square Test

NaI Uptake Probe
- Assess accuracy at installation and annually.
- Evaluate Resolution FWHM
- Estimate MDA for Bioassays
- Chi Square Test semi-annually

Survey Meters
- Calibrated Annually/Check Source
- Should be check for functionality with a check source whenever used.
- Should be checked for battery leakage at least semi-annually.
- Replace batteries that are getting low.

Package Receipt
- All radioactive packages received displaying a Radioactive White I, Yellow II or Yellow III labels which are less than Type A quantities
- Wipe the external surface of the package (not required for gases). If there is contamination >2,200 dpm/100 cm², stop and immediately notify the Radiation Safety Officer.

Package Receipt
- All radioactive packages received displaying a Radioactive White I, Yellow II or Yellow III labels which are equal to or greater than Type A quantities
- Monitor the exposure levels at 3’ from the package and at the surface of the package.
- If the exposure rate exceeds 10 mR/hr at 3 feet, or 200 mR/hr at the surface immediately notify the Radiation Safety Officer.

Daily Surveys
- All radiological elution, preparation, and administration areas, will be surveyed at the end of each day of use with a low-range survey meter.
- If diagnostic administrations are occasionally made in patients' rooms and special care is taken to remove all paraphernalia, those rooms need not be surveyed.
Weekly Surveys

- All radiopharmaceutical use, storage and waste storage areas will be surveyed weekly with a low-range survey meter for exposure levels and by swipe for removable contamination.
- The swipe sample assay procedure should be sufficiently sensitive to detect the presence of 2,000 dpm per swipe of removable contamination.

Survey Records

- The record must include the date of the survey, the results of the survey, the instrument used to make the survey, and the name of the individual who performed the survey.
- It is appropriate to set trigger levels at which actions are required.

Survey Map

Waste Disposal

- All radioactive materials with a physical half-life of less than 120 days will be held for decay-in-storage before being disposed of in the ordinary trash.
- Monitor all waste at the surface of the container, with no interposed shielding, at the time of disposal, and determine that its radioactivity cannot be distinguished from background radiation levels. This will be done with a radiation detection survey meter set on the most sensitive scale.

Waste Disposal

- Generally recommended that waste be held for 10 half-lives of longest lived material.
- Make a record of the above steps including initial date placed into storage, radionuclides, general description of the materials, date of disposal, survey meter used, background reading, measured dose rate, ultimate disposition and the initials of the individual performing the survey.

Sealed Source Inventory

- Sealed source inventory required in 6 months.
- Must include nuclide, activity, serial number, location
Sealed Source Leak Tests

• Test the source for leakage before its first use unless the licensee has a certificate from the supplier indicating that the source was tested within 6 months before transfer to the licensee; and
• Test the source for leakage at intervals not to exceed 6 months
• Sources containing 3.7 MBq (100 µCi) or less of beta or gamma-emitting material or 0.37 MBq (10 µCi) or less of alpha-emitting material

Leak Test Results

<table>
<thead>
<tr>
<th>Source</th>
<th>Activity</th>
<th>Units</th>
<th>UGC 94</th>
<th>Geiger Counter</th>
<th>Net</th>
<th>Results</th>
<th>MBq</th>
<th>MILS</th>
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<tbody>
<tr>
<td>Cs-137</td>
<td>26 MBq</td>
<td>100</td>
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<td>1.0 MBq</td>
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<tr>
<td>Cs-137</td>
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<td>1.00</td>
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</tr>
</tbody>
</table>

DOT Returns

• Sealed Sources
• Radiopharmaceuticals
  – Unused doses
  – Contaminated syringes
• Monitoring
  – Contamination
  – Exposure

LIMITED QUANTITY SHIPMENTS

• The radiation level at any point on the external surface of the package must not exceed 0.5 millirem per hour.
• Removable contamination on the external surface of the package must not exceed 2,200 dpm/100 cm² (3.7 Bq/100 cm²) for beta/gamma emitting radionuclides.
• Individual shipping must receive DOT Training.

Posting

Name and telephone number of RSO or an alternate person(s) should be posted conspicuously in areas of use, so that it is readily available to workers in case of emergencies. Licensee should have emergency equipment readily available for handling spills.

Spill Kits

• Disposable gloves
• Housekeeping gloves
• Disposable lab coats
• Disposable head coverings
• Disposable shoe covers
• Roll of absorbent paper with plastic backing
• Masking tape
• Plastic trash bags with twist ties
• “Radioactive Material” labeling tape
• Marking pen
• Pre-strung “Radioactive Material” labeling tags
• Box of Wipes
• Instructions for “Emergency Procedures”
• Clipboard with a copy of the Radioactive Spill Report Form for the facility
• Pencil
• Appropriate survey instruments, including batteries (for survey meters).
Patient Release

- A licensee may authorize the release from its control of any individual who has been administered unsealed byproduct material or implants containing byproduct material if the total effective dose equivalent to any other individual from exposure to the released individual is not likely to exceed 5 mSv.

Documentation

- A licensee shall retain a record of the basis for authorizing the release of an individual in accordance with § 35.75, if the total effective dose equivalent is calculated by:
  1. Using the retained activity rather than the activity administered;
  2. Using an occupancy factor less than 0.25 at 1 meter;
  3. Using the biological or effective half-life; or
  4. Considering the shielding by tissue.

Bioassay - RSO

- Personnel monitoring program, including determining the need for and evaluating bioassays, monitoring personnel exposure records, and developing corrective actions for those exposures approaching maximum permissible limits.
- Regulatory Guide 8.20 “Applications of Bioassay for I-125 and I-131”

Breast Feeding

- If the total effective dose equivalent to a nursing infant or child could exceed 1 mSv (0.1 rem) assuming there were no interruption of breast-feeding, the instructions must also include:
  1. Guidance on the interruption or discontinuation of breast-feeding; and
  2. Information on the potential consequences, if any, of failure to follow the guidance.
- The licensee shall maintain a record of instructions provided to a breast-feeding female in accordance with § 35.2075(b).
Duties and responsibilities of the RSO include:

- Oversight of ordering, receipt, surveys, and delivery of byproduct material
- Monitoring and surveys of all areas in which radioactive material is used
- Packaging, labeling, surveys, etc., of all shipments of byproduct material leaving the institution
- Personnel monitoring program, including determining the need for and evaluating bioassays, monitoring personnel exposure records, and developing corrective actions for those exposures approaching maximum permissible limits
- Training of all personnel
- Waste disposal program
- Inventory and leak tests of sealed sources
- Decontamination
- Investigating any incidents and responding to any emergencies
- Maintaining all required records.

The RSO performs audits of all areas of use and individuals who are authorized to use byproduct material to ensure work is done in accordance with the license, regulations, and user permit conditions.