Gamma Sample Changer

General

1. Introduction
To measure the level of radioactivity of a radionuclide which emits gamma rays in small samples (up to 5 ml), a so-called gamma sample changer is often used. This device contains a scintillation counter consisting of a NaI well crystal, a photomultiplier, an amplifier and a counting unit (scaler/timer).
The energy window is adjusted to the radionuclide to be measured by adjusting the high voltage, the amplification factor, the pulse height analyser or a combination of these.
The count samples can be found in test tubes, which are placed one by one into the well crystal using a hoist. The 'well' ensures a large solid angle for the detection and thus maximises sensitivity. From the number of detected photons and the measuring time, the count rate can be determined.

2. International protocols
IAEA. Quality Control of Nuclear Medicine Instruments. TECDOC-317, Chapter 3; 1984.

3. Requirements
Test tubes and calibration sources.

4. Test frequency
All tests must be performed on acceptance. Routine checks must be repeated regularly (see section protocols).

5. Archiving
The test results must be recorded in a spreadsheet.

6. Manual
It is advisable to have an overview of the electronic components, their settings, a circuit diagram and operating instructions.

Background radiation

1. Introduction
Radioactive contamination of the gamma sample changer can interfere with all measurements. Regular checks of the background radiation are therefore necessary.

2. Frequency
This test can be carried out easily by adding an empty tube to each series of measurements.

3. Method
Measure the count rate of an empty test tube.

4. Requirements
A clean test tube.

5. Procedure
Position an empty test tube in the sample changer; determine the count rate in the usual manner.

6. Analysis and interpretation
Compare the value found with those of previous measurements.

7. Action thresholds and actions
If too high a count rate is found, e.g. more than two standard deviations greater than previously measured values, this is probably an issue of radioactive contamination. It is then necessary to repeat the measurement with another clean test tube and possibly to clean the equipment.

8. Pitfalls and remarks
The background radiation depends on the setting of the energy window. Check if this setting is correct by counting a standard of the relevant radionuclide.

Shielding

1. Introduction
It is important that the scintillation counter is well shielded with lead all around, such that radiation from the other samples which are placed in the sample changer does not affect the count rate of the sample located in the well crystal.

2. Frequency
Annually.

3. Method
Position a series of 5 samples in the sample changer, 4 of which cause a relatively high count rate and one empty tube; place the empty tube in the middle of the series. Measure the count rate of all five samples; compare the count rate of the empty tube with that of the background radiation.

4. Requirements
Five test tubes, cup with diluted standard.

5. Procedure
Fill four test tubes from the cup, each with 2,0 ml. Position the 5 test tubes in the sample changer (the empty tube in the middle); count the 5 tubes, each for 1 minute.

6. Analysis and interpretation
Compare the count rate of the empty tube with the background radiation.

7. Action thresholds and actions

In the event of a difference of more than two standard deviations from the background radiation, the cause of the reduced shielding must be identified and remedied.

Sensitivity

1. Introduction

Due to faults in the scintillation counter, the measurement sensitivity can become deranged; these faults may occur because of problems with the electronics in the counting unit, but also because of impact damage to the crystal (e.g. through a faulty hoist) or caused by chemicals (because of a faulty test tube).

2. Frequency

This test must be performed on acceptance and further at least once a year. In most applications, the test series includes a standard (one calibration source of the relevant radionuclide), such that the test method prescribed here is performed automatically and very frequently.

3. Method

Measuring the count rate of a sample of known intensity is the easiest way to check the equipment. Because the setting of the energy window depends on the radionuclide, the measurement must be repeated for each radionuclide used in practice, in exactly the same type of test tube and in exactly the same volume in which the samples are counted.
For optimum adjustment of the energy window, a multichannel analyser, a rate meter, or even better, an oscilloscope can be used.

4. Requirements

A standard of the relevant radionuclide with a known source intensity in a test tube of known dimensions and in a well-defined volume (e.g. 2,00 ml).

5. Procedure

Position the standard in the counting position and record the count rate using the scaler/timer.

6. Analysis and interpretation

Calculate the sensitivity in cps/Bq.
Compare the results of the measurements with those of the previous measurements.

7. Action thresholds and actions

If there is a difference of more than 5% from the previous measurement(s), it must be considered whether the energy window is optimally adjusted. The rate meter, the oscilloscope or the multichannel analyser may be of help for this.

8. Pitfalls and remarks

If the source intensity is excessive, the dead time will play a role and too low a count rate will be found. This can be avoided by choosing the source intensity in such a way that the count rate is lower than 10 kcps. A check of the spectrum using the oscilloscope can be helpful here.