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**Methods for measuring radionuclides in the human body with
whole body counts
(English Translation)**

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Foreword

This standard was drafted in accordance with the rules given in GB/T 1.1-2009.

Drafting organizations of this standard. Chinese Center for Disease Control and Prevention, Institute of Radiation Protection and Nuclear Safety Medicine, Jiangsu Provincial Center for Disease Control and Prevention, China Institute of Radiation Medicine, Chinese Academy of Medical Sciences, Institute of Radiation and Radiation Medicine, Academy of Military Medical Sciences, Chinese Institute of Metrology, Suzhou Thermal Institute of Engineering.

1 Scope

This standard specifies the method for measuring the type and activity of radionuclides in the human body by a whole body counter.

This standard is applicable to the qualitative and quantitative analysis of radionuclides in the human body by whole body counters.

2 Normative references

The following documents are indispensable for the application of this document. For dated reference documents, only the dated version applies to this document.

For undated references, the latest version (including all amendments) applies to this document.

GB/T 11713 High purity germanium energy spectrum analysis general method

3 Terms and definitions

The following terms and definitions apply to this document.

Whole body counter

Directly measure X-rays or γ -rays emitted by radioactive substances in the human body from outside the human body to perform qualitative and quantitative analysis of radionuclides Analysis of the device.

Lower detection limit the lowest activity that the spectrometer can detect under a given confidence level.

Motif

An object whose absorption or scattering effect on ionizing radiation is basically the same as that of human tissue.

Note: It can be used to simulate actual measurement conditions in various measurements.

4 Equipment

4.1

Whole body counter. It consists of detectors, shielded lead chambers, electronic components, data processing systems, etc. Among them, electronic components include Preamplifier, main amplifier, analog-to-digital converter (ADC), high-voltage power supply (HPS) and multi-channel analyzer.

4.2

Types of whole body counters. There are two commonly used ones. high-purity germanium (HPGe) has high energy resolution and relatively low detection efficiency; sodium iodide (thallium) (NaI(Tl)) has high detection efficiency and relatively low energy resolution. According to the purpose and requirements of the measurement, select the type and group of extracorporeal detectors Together.

4.3

High voltage power supply. The detector has a stable working high-voltage power supply, its steady-wave voltage is not more than 0.01%, and the high-voltage semiconductor detector should be connected the continuation is adjustable without any discontinuities.

4.4

Spectrum amplifier. Should have waveform adjustment and match with preamplifier and multi-channel pulse amplitude analyzer.

4.5

Multi-channel pulse amplitude analyzer. It should be selected according to the complexity of the energy spectrum, the ray energy distribution range and the energy resolution of the detector, etc.

The track width and number of the multi-channel analyzer.

4.6

Data processing system. Receive and process the spectrum data from the multi-channel analyzer. The data processing system consists of computer hardware and software equipment to make.

4.7

Data processing system hardware. It mainly includes a computer and its supporting read-in device.

4.8

Data processing system software. Various routine procedures for analyzing spectrum should be included, such as energy calibration, efficiency calibration, spectrum smoothing, peak finding, Basic procedures such as peak area calculation and heavy peak analysis.

5.1.1 Calibration source

The calibration source is a prerequisite for the normal energy calibration and efficiency calibration of the whole body counter. Single and multi-energy nuclei suitable for energy calibration See Appendix A for elements and their main parameters.

5.1.2 Traceability of scale source

The calibration source should have accuracy and traceability, and have an inspection certificate. In addition to the given activity (or specific activity) and uncertainty on the certificate, the calibration date, standard source purity, mass or volume, chemical composition, nuclide half-life, ray branch ratio and standard source calibration should also be marked method. In addition, the total uncertainty of the radionuclide standard source should be less than 5%.

5.2.1 Scale range

The energy of the scale source ray should be evenly distributed in the energy range of the required scale (usually 40keV~2000keV), and at least 4 energy points are required.

The calibration source should be a mixed source emitting multiple energy rays.

5.2.2 Scale curve

Use spectroscopic software to do a straight line fitting between the ray energy and the peak position of the total absorption peak. Energy of high-resolution energy spectrum system in good working condition the scale curve should be a straight line, and its nonlinearity should be less than 0.5%. If it deviates from linearity, the energy calibration should be done again. Specific requirements according to GB/T the 11713 regulations are implemented.

5.2.3 Verification of the calibration curve

During the measurement, the whole body counter should be checked with at least two energy points rays every day. The energy of the used rays should depend on the low energy end and high energy end of the near-scale energy zone. If the peak position remains substantially unchanged, the scale data remains applicable. For HPGe detectors greater than 1keV, when the NaI detector is greater than 0.5FWHM, the energy calibration should be redone.

5.3.1 Efficiency scale

When measuring the radionuclide content in the human body, the efficiency of the whole body counter should be scaled.

5.3.2 Efficiency calibration source

The activity of the radionuclide of the efficiency calibration source should be less than 1000kBq, and the energy distribution should be appropriate for the energy used in the calibration of the efficiency curve it should be distributed in the energy range of 40keV~2000keV, and at least 7 energy gamma rays should be selected. There should be 2 low energy ranges (40keV~200keV)~ 3 gamma rays. The efficiency calibration is carried out by the phantom.

5.4 Scale phantom

5.4.1

Select the scale mode according to the measured radionuclide, the distribution of the radionuclide in the body, the measurement method and the measured photon energy.

Body, see Appendix B for details.