Radionuclide diagnosis is presently widely used in practically all branches of medicine. Development and improvement of radionuclide diagnosis has been based on special medical radionuclide diagnostic devices. A broad range of such devices has been developed, allowing implementation of various clinical radionuclide diagnostic techniques. By functional purpose mass-produced radionuclide diagnostic devices fall into three groups:

1) devices for visual presentation of radioactive probe distribution patterns in a patient's body (so-called gamma-topographic scanners, gamma-chambers, tomographs);
2) devices for dynamic monitoring of radionuclide accumulation, transport, and clearance in a patient's body with the object of diagnosis of nonmalignant diseases of internal organs and systems of the body;
3) devices for laboratory examinations, medico-biological scintillation counters for measuring radionuclide content in biological samples.

Diagnostic accuracy substantially depends on the performance of the measuring devices used. Further development and improvement of medical radionuclide diagnostic devices is retarded by the lack of unified methods for metrological support of quality assurance during their calibration and verification. Various radionuclide sources of ionizing radiation, radioactive phantoms, and test objects are used in industry and in clinics to verify the parameters of given classes of devices. With the advent of new radionuclide devices, new methods for their calibration appear, which are usually different from previous ones. There has been a trend in recent years in gamma-topography to replace questionable and arbitrary personal evaluation of examination data with quantitative analytical procedures. Therefore, the problem of development of unified methods and equipment for metrological support of quality assurance of radionuclide diagnostic devices is of topical importance.

Evaluation of spatial and amplitude distortion of gamma-topographic signal is very important for quality assurance of reproduction of the examined object structure in gamma-topography. Such evaluation can be fulfilled by verification of the basic performance of the device used [1].

Various international organizations, such as the International Electrotechnical Commission (IEC), International Atomic Energy Agency (IAEA), World Health Organization (WHO), American Association of Medical Physicists, Bureau for Radiactive Protection of the USA, National Electric Manufacturing Association of the USA (NEMA), Department of Health and Social Insurance of Great Britain, and some others during the last two decades have developed theoretical and practical aspects of quality assurance of radionuclide diagnostic devices. Their recommendations for gamma-chamber control in medical institutions concern the following parameters.

1. Integral nonuniformity, which is defined as the relative difference between maximum and minimum counting rates in different zones of the visual field of the gamma-chamber detector recording radiation from a uniform plane radiation source.
2. Differential nonuniformity, which is defined as the relative maximum difference between counting rates in two neighboring zones of certain size.
3. Point source sensitivity variation, which is defined as the relative difference between maximum and minimum counting rates from a collimated small-size source located in different zones of the visual field of the gamma-chamber detector.
4. Absolute spatial nonlinearity, which is defined as the maximum deviation of pixels from their real position as measured in the absence of spatial distortions.
5. Differential spatial nonlinearity, which is defined as the maximum difference in deviation of two neighboring pixels from their real position as measured in the absence of spatial distortions.
6. Energy resolution, which is defined as the minimum energy bias between two gamma-quantum lines which the device can distinguish as separate spectral lines.

7. Sensitivity, which is defined as the counting rate to source activity ratio.

8. Spatial resolution, which is defined as the minimum distance between two sources when they are still distinguished on the image as two different sources.

9. Counting rate parameter, which is the counting rate dependence on radiation source activity.

10. Quality of multichannel recording, which is defined as the error in determining the position of a point source caused by the measurement of the recorded energy.

11. Image scale, which is defined as the ratio of object image size to real object size.

12. Quality of detector protection, which is defined as the ratio of the counting rate of a small-size source of radiation placed at various sites outside the visual field of the detector to the counting rate of the source of radiation placed in the center of the visual field.

13. Counting rate against background, which is defined as the counting rate from background pulses or from intrinsic noise of the gamma-chamber as measured over a certain energy range.

To measure the listed characteristics, a radiochemical technology was developed for producing standard reference samples of activity of radionuclides in gamma-radiation sources of different shape, including flat and volume sources with high surface activity of radionuclide and with highly uniform external ionizing radiation; such high uniformity is provided by uniform distribution of the radionuclide over the working surface of the source.

Calibration (verification) of radionuclide introsopes required reference samples of radionuclide activity in flat and volume solid-state sources of ionizing radiation with high working surface (more than 1000 cm²), sufficiently high surface activity (more than 5-10⁵ Bq/cm²) of radionuclide, high uniformity (98%) of external ionizing radiation, and minimum area of the control segment of the working surface of the source to be developed.

To provide more accurate calibration of radionuclide diagnostic devices, the radionuclide materials used in the reference samples of activity and methods of preparation of flat sources of ionizing radiation should meet the following specific requirements: high uniformity of radionuclide distribution over large working surfaces of radiation sources, adaptability for manufacture of the reference samples, correspondence between basic spectrometric characteristics of the radionuclide in the source of ionizing radiation and those of studied objects.

A method is known for preparing a flat solid-state source of ionizing radiation [6]. According to the method, a solid support for radionuclide is impregnated with radioactive solution containing the radionuclide, the solvent then being evaporated by heating. To attain better uniformity of radionuclide distribution over the working surface of the source of ionizing radiation, the support was either rocked or rotated until the applied radioactive solution dried completely.

A basic drawback of this method is its inability to produce uniform distribution of radionuclide over the working surface of the radionuclide source of radiation, since during evaporation of large amounts of solution from a large working surface of the source (more than 1000 cm²), the character of the radionuclide distribution and even the share of the surface covered with radioactive particles are difficult to control.

A method for manufacturing a radioactive sample is known which consists of filling of vessels of various shape (usually flat) with radioactive solution. This method is widely practiced in different countries for preparing reference samples for verification of introsopes: "flat radioactive source with uniform radionuclide distribution over working surface" [5] and "test objects" of the hepatic section phantom type [9].

However, this method also has a number of shortcomings.

1. The radioactive source should be routinely recharged every day.

2. The radiant flux density is poorly uniform, since it is practically impossible to fill a flat large vessel with liquid without gas bubbles inside the vessel, the bubbles causing nonuniformity of radionuclide distribution over the volume behind the working surface of the radionuclide source of radiation.

3. The difficult procedure for preparing flat radionuclide sources with discontinuous distribution of the radionuclide over the working surface of the source, i.e., the so-called radioactive test objects [5], used in medical engineering for calibrating gamma-chambers, scanners, and tomographs. The difficulty is caused by air bubble formation at the working surface of the source during its filling with radioactive solution.

A method is also known for preparing flat radionuclide sources [4], according to which the support of the source of ionizing radiation (an aluminum plate) is immersed into radioactive solution, exposed there for some time, then washed, dried, and packed. Before immersion, the support is subjected to electrochemical oxide coating in sulfuric acid solution. The advantage