AEC-NASA TECH BRIEF

Review of Physics, Instrumentation and Dosimetry of Radioactive Isotopes

A review of general radioactive isotope information, stressing radioactivity, methods of measurement, and dosimetry of radioactive nuclides has been especially prepared for the medical profession to serve as a primer and general information reference.

The instability of a given radionuclide results in a change in the composition and energy state of its nucleus that leads to a stable nuclide. Two features of this change which are specific to a particular radionuclide are: (1) the rate of nuclei change (decay); and (2) the type and energies of the radiations emitted during change.

The principal types of emission which may occur are presented: alpha particle (α) emission, beta particle (β) emission, positron ($\beta-$) emission, electron capture, gamma (γ) emission, and internal conversion. Alpha particle emission occurs in high atomic number elements, emitting a helium nucleus $_2He^4$. Beta particle emission occurs when the neutron/proton ratio is too high. When the neutron/proton ratio is too low, positron emission occurs, lowering the atomic number by one unit. Electron capture involves the capture of an orbital electron by a nucleus with a low neutron/proton ratio. Gamma emission is not usually a primary process and does not alter the composition of the nucleus, but rather reduces the excited nucleus to the ground state. Finally, in internal conversion, a gamma ray leaving the nucleus interacts with an orbital electron, causing the absorption of the photon energy and the emission of an electron.

The primary methods discussed of measuring the ionizing radiation include ionization chambers, Geiger or proportional counters, scintillation counters, solid state detectors, photographic film, and chemical systems. The most useful quantitative methods for radionuclide assay in medicine, the counting systems and ionization counters, are stressed.

The basic principles of β and γ dosimetry for radioactive material distribution are considered, because the radionuclides used most frequently in clinical and biological studies are either pure β or β–γ emitters.

Notes:

1. Additional details are contained in: *Science of Ionizing Radiation,* 1965, chapter 7, p. 133–170; Charles C. Thomas, Publisher. The chapter includes a table which summarizes nuclear decay data for nuclides which may be useful in medicine.
2. Inquiries concerning this publication may be directed to:

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   Argonne National Laboratory
   9700 South Cass Avenue
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   Reference: B67-10640

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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