Modification to Prescription for ($k\beta/\ell$) Pulsing

Pulsed neutron generators used in reactor research can be grouped into two general classes: sealed-off tube devices in which the target potential is pulsed; and accelerator systems in which the target is operated dc, and pulsing is derived by electrostatic deflection of the ion beam. In the event of the latter, a certain amount of leakage beam is invariably present between pulses. This leakage beam, although measuring only 10^{-2} to 10^{-4} times the pulsed current, can constitute a source of comparable magnitude to the low-duty factor pulses.

When the derivation of Garelis and Russell[1] is repeated with the addition of a steady-source term, Eq. (27) becomes

$$N_n = e^{-\alpha_n \tau} + \frac{R}{\alpha_n \$_n} + \frac{Q\ell}{\Delta k_n}, \qquad (1)$$

where the source strength 'Q' represents the effect of the leakage beam and of any (α,n), (γ,n), or spontaneous fission reactions taking place in the assembly. In contrast to the conventional 'α' technique, the '($k\beta/\ell$)' method requires a determination of the fraction of the between-pulse flux which is produced by the steady-neutron sources. Ordinarily, this presents only a simple background-subtraction problem[2]. However, in the case of the accelerator neutron generators, the situation is slightly more complicated, and the prescription given by Garelis[3] must be modified as follows:

After tuning up the accelerator, deflect the beam off, and wait until equilibrium is established. Start recording with the first pulse, and continue until adequate counting statistics are obtained. Then, with the accelerator otherwise still functioning, deflect the beam off, and continue counting for a time that is long compared to the longest-lived precursor. Finally, with no change in the accelerator settings, determine the effect of steady sources by starting a new measurement comprising an equal number of sweeps.

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Received August 31, 1964

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Empirical Gamma-Ray Albedo Formula*

Differential dose albedo measurements have been made at the U. S. Naval Radiological Defense Laboratory (USNRDL) using Cs^{137} and Co^{60} as sources, 'semi-infinite' slab thicknesses of concrete, iron and aluminum as scattering media and three angles of incidence. More than 300 measured values of dose albedo were collected using a plastic scintillator as the transducer of a pulse-dosimetry system having a reproducibility of better than 1% and an estimated probable error on the order of 5%.

Since differential dose albedo measurements are used as input data for engineering shielding calculations it is desirable that they be convertible into analytic form. To this end, differential dose albedo data points, α_d, for a particular source energy, E_0, angle of incidence, θ_0, and slab material, Z, were converted[1] to $A_d = \left(\alpha_d \frac{\cos\theta_0}{\cos\theta}\right)$ and plotted versus the Compton scattering angle, θ_s, in radians. It was found that each set of plotted points could be represented by an empirical formula, $A_d(\text{emp}) = c\, e^{-m\theta_s} + b'$, where each of the adjustable parameters c, m, and b' is a function of E_0, θ_0, and Z. The deviations of the empirical A_d's from the experimental were on the order of 3%.

Further, it was found that if suitable average values $\bar{c}$ and $\bar{m}$ were selected, all of the dose albedo data points taken could be fit by a single formula, $A_d(\text{emp}) = \bar{c}\, e^{-\bar{m}\theta_s} + b$, where now only b is a function of E_0, θ_0, and Z. This simplification is necessarily accompanied by some loss of accuracy.

In the figure, the differences, $A_d - b$, between the measured dose albedo values and the fitting parameter b, are plotted as points and the function $e^{-\pi\theta_s}$ is drawn as a solid curve. The empirically determined values of b for each (E_0,θ_0,Z) configuration are tabulated in the figure. The selection of 1 for $\bar{c}$ and π for $\bar{m}$ was made by an approximation process. No fundamental significance is to be inferred from their presence in the formula since they were chosen partly for their mnemonic value.

Although no extensive effort was made to optimize the fit, 90% of the data points, A_d, fall within 15% of the value, $A_d(\text{emp})$, predicted by the formula for the same angle, θ_s.

*Work supported in part by the U. S. Naval Civil Engineering Laboratory.

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