APPENDIX F

OTHER COMPUTER CODES

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PUCALC COMPUTER CODE

The computer program PUCALC is used to produce plutonium urinary excretion curves as a function of time post intake for alternative values of systemic transfer rate and presystemic deposition. The computer-generated curve is superimposed on a plot of actual plutonium-in-urine data to provide a visual comparison of fit. Various values for systemic transfer rate and presystemic deposition can be entered until an acceptable fit is obtained.

Generation of Excretion Curve

The excretion curve generated by PUCALC is based on the excretion function developed by Jones (1985) (Equation [9.1]). The Jones function predicts the urinary excretion of plutonium following an acute uptake. For PUCALC, the Jones function has been extended to the general case in which there is a gradual transfer of plutonium into the bloodstream from a presystemic compartment. The acute uptake case becomes a special case where the transfer of plutonium into the systemic circulation occurs rapidly.

The equation describing the general case is as follows:

$$E_u(R)/U(\infty) = \lambda \int_0^R J(R-x)\exp(-\lambda x)dx \qquad (F.1)$$

where $E_u(R)$ = the urinary excretion, in disintegrations per minute, on day R following initial deposition of the plutonium in the presystemic compartment

$U(\infty)$ = the total quantity of plutonium, in disintegrations per minute, initially deposited into the presystemic compartment

λ = the rate of transfer, in day^{-1}, from the presystemic compartment into the blood

R = the number of days after intake to the day for which the excretion is to be calculated

x = the number of days between intake and incremental uptake

J(R-x) = the value of the Jones excretion function at time R-x.

The J(R-x) is determined by substituting R-x for t in Equation (9.1).

The excretion curve plotted by PUCALC is produced by solving Equation (F.1) for 75 different values of R spaced equally to cover the period from 1 to about 15,000 days. Solution of Equation (F.1), by integration over the period 0 to R, gives the following function:

$$E_u(R) = \lambda\, U(\infty) \sum_{i=1}^{4} K_i \qquad \text{(F.2)}$$

where $K_i = a_i[\exp(-\lambda R) - \exp(-b_i R)]/(b_i - \lambda)$

and

i	a_i	b_i
1	.00475	.558
2	.00024	.0442
3	.0000855	.0038
4	.0000142	.0000284

The curve generated by Equation (F.2) can be subtracted from the observed excretion data to show if there is residual urinary activity. The curve-subtraction process is performed by solving Equation (F.2) for each value of R for which a bioassay result exists and subtracting this value from each data point. A tendency of the adjusted data to show the presence of net observed activity indicates either a component(s) of the intake not accounted for (i.e., part of the activity in the presystemic compartment is clearing with a different transfer rate) or an additional intake.

THE GENERAL COMPARTMENT MODELER (GENCOMP) COMPUTER CODE)

The GENCOMP computer code[a] was developed by Hanford Internal Dosimetry staff to solve a system of first-order differential equations for catenary compartments using a stiff numerical algorithm. It allows determination of activities or amounts in a series of catenary compartments for any time post intake or onset of intake. The code allows a wide variety of options for input to the first compartment. For instance, it can accommodate a repeating pattern of x days of input followed by y days of no input, which more closely simulates the "chronic-acute" intake condition experienced by routinely exposed workers. Activities or amounts in each compartment can be calculated for any time during the period of intake or after intakes have stopped. As an example of its use, GENCOMP can model fecal excretion by 3 days of no intake prior to excretion. Thus, it can be used to estimate inhalation intake rates for dose evaluation from fecal samples.

REFERENCE

Jones, S. R. 1985. "Derivation and Validation of a Urinary Excretion Function for Plutonium Applicable Over Tens of Years Post Intake." Radiation Protection Dosimetry 11(1):19-27.

(a) May, R. A. 1990. "User documentation for the General Compartment Modeler, Version 1.0." Copy available in the Hanford Radiation Protection Historical Files, Pacific Northwest Laboratory, Richland, Washington.

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