Letter to the Editor

Comments on "A Method of Computing Fission-Product Decay Heat in a Reactor with Time-Dependent Flux"

Barclay and Dormuth[1] have recently presented a system of equations that can be used to compute the total energy release rate, as a function of time, due to fission-product decay in a uranium-fueled reactor with a time-dependent flux. They have fitted the ^{235}U fission-product decay-heat data proposed in an ANS Draft Standard[2,3] in the range 0 to 10^8 sec after shutdown by a sum of nine exponentials decaying with time as in Eq. (1).

$$\text{Percent Operating Power} = M(\infty,t)/2 = \sum_i G_i^* \exp(-\lambda_i^* t) \quad . \tag{1}$$

Here $M(\infty,t)$ MeV/fiss is the total absorbable energy release for a decay time t following reactor operation at a constant fissioning rate for an "infinite" irradiation time. The parameters G_i^* and λ_i^* so obtained are employed in their system of equations.

In anticipation of application to a system of equations, such as those presented by Barclay and Dormuth, an eleven exponential fit had been developed in 1962 (Ref. 4) to $M(\infty,t)$ in the range 0 to 10^9 sec after shutdown based on the same decay-heat data.[3] In Table I, the nine and eleven exponential representations are compared with $M(\infty,t)$. It is evident that both representations reproduce $M(\infty,t)$ to within about 3.5% over the time intervals they were meant to cover. By 1966, Margolis and Redfield[5] had implemented this system of equations in the reactor kinetics and decay-heat section of the FLASH program utilizing parameters from the eleven exponential representation. Subsequent FLASH computer programs[6-9] continued the use of this formulation as have the RELAP-2 program[10] and its successor RELAP-3 (Ref. 11).

TABLE I

Comparison of Exponential Representations to Uranium-235 Fission-Product Decay Energy

	Total Absorbable Energy (MeV/fiss)		
t (sec)	$M(\infty,t)$	Nine-Exponential Representation	Eleven-Exponential Representation
0	14.0	13.5	14.0
0.1	13.5	13.4	13.8
1.0	12.5	12.5	12.6
10	10.0	10.0	9.99
10^2	6.60	6.60	6.75
10^3	3.73	3.75	3.85
10^4	1.94	1.92	1.95
10^5	0.957	0.955	0.959
10^6	0.539	0.540	0.538
10^7	0.238	0.240	0.239
10^8	0.110	0.113	0.110
10^9	0.0534	0.0149	0.0534

It is apparent that the exponential formulation presented by Barclay and Dormuth has had a significant prior usage and this usage should have been acknowledged in their paper.

ACKNOWLEDGMENT

Operated for the U.S. Atomic Energy Commission by Westinghouse Electric Corporation.

K. Shure

Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
P. O. Box 79
West Mifflin, Pennsylvania 15122

May 17, 1974

Editor's Comment: The authors of Ref. 1 offer apologies for not citing the eleven-exponential fit which did not come to their attention until after completion of their analysis. It is interesting to observe that the 1962 work cited by the author of the Letter was not published until 1972 (Ref. 4).

[1] F. W. BARCLAY and K. W. DORMUTH, *Nucl. Sci. Eng.*, **53**, 436 (1974).

[2] "Decay Energy Release Rates Following Shutdown of Uranium-Fueled Thermal Reactors," Draft Standard ANS-5.1, American Nuclear Society (1971).

[3] K. SHURE, "Fission Product Decay Energy," WAPD-BT-24, Westinghouse Electric Corp. (1961).

[4] K. SHURE, "U^{235} Fission Product Decay Energy, 1972 Re-evaluation," WAPD-TM-1119, Westinghouse Electric Corp. (1972).

[5] S. G. MARGOLIS and J. A. REDFIELD, "FLASH—A Program for Digital Simulation of the Loss of Coolant Accident," WAPD-TM-534, Westinghouse Electric Corp. (1966).

[6] J. A. REDFIELD, J. H. MURPHY, and V. C. DAVIS, "FLASH-2: A Fortran IV Program for the Digital Simulation of Multinode Reactor Plant During Loss of Coolant," WAPD-TM-666, Westinghouse Electric Corp. (April 1967).

[7] J. H. MURPHY, J. A. REDFIELD, and V. C. DAVIS, "FLASH-3: A Fortran IV Program for the Simulation of Reactor Plant Transients in Space and Time," WAPD-TM-800, Westinghouse Electric Corp. (July 1968).

[8] T. A. PORSCHING, J. H. MURPHY, J. A. REDFIELD, and V. C. DAVIS, "FLASH-4: A Fully Implicit Fortran IV Program for the Digital Simulation of Transients in a Reactor Plant," WAPD-TM-840, Westinghouse Electric Corp. (March 1969).

[9] J. H. MURPHY, J. A. REDFIELD, and V. C. DAVIS, "FLASH-5: A Fortran IV Program for Transient Simulation of a Reactor Plant with a Detailed Core," WAPD-TM-999, Westinghouse Electric Corp. (May 1973).

[10] K. V. MOORE and W. H. RETTIG, "RELAP-2—A Digital Program for Reactor Blowdown and Power Excursion Analysis," IDO-17263, Phillips Petroleum Co. (1968).

[11] W. H. RETTIG, G. A. JAYNE, K. V. MOORE, C. S. SLATER, and M. L. UPTMOR, "RELAP-3—A Computer Program for Reactor Blowdown Analysis," IN-1321, Idaho Nuclear Corp. (June 1970).