

NUCLEAR ENGINEERING HANDBOOK

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NUCLEAR ENGINEERING HANDBOOK

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PREFACE

The "Nuclear Engineering Handbook" has been prepared to satisfy a pressing need for an authoritative single-volume compilation of nuclear information and data. More than 70 contributors, each a specialist in his particular area of nuclear science or engineering, have contributed sections to satisfy the needs of engineers, scientists, students, research workers, and others interested in nuclear science and technology.

The handbook presents the basic data used in all phases of nuclear engineering. Science and technology, and theory and practice are thoroughly covered, with special emphasis on reactor engineering. Reactor designers will be particularly interested in the sections on reactor physics, radioactivity, shielding, fluid flow, and heat transfer. Formulas, comprehensive tables, and methods of calculation make this material especially useful. Among the special features of the book are a series of important contributions on the present state of reactor technology and the economics of nuclear power.

The book has been planned for easy reference with an introductory section which serves as a guide to the handbook. This section also contains a collection of the most frequently used data and formulas.

Dr. Charles E. Crompton, Dr. J. R. Dietrich, Dr. Walter H. Zinn, and other contributing authors have offered important advice concerning the constitution of particular sections of the handbook. Dr. Norman Hilberry and Mr. Neal F. Lansing have offered many valuable suggestions, and several officials of the United States Atomic Energy Commission have been most helpful in promptly reviewing handbook material relative to classification. This assistance and the many long hours of careful work of the contributing authors are gratefully acknowledged.

HAROLD ETHERINGTON

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SECTION 1

MATHEMATICAL DATA AND GENERAL TABLES

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BY HAROLD ETHERINGTON

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1-1 SELECTED DATA AND FORMULAS AND GUIDE TO THE HANDBOOK

BY
Harold Etherington

The tables of Art. 1 provide a systematic guide to the more important tabulated and graphic data of the handbook. Subsequent articles contain collections of frequently used data and formulas largely selected from other sections of the handbook, together with references to pertinent sections.

1 GUIDE TO HANDBOOK TABULATED DATA

Tables 1 to 18 facilitate selection and location of important data. These tables are arranged by subject, in approximately the same sequence as they occur in the handbook, but with no correspondence between table numbers and handbook section numbers. The sequence is as follows:

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Table 1. Tables of Mathematical Functions*

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β	8-5	4
Thermal fission of U^{238}		
$r_{1/2}, \tau_i, \lambda_i, \beta_i/\beta, \beta_i, \beta_{tr}, \beta_v$	1-46	39
Photoneutrons (D₂O reactor)	2-3	3
Thermal-neutron properties:		
$\sigma_s, \sigma_f, \sigma_a, \rho, \eta, \alpha$ for Th^{232}, U (natural), $U^{233}, U^{235}, U^{238}, Pu^{239}$	2-5	6
σ_s, σ_f, η for $U^{238}, U^{235}, Pu^{239}$ (Westcott values)	1-21	25
η, ρ, α for $U^{238}, U^{235}, Pu^{239}$ natural uranium	1-26	28
L and λ_{tr} for Th, ThO_2, U, U_2O_8	6-86	13
Resonance-neutron properties:		
Absorption integrals and parameters for U^{235} and Th^{232}	2-26	21
Resonance constants A and μ for uranium, compounds, and mixtures	6-82	9
Resonance constants $A, \mu/A$, and λ_0 for Th^{232} and uranium	2-27	23
α_1 for U and U_2O_8	2-27	22
Intermediate- and fast-neutron properties:	6-83	10
$\sigma_f/E^{1/2}$ for U^{235}	2-6	7
$\alpha(E)$ for U^{235} and Pu^{239}	2-6	8
$\eta(E)$ for $U^{235}, U^{238}, Pu^{239}$	2-7	9
Fast σ_f and σ_a for fuels	2-6 to 8	7-11
σ_f of nonthermally fissionable nuclei	2-8	12(11)
Spontaneous fission of nuclides	2-5	5
Fast-fission effect ϵ	6-85	12, Art. 9.5
Moderators:		
$\rho, N, \Sigma_s, \xi \Sigma_s, D_{th}, L, \tau$	2-9	13
$\rho, N, \Sigma_{s,th}, \Sigma_{a,th}, \lambda_{tr,th}, D_{th}, L_{th}, \xi, \Sigma_{s,f}, \xi \Sigma_{s,f}, \lambda_{tr,f}, D_f, \tau$	1-20	24
L, λ_{tr}	6-86	13
τ for moderators and mixtures	6-88	14
Time and number of collisions to thermalize	2-10	14
Resonance constants ξ_s and α_1/ρ	6-83	11
Photoneutrons (D ₂ O reactor)	2-3	3
ρ for H ₂ O as a function of temperature	9-10	20
ρ for D ₂ O as a function of temperature	1-49	41
Fission products:	9-16	28
$\sigma_a(E)$ for Xe^{135}	2-11	15
Yield and σ_d of Xe^{135}, Sm^{149} , and long-lived fission products	2-11	16
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* For data of a more general character, see Table 4. For radioactivity data, see Table 7.