Book Review

Thermal Analysis of Pressurized Water Reactors. By L. S. Tong and Joel Weisman, American Nuclear Society (1970). 302 pp. $24.00.

This AEC Monograph is the first formal hard-cover treatise on this topic. Authored by the then managers of thermal and hydraulic engineering, and analysis, respectively, in the Westinghouse PWR Systems Division, it has been eagerly awaited by reactor designers and teachers since its preparation began. It is intended, not as a manual but as a text or general reference, to concentrate on existing central station PWRs, present modern engineering design approaches and experience, describe the simple and reliable general calculation techniques, provide references for more special treatments, and indicate the trend of future developments. Within the limitations of its size it must be adjudged to excellently meet these specifications. The treatment, though concise, contains adequate description for ready understanding by the studious reader, plus appropriate mathematical analysis and design parameters. And impressively, it is clearly an "inside job," predominantly covering techniques and data developed by and used in the nuclear trade rather than merely applying general fundamental procedures to design situations, as had to be done early in the game.

The first chapter describes the mechanical design of PWRs and their steam plants in some detail, as well as other reactor concepts more briefly. It then describes both the unperturbed and actual thermal power distributions throughout commercial cores, effects of voids, water slots, and control rods, etc., leading to the actual power generation in fuel clusters and rods, including after shutdown.

The second chapter covers the properties, constitution, and construction of fuel and cladding and of fabricated fuel elements, also steady and transient fuel temperatures. As an example of the professionalism of this volume, fuel rod gap conductance receives 10 pages, with proposed models explained and empirical data, graphical correlations, and equations presented, and fission gas release receives almost 3 pages.

Chapter three summarizes briefly the applicable conventional hydrodynamics, followed by parallel flow in rod bundles, boiling flow, liquid and vapor entrainment, crossflow mixing in bundles, flow in plenums, and induced vibrations. Finally, analysis of flow instability and of critical flow are treated in depth with 12 pages each.

The Heat Transfer and Transport chapter, though packed with information on coolant temperature rise, transients, heat transfer coefficients, grid spacers, turbulence promoters, heat conduction, and 15 pages on boiling condensed from Tong's earlier treatise in that area, ends up the shortest chapter, at 40 pages.

Thermal and Hydraulic Performance, the last and longest chapter pulls the rest of the book together. It sets thermal design limitations and procedures, and touches on fuel rod and core design and coolant requirements. Then the statistical basis of individual hot channel subfactors is covered, plus the trend in decreasing unnecessary overdesign by combining subfactors statistically and the use of core flow-distribution experiments and computer codes to further decrease the uncertainties. Next are steady-state performance and optimization, reliability of the thermal design, and protective instrumentation. Finally, transient behavior is studied, with the hypothetical accidents due to loss of flow, loss of coolant, and reactivity insertion receiving 18 pages.

Appearance and printing are attractive. Either author will furnish a short list of corrections on request. Only one other error was found in a careful search. However, a demurrer, no fault of the authors, could be entered as to price. At almost 8¢ per 500 word page, it costs much more than possible competitors and more than other AEC Monographs, and even with the tenth-copy-free policy for classrooms, adoptions and impact must suffer. Apparently priced for break-even on 500 sold, sights seem to have been set too low.

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About the Reviewer: Charles F. Bonilla, professor at Columbia University and an early worker in nuclear thermal design, originated predictive methods for primary coolant core pressure drop and distribution, statistical hot-spot temperatures, etc. He also has authored or edited several books and chapters in this field, including AEC reactor handbooks, the IAEA Shielding Compendium *and McGraw-Hill's* Nuclear Engineering *and* Nuclear Engineering Handbook. *At present he serves as thermal design editor of the journal* Nuclear Engineering and Design *and is director of the Heat Transfer Research Facility at Columbia, which has furnished burnout and other thermal parameters for most U.S. power reactors.*