Book Review

Thermal Effluent Disposal from Power Generation. Edited by Zoran P. Zarić. Hemisphere Publishing Corporation, Washington, D.C. (1978). 375 pp. $40.00.

This volume contains most of the lectures presented at the international advanced course on Heat Disposal from Power Generation held August 23-28, 1976 in Dubrovnik, Yugoslavia, under the sponsorship of the International Centre for Heat and Mass Transfer. Zoran P. Zarić of the International Centre and Donald R. F. Harleman of the Massachusetts Institute of Technology (MIT) served as program directors for the course.

The book is divided into three sections, dealing with thermal discharges and the aquatic environment, the atmosphere, and climate, respectively. Eighteen papers are presented, ten of which deal with various aspects of thermal discharges in the aquatic environment.

Not all the lectures in the course are presented in this volume. However, all of the major topics are included or adequately summarized. Each of the lectures is well referenced.

The initial chapter of this course book is a summary of hydrothermal modeling techniques, dealing principally with the popular "integral" procedures of thermal effluent spreading predictions. The chapter is best described as a brief summary of the book *Heat Disposal in the Water Environment*, which was recently published by the MIT Press.

In the second chapter, G. Abraham of the Delft Hydraulics Laboratory describes the entrainment concept for tracer or heat dilution in jet discharges. He provides various solutions for jet discharges into deep water and compares mathematical solutions with experimental data. The paper concludes with a discussion of the limitations of the assumptions and the entrainment concept.

Policastro and Dunn of Argonne National Laboratory review in detail several validation efforts carried out on the popular integral and phenomenological models for predicting heated surface discharges. Unsurprisingly, they found that these models can provide only general estimates of plume characteristics and that precise predictions are not possible. Failure of integral model methods was attributed primarily to the fact that these methods were too idealized, neglecting many of the significant phenomena in plume dispersion, such as wind, boundary interferences, and transient effects; second, the phenomena considered in the model are often poorly simulated. A limited data base that precluded proper inclusion of many controlling factors was also listed as a reason for the failure of phenomenological models to provide accurate predictions. They suggest that an improved state-of-the-art can be achieved by pursuing numerical (finite difference) modeling as well as a basic laboratory study of plume dispersion.

Because of the unsatisfactory performance of integral methods, more sophisticated prediction procedures based on "numerical" or "differential" methods are being used more commonly, and several of the lectures included in this volume deal with this subject.

In a separate chapter, Policastro and Dunn review the formulation of the various numerical models presented in the literature, summarize their verification with laboratory and field data, and discuss the major issues surrounding the application of numerical modeling to surface thermal discharges.

S. Lee, S. Sengupta, and R. Bland discuss a general three-dimensional numerical model that gave satisfactory results for widely varying topography and discharge configuration. Airborne radiometer data and *in situ* current and temperature profile measurements were used to enhance the model development effort. Further work is in progress, indicating a need to establish verification at different sites, with varying discharge geometry and meteorological conditions.

O. F. Vasiliev provided a brief analysis of the state of modern theoretical research of the hydrodynamic behavior of cooling ponds and, in addition, provides some interesting insights into USSR engineering practice. He suggests two three-dimensional numerical models for cooling pond analysis, and some results of practical computations are reported.

In a following chapter, Vasiliev discusses the possibility of reducing a three-dimensional hydrothermal model to a more simplified two-dimensional model. Two two-dimensional models are presented, one with depth averaging, and the other with width averaging.

C. Zimmermann and P. Geldner made two contributions, one a summary of the research effort in the Federal Republic of Germany (FRG) on the effect of outlet conditions on thermal plumes in river discharges and the other, a chapter entitled "Thermal Loading of River Systems," which describes the standards, regulations, and engineering practice for cooling water discharge into rivers in the FRG, including thermal transport capacity calculations for the Rhine River.

The section on heat discharges in the aquatic environment concludes with a chapter by G. Dinelli of Italy on thermal effluent monitoring by a combination of aerial infrared and ground surveys. A discussion of the fundamentals of infrared remote sensing surveys is included.

Problems and techniques used in predicting and measuring cooling tower plume behavior in Europe are summarized in separate chapters by G. Ernst and A. Junod. Current U.S. practice and the research effort by the U.S. Environmental Protection Agency are summarized by M. A. Shirazi and B. A. Tichenor. Their chapter describes major research problems, including the need to develop methods to accurately measure both drift quantity and particle size distribution.

P. E. Brog provides an exhaustive description of the "KUMULUS" program model for evaluating the primary impacts of cooling tower plumes. The KUMULUS program and its predecessor, "SAUNA-S," have been used for preparing documents for electrical firms and authorities in Switzerland, the FRG, and Belgium.

In the last chapter of the section dealing with atmospheric discharges, W. Egler and G. Ernst present the basic concepts of a numerical model for cooling tower plume predictions. Their model for the cooling tower plume is represented by a system of 17 differential equations that must be integrated simultaneously. Their work is continuing with the determination of constants.

In the final section, heat releases from various types of power plants are presented and compared by M. A. Styrikovich, and possible long-term impacts are discussed. The last two chapters of the book deal with potential impact of power production on the global climate and meteorology. B. Berkovsky discusses the possible effects of anthropogenic discharges of CO_2 and aerosols on global climate, while A. Junod, after introducing some basic concepts on climate and climate change, discusses the general relationships between energy use and meteorology. Special attention is given to the meteorological assessment of the potentialities of nonconventional energy resources, such as wind and solar energy.

The aim of the course, which is summarized in this volume, was to familiarize participants with alternate methods of heat disposal as well as with the most recent techniques of engineering analyses and design necessary for their implementation and an assessment of their environmental effects. The book achieves this aim and should be an extremely useful reference to all those concerned with predicting the various effects of thermal discharges from power generation, both in waters and in the atmosphere.

The international scope of the papers and literature references makes this volume particularly valuable.

Richard F. Cole

U.S. Nuclear Regulatory Commission
Atomic Safety and Licensing Board Panel
Washington, D.C. 20555

November 17, 1978

About the Reviewer: Richard F. Cole [BS, civil engineering, Drexel University, 1959; MS, sanitary engineering, MIT, 1961; PhD, environmental engineering, University of North Carolina (UNC), 1968] is currently a member of the Atomic Safety and Licensing Board Panel (ASLBP) of the U.S. Nuclear Regulatory Commission. Before joining ASLBP in 1973, Dr. Cole was on the faculty of the Department of Environmental Sciences and Engineering, School of Public Health, at UNC at Chapel Hill. From 1969 to 1973, Dr. Cole was director of the International Program in Sanitary Engineering Design. From 1965 to 1969, he served as project leader and field coordinator for UNC/Chapel Hill in assisting the University of San Carlos at Guatemala City, Guatemala to establish the Regional School of Sanitary Engineering, a graduate program in Central America and Panama. Prior to his work at UNC, Dr. Cole served as assistant regional engineer of the Philadelphia office of the Division of Sanitary Engineering of the Pennsylvania Department of Health (1955-1962).