Book Reviews

Annual Review of Nuclear Science. Vol. 25. Edited by E. Segrè. Annual Reviews, Inc., Palo Alto (1975). $17.50.

This is the 25th in a distinguished series of review volumes that each year select for review about a dozen topics in nuclear science of considerable current interest. Each topic is discussed in sufficient depth as well as breadth to be of value to both those actively engaged in the field and those working in other areas of nuclear science and engineering. Each article is commissioned with a recognized scholar in the field and so is authoritative as well as highly informative. Of special value is the comprehensive bibliography at the end of each article.

Three of the articles in this volume are devoted to nuclear processes involving high-energy-beam particles above 100 MeV. A. E. L. Dieperink and T. deForest, Jr. review studies in which a high-energy nucleon or electron knocks out a nucleon of a target nucleus. Because of the high energy and momentum, such processes can be described by a spectral function $P(\boldsymbol{k}, E)$, where E is the excitation energy of the product nucleus with respect to the ground state of the target nucleus and $\boldsymbol{k}$ the momentum of the knocked-out particle. These studies are undergirded by a relatively simple theoretical base and show considerable power in the interpretation of experimental results. M. Blann reviews work in pre-equilibrium decay following such a high-energy knock-out or inelastic scattering event in which the product nucleus decays to an equilibrium state by cascade, evaporation, and other means. In the third review in this class, T. W. Donnelly and J. D. Walecka discuss studies involving high-energy elastic and inelastic electron interactions with nuclei. Electrons in the energy range 100 to 600 MeV have important advantages as probes of nuclear matter, and the results of such studies to date are impressive.

A very interesting review by G. Baym and G. Pethick is devoted to theoretical work on neutron stars in which Hans Bethe has been playing a very active role. The power of our present understanding of nuclear structure, solid-state physics, and superconductivity to deal with states of nuclear matter that are inaccessible to experimental observation is impressive. It is possible to deal with the equations-of-state and properties of superdense nuclear matter in a highly detailed and sophisticated manner that is surprisingly convincing to one unfamiliar with this fascinating field of theoretical physics. Another article by R. Seki and C. E. Wiegand is devoted to a very different but equally exotic field of current research: that of atoms in which a K^-, $\bar{p}$, or Σ^- cascades through atomic orbitals in place of an electron until terminated by nuclear transformation in the nucleus. An impressive aspect of this review is the advanced stage that x-ray spectroscopy has now reached.

A very interesting article by G. W. Wetherill reviews the present status and reliability of establishing a chronology for the early history of the solar system by radiometric means. The techniques, methodology, and reliability of radiometric measurements for this purpose are well described. Here again, those not familiar with this field will be impressed by the progress made and the degree of assurance achieved during the past decade.

Several articles deal with new techniques or instrumental opportunities for opening up new areas of research that have previously been inaccessible. One of the most interesting of these is the article by W. M. Gibson on blocking measurements of nuclear decay times. This is an outgrowth of the discovery of channeling of ions in crystal lattices. For nuclear species that can be incorporated in a crystal lattice this phenomenon permits an extension from the Doppler shift lower limit of 10^{-10} sec for the observation of nuclear decay times to 10^{-18} sec. Other articles of this type are those of F. S. Goulding and B. G. Harvey on new techniques for identifying on-line the Z and A of product nuclei, and of H. Oeschger and M. Wahlen on very low level counting techniques in which reductions in background counting rates of 10^3 to 10^4 can be achieved. In another article in this class, F. A. Kirsten reviews recent developments in computer interfacing for data analysis on high-energy physics experiments. Another article not quite belonging to this class by A. H. Rosenfeld reviews the methodology, organization, and problems of the Particle Data Group at the Lawrence Berkeley Laboratory over the past 20 yr in listing and categorizing the growing and shifting assortment of particles and resonances found in high-energy physics experiments.

The two remaining articles deal with fusion and safeguards. In the former, R. L. Hirsch reviews fusion research worldwide and evaluates the prospects for achieving energy-producing deuterium-tritium thermonuclear reactions in Tokamak and other plasma systems. Assuming success in doing so in the next two generations of large-scale experimental systems, the article concludes with a section on fusion reactor engineering and the prospects and problems in the practical achievement of electric power generation with such a reactor. The article on nuclear safeguards by T. B. Taylor is mostly devoted to nuclear weapons technology. The extent to which most aspects of the design of a nuclear weapon are accessible through the open literature is detailed, and the critical mass for a weapon with a 15-cm-thick natural uranium reflector is tabulated for various ratios of $^{235}U/^{238}U$ and $^{239}Pu/(^{240}Pu + ^{242}Pu)$. The implications of this analysis for the proliferation of nuclear weapons are discussed and the planned rate of production of plutonium in power reactors in thirty nations in 1974 and 1980 is tabulated. The article concludes with a brief discussion of schemes for safeguarding power-produced plutonium from diversion to weapons.

William G. Pollard

191 W. Outer Drive
Oak Ridge, Tennessee 37830

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About the reviewer: Bill Pollard became engaged in studies of the extraction and utilization of nuclear energy upon joining the gaseous-diffusion research and development team at Columbia University in early 1944, an association that continued until essentially the date of this review when he retired from the Oak Ridge Associated Universities (ORAU). The association embraces many achievements including the conception and fruition of the Oak Ridge Institute of Nuclear Studies (now ORAU), of which he was executive director for many years. He completed his graduate studies in physics at Rice University in 1935 and was a member of the faculty of the University of Tennessee in the 1940's.

Dr. Pollard's position in the priesthood of the Episcopal Church and his stature in the physics community have emphasized the absence of conflict between religion and science.

Symposium on Cooling Tower Environment—1974. CONF-740302, U.S. Energy Research and Development Administration (1975). 682 pages. $13.60.

This symposium was conducted at the University of Maryland at College Park in March 1974. It was sponsored by the State of Maryland Power Plant Siting Program in conjunction with the U.S. Atomic Energy Commission, now the U.S. Energy Research and Development Administration.

The compelling reason for the symposium can be traced to the legally momentous Calvert Cliffs decision by the U.S. District Court in the matter of licensing of nuclear power plants. This decision set the pattern for environmental impact statements for all nuclear plants then under construction or in any phase of the licensing procedure.

As the program for preparation of these statements progressed, it soon became evident that the once rather neglected appendage to process industries, the cooling tower, suddenly was to be elevated to the rank of "super star." For operators of large electric generating plants were suddenly faced with the fact that one of the most obvious and noticeable impacts from the standpoint of public visibility was the tremendous volume of cooling water and related equipment required for removal of the waste heat from the power cycle. The obvious solution—cooling towers—soon were seen to create a totally new set of problems that up to this point had received very little attention.

With the advent of the environmental statements and court hearings, the environmental effects of the large towers soon received much attention from all concerned—designers, plant operators, environmentalists, and the lay public. The task of evaluating the cooling systems proved to be nearly as formidable as evaluating the nuclear plants themselves, in that the analyses of their environmental effects required a rigorous multidisciplinary approach.

In its efforts to answer some of the questions relating to ecological effects of power generation, the State of Maryland through its Plant Siting Program has provided a valuable research program for obtaining much needed information at an existing generating station. It was apparent that this program fit well with several other ongoing programs in both the government's and the private sector's efforts relating to studies of the electric power industry. The purpose of the symposium was to bring together many of the researchers doing important work in the field to report on their latest results and to encourage free discussion and exchange of information. The papers presented represent work done in all the major areas associated with the environmental effects of cooling tower operation.

Among the papers presented are studies of the overall economic and social implications of selecting a cooling system for a steam electric plant. Included is a review of the many possible choices, including wet cooling towers of both mechanical- and natural-draft type; a combination of wet-dry cooling towers; and a choice of cooling lakes, ponds, or spray canals. It should be recalled that when the merits of a cooling system for a given unit are assessed, any reduction of the net plant capability below its design rating must be replaced by additional generating capacity or the incremental cost of power resulting from that particular cooling system must be considered. This requires a very careful analysis of both capital expenditures and operating costs. The environmental cost, therefore, must be considered versus the selection of the system on a strictly economic basis. Although this area is not the central theme of this symposium, it is addressed in at least two papers.

Several papers deal with the phenomena associated with the operation of these large cooling systems. Included are papers related to the large vapor plumes whose traverse depends on external meteorological conditions, the possibility of plume recirculation, and ground level interference from downwind mechanical-draft cooling towers. The effect of vapor plumes on the environment, as well as the possibility of contribution of moisture to additional fogging, is discussed. The latter is of particular significance where cooling towers are close to well-traveled or major highways.

Mathematical models for the cooling tower plumes were presented. Although these models all involve very sophisticated analytical techniques, it is rather unfortunate that validation of the models is far less sophisticated at this time. In most cases, there are insufficient data taken at the actual sites to clearly substantiate the accuracy of the models. However, with the increasing addition of meteorological towers at newer installations and observations at many more operating facilities, plume model validation techniques should improve in the near future.

Another area of significance associated with the operation of cooling towers relates to the amount of chemical drift deposition associated with the traverse of the plume. The discussion included a presentation of several techniques for measuring drift particle characteristics. Development of a laser-light scattering measurement system for determining the distribution and particle size of the solids is described. When drift measurement problems were first discussed four years ago, the accepted measure available on the basis of manufacturers' guarantees was on the order of 0.2% of the total recirculating water flow. It was also known that air flows associated with cooling towers could carry droplets as large as 1000 μm out of the tower to the surroundings. Fortunately, through the use of the more sophisticated measuring techniques involving