Controversies about nuclear power in this period were centered on how best to rapidly develop the technology, despite uncertainty over risks.

The study includes an excellent discussion of the Power Reactor Development Company (PRDC) case that illustrates these themes and resulting problems. In 1955 the PRDC proposed building a fast-breeder reactor fairly close to a populated area in Michigan. Because the AEC's own breeder-reactor research program was proceeding concurrently with the PRDC's schedule, little information existed as to the safety of the proposed design. Consequently, the ACRS recommended against the proposed application, citing the desirability of further experimentation at a remote site. This recommendation set off a major controversy between the AEC and JCAE that resulted in major licensing changes: opening of procedures to public scrutiny, formalizing of procedures, and, ultimately, separation of regulation and promotion within the AEC and establishment of formal construction-permit hearings.

Opening the AEC process to the public and to independent review was viewed by Congress as a means of improving technical review of reactors, as well as strengthening public confidence in a program where the extent of risk was uncertain. The result of controversy over radiation risks combined with support for nuclear technology was a system of formal review and regulation that lacked an underlying consensus about safety. But, as the authors explain, the hope of Congress and the AEC was that the regulatory procedures instituted in the early 1960's would enable the development of a consensus about safety and nuclear technology.

Mazuzan and Walker state at the outset that a purpose of their history is to provide policymakers concerned with regulation with information "about the context in which previous decisions of a similar nature were made." In this they succeed admirably. But the more sobering conclusion that can be drawn from this study is that many of the current problems with nuclear regulation surfaced 30 years ago at the outset of commercial development, and, similarly, that major issues that were debated then and that the regulatory procedures were designed to resolve—accident risks, potential radiation releases, adequate site rules, waste disposal—remain debated and unresolved today. Understanding why these issues have not been resolved is probably crucial to attempts at reforming nuclear regulation to allow further investment in nuclear power technologies. This book provides valuable background: it will be of interest to the nuclear industry, policymakers, and the general public.

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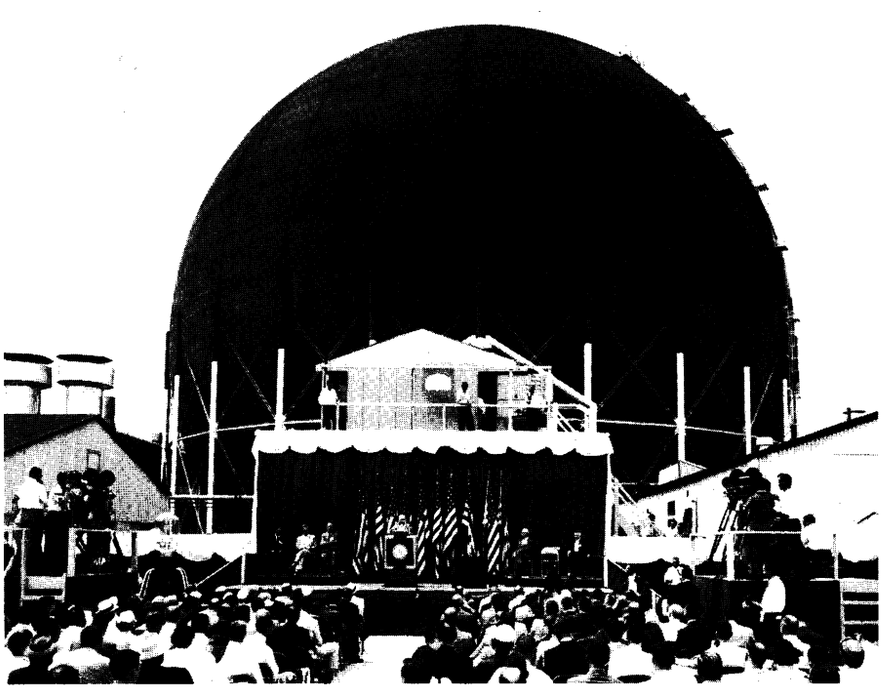

"Ceremony on occasion of first electricity generated by General Electric's prototype plant at West Milton, New York, July 1955." The Reactor Safeguard Committee established by the AEC "never assumed that safety for populated areas depended solely on isolation. The locations of the large government reactors at Hanford, Savannah River, and the Idaho National Reactor Testing Station were selected, in large part, because of their isolation. But other . . . facilities constructed in the early 1950's, such as [that] at West Milton, . . . signaled the need for . . . engineered safety features that would compensate for their proximity to population centers. The . . . designers of the West Milton reactor set a major safety precedent by enclosing it in a large shell containment structure." [From *Controlling the Atom*; credit, National Archives]

The Vallecitos Case

The Atom and the Fault. Experts, Earthquakes, and Nuclear Power. RICHARD L. MEEHAN. MIT Press, Cambridge, Mass., 1984. xvi, 161 pp., illus. $13.95.

In this short book, Meehan warns that he gives a personal and by no means complete or even scholarly history of scientific-legal controversies concerning the licensing of nuclear power reactors in California during the last two decades. He should not be too modest, however, for he grapples with abiding moral and philosophical questions dressed in new clothes. The centerpiece of the book is the case of the Vallecitos Test Reactor in California's Coast Range, west of Livermore and 35 miles from downtown San Francisco. The reactor was operated by General Electric as the first (in the United States) privately financed nuclear power plant, the first commercial test reactor, the first commercial neutron radiography facility, and the producer of half of the free world's supply of medical radioisotopes.

In the summer of 1977 the reactor's operating license came up for renewal, and the Nuclear Regulatory Commission insisted that General Electric perform geological explorations to check for active faulting in the vicinity of the reactor. A geotechnical company of which Meehan was a partner was retained by General Electric to do the explorations, and Meehan was able to observe at first hand the consequent drama that stretched until the autumn of 1983, when the NRC approved the decisions of the licensing and appeals boards that the reactor could be operated safely. During the intervening six years, the test reactor remained fully manned but shut down and General Electric lost its medical isotope business to the Canadians and others.

The book also contains less personal treatments of other licensing cases, such as the attempts by Pacific Gas and Electric Company to construct nuclear power

plants at Bodega Head and Point Arena in northern California and by Southern California Edison to construct a plant at Malibu in southern California. Meehan also refers to the highly publicized controversy concerning the licensing of the nuclear power station at Diablo Canyon on the central coast of California. The book was published a few weeks before the production of commercial quantities of electricity by Unit I of this power plant began in November 1984, after 16 years of licensing procedures.

In this kind of controversy, an immediate reaction of a scientist who has not had experience with frustrating regulatory procedures might be that what is wanted is a round-table conference where the various protagonists, as scientists, can settle the issues on the "facts." Nowadays, however, there is wide agreement that only certain kinds of issues admit of such solutions. Meehan demonstrates that attitudes on appropriate criteria of risk are extremely difficult to change and that sometimes no common mode of refutation of geological claims is available. Indeed, throughout his account of the confrontations, Meehan quotes leading engineers, seismologists, and geologists making appeals for the need for "judgment." We are left only with a moderate likelihood that the present regulatory process will produce convergence on such issues as whether there is an active fault. Our best expectation is that the regulatory activities will lead to the emergence of economically tolerable siting and design solutions that will permit construction of a facility that has a very high probability of being safe if there is a large earthquake or nearby faulting.

In the Vallecitos hearings, the author points out, probabilistic concepts were used for the first time in the strictly geological domain. The geological hazard assessment depended upon two hypotheses: that there was a nearby active fault (of variously estimated type) and that there could be a large landslide. The injection of probability arguments allowed both sides to carry forward discussion. For example, it was agreed that, given a nearby active fault, the odds of a damaging amount of slip on it each year are about one in 10,000. The odds of movement occurring along a closer slip plane are about one in 100, so that the joint probability of such fault displacement occurring under the plant is about one in a million. The question then becomes: Is this risk so small as to be overwhelmingly acceptable to all?

It is of interest that the legal underpinnings of the procedures described seem to be few, and, indeed, it is clear that the regulatory process has generated its own common law. On the matter of standards for admitting scientific evidence, the traditional legal doctrine (*Frye v. United States*, 293 F. 1013 [D.C. Cir. 1923]) discourages scientific originality in court testimony by directing judicial motives toward scientific principles that have already gained general acceptance among the scientific profession. From the evidence presented in the book, this doctrine is more honored in the breach than in the observance. On the matter of using probability to weigh evidence in the courtroom, the strongest precedent is in *People v. Collins* (66 Cal. Rpt. 242 [1968]), in which the court rejected prosecution testimony offered by a mathematician that guilt or innocence could be established by probability calculations.

The book is written with verve and style, and this reader found it absorbing. Undoubtedly, my fascination was helped by knowing many of the participants who are named and discussed. Although many other readers will not have this background, they should still find the book both provocative and stimulating.

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A Medical Misreckoning

To Do No Harm. DES and the Dilemmas of Modern Medicine. ROBERTA J. APFEL and SUSAN M. FISHER. Yale University Press, New Haven, Conn., 1984. xii, 199 pp. $15.95.

In 1971 the Food and Drug Administration (FDA) ruled that the synthetic estrogen diethylstilbestrol (DES) was contraindicated for use in the prevention of miscarriages. Seven years later, a letter from a task force on DES sponsored by the Department of Health, Education and Welfare informed every licensed physician in the United States about the results of the most recent research. Some 4 to 6 million American women and children had been exposed to DES during pregnancy. Studies had shown a clear association between intrauterine exposure to DES and vaginal cancer and other female and male genital abnormalities, and also an excess in breast and gynecological cancers in the women for whom DES had been prescribed.

In addition to a description of the social and historical context within which the DES story unfolded, Apfel and Fisher, both psychiatrists, provide an exposition of the psychological dimensions of the DES problem. The authors discuss the history of DES, showing how this powerful drug quickly won wide acceptance after it was synthesized in 1938. Among other factors, the authors stress that, had higher standards of research design been required to assess the safety and efficacy of pharmaceutical products, the subsequent problems might have been mitigated. The FDA approved DES for use in humans in 1941, after extensive reviews to ascertain the safety of the product, the major criterion under the 1938 Food, Drug, and Cosmetic Act.

Efficacy was not to be a standard until 1962. Approved usage was limited to gynecological conditions, not including conditions of pregnancy. However, DES was used throughout the 1940's in clinical trials involving high-risk pregnancies, and seven papers reported that DES reduced pregnancy accidents and produced babies that were larger than average for their gestational age (p. 21). By 1952, the FDA declared the drug safe, thus opening the way to extensive usage in pregnancy at higher doses than before.

The authors point out that none of the seven studies were blind and that other studies in the 1950's and 1960's demonstrated that when appropriate control groups were used DES seemed at the least ineffective and possibly harmful to the fetus (p. 23). By the late 1960's all but one of the major obstetrics textbooks concluded that DES was not effective in preventing spontaneous abortions, but thousands of pregnant women continued to receive it, an example of "the power of the anecdotal report and the resistance of medical practice to the results of well-designed clinical drug research" (p. 24).

Finally, in 1971, when the *New England Journal of Medicine* published the first reports of a rare vaginal cancer in adolescents whose mothers had taken DES, "the medical community was stirred, alarm ran through the media, and the FDA issued a drug alert to all physicians in the nation, warning them that DES was contraindicated for use in pregnancy" (p. 25).

These chapters and one describing the physical effects of DES are brief but well documented. The remaining chapters describe the emotional effects on DES daughters, on their mothers, and on the physicians.

The authors state that their sample of DES mothers and daughters is biased. They studied activists, people seeking help for emotional distress, and litigants. The authors are aware of the need for