als subjected to multiaxial stress. Hecker returned permanently to Los Alamos in 1973. There he has studied large-strain deformation, plastic instability, and the phase stability and mechanical behavior of plutonium alloys. Hecker is now chairman of the Center for Materials Science at Los Alamos.

Sutherland, a biochemist, is the first woman to receive the Lawrence Award. She was cited "for her analyses of the consequences of damage repair in bacteria and human cells exposed to ultraviolet light."

Dunn, a molecular biologist, was cited "for his fundamental contributions of great potential importance in determining modes of radiation damage and to the understanding of mechanisms by which DNA is transcribed and processed into functional messenger RNA."

Raymond, an inorganic biochemist, was cited "for elegant experimental characterization of the microbial iron transport process and extension to the synthesis of actinide sequestering agents of potential importance to the removal of plutonium from the body."

Rasmussen and Rosenbluth receive Fermi Prize

The 1985 Enrico Fermi Prize, the highest scientific award given by the US government, will be shared by Norman C. Rasmussen (MIT), for developing risk-assessment techniques used in safety analyses of nuclear power plants, and Marshall N. Rosenbluth (University of Texas at Austin), for contributing to the understanding of controlled thermonuclear fusion, particularly plasma stability and confinement. The prize is awarded by the Department of Energy in recognition of "exceptional and altogether outstanding scientific and technical achievement in the development, use and control of atomic energy." Although Fermi himself got only $25 000 when the award was first made in 1954, since last year each prize winner receives a Presidential citation, a gold medal and a $100 000 check.

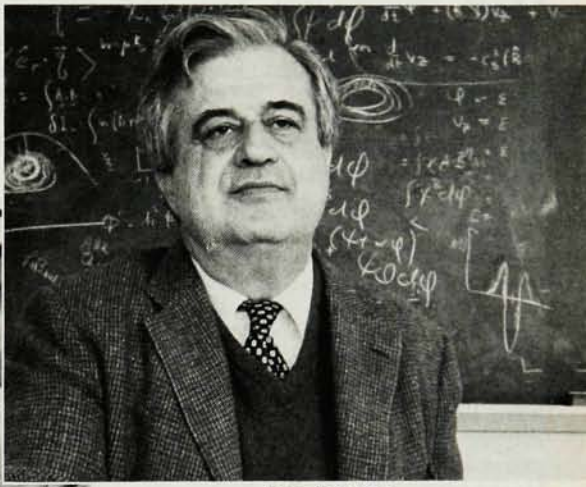
The awards will be presented in a ceremony on 6 February at DOE's Washington headquarters in the Forrestal Building.

Rasmussen is best known as the author of *Reactor Safety Study: An Assessment of Accident Risks in US Commercial Nuclear Power Plants*, more commonly known in reactor circles as WASH-1400. The report was prepared by a study group on light-water-reactor safety headed by Rasmussen at the request of the Atomic Energy Commission, the agency that later evolved into DOE. Since its publication in 1975, WASH-1400 has served as the basis for analyzing the risks of severe accidents for inclusion in the environmental-impact statement for each power reactor built in the last decade.

The probabilistic risk-assessment technique devised by Rasmussen provides a systematic approach to a variety of possible accident sequences at nuclear power plants. When environmental activists raised objections to Rasmussen's methodology, Congress directed the Nuclear Regulatory Commission to conduct an objective study of WASH-1400. The report of the study group, headed by Harold W. Lewis (University of California at Santa Barbara), found that WASH-1400 was:

> a substantial advance over previous attempts to estimate the risks of the nuclear option. The methodology has set a framework that can be used more broadly to assess choices involving both technical consequences and impacts on humans. WASH-1400 was largely successful in three ways: in making the study of reactor safety more rational, in establishing the topology of many accident sequences and in delineating procedures through which quantitative estimates of the risk can be devised for those sequences for which a data base exists.

RASMUSSEN



ROSENBLUTH

Though their review questioned some of the statistical data in WASH-1400 and criticized NRC for dragging its feet in making full use of it, the Lewis panel concluded that it led to a rethinking of the nature of reactor hazards and a redirection of safety research, reactor design and plant practices. Probabilistic risk assessment is now widely used in nuclear-regulatory procedures to help decide on such matters as plant modification, maintenance and operation.

Rosenbluth studied under Edward Teller and Fermi at the University of Chicago, receiving a PhD in physics in 1949. He then went to Los Alamos, where he contributed to the design of the first thermonuclear weapons. Upon leaving Los Alamos in 1956, he joined the General Atomic Laboratory, which was then a prime mover in controlled-fusion R&D. In 1960, while at General Atomic (later renamed GA Technologies), Rosenbluth joined the faculty of the University of California at San Diego. He moved to Princeton in 1967 as professor at the Institute for Advanced Study and senior research physicist at Princeton University's Plasma Physics Laboratory. Since 1980 he has been the director of the Institute for Fusion Studies, University of Texas at Austin.

Among plasma physicists, Rosenbluth is considered an outstanding theorist. He was one of the first to penetrate the instabilities that plagued attempts in the 1950s to create stable plasmas. He suggested ways of avoiding these instabilities that led, along with Soviet contributions to the field, to designs for what are now the principal configurations for fusion research, the tokamaks.

Rosenbluth's work spans virtually the entire history of fusion research.

His work provided a physical understanding of plasma as individual particles behaving in a collective manner. This was followed by a mathematical formulation of the kinetic theory, which provided a rigorous basis for modern plasma physics. His theory of inhomogeneous plasmas laid the foundation for much of the work on plasma instabilities. He has made major contributions to our understanding of neoclassical diffusion, synchrotron radiation, trapped-particle instabilities and magnetohydrodynamic instabilities—all of which are critical to developing successful approaches to plasma confinement and, hence, practical fusion-energy systems.

In addition, his analysis of the scattering of relativistic electrons within nuclei provided the theoretical underpinning for experimental work by Robert Hofstadter and others on the structure and charge distribution within nuclei. Rosenbluth was coauthor in 1953 of the first paper to propose the use of Monte Carlo techniques in computer studies of statistical mechanics, and he has recently been active in research on free-electron lasers, proposing the variable-pitch wiggler and delineating the role of sideband instabilities.

Five honored for particle-accelerator advances

The US Summer School on Particle Accelerators, which has been sponsored annually by DOE, NSF and the High-Energy Physics Laboratories since its inception in 1981, last July honored five individuals for their contributions to the development of accelerator physics and technology. Ernest D. Courant (Brookhaven National Laboratory), M. Stanley Livingston (MIT) and Robert R. Wilson (Cornell University) received the Historic Award. Helen T. Edwards (Fermilab) and John M. J. Madey (Stanford University) were presented with the Accelerator Physics and Technology Prize. These prizes and awards are sponsored by the Universities Research Association, Varian Associates, Varian Vacuum Products, Westinghouse Electric Company and the Houston Area Research Center.

Courant and Livingston were honored for their "discovery of the principle of alternating gradients and for the conceptualization of strong focusing accelerators." Courant received his PhD in physics in 1943 from the University of Rochester. He worked on the Canadian Atomic Energy Project at Montreal and Chalk River in 1943–46, and then became a research associate in theoretical physics at Cornell. He joined Brookhaven in 1948, and in 1960 he was named senior physicist. Livingston received his PhD in physics from the University of California at Berkeley in 1931 for research with Ernest O. Lawrence on the original cyclotron. He held a research position at the University of California (1932–34) and a teaching position at Cornell (1934–38), where he built a small cyclotron. In 1938 Livingston became an associate professor at MIT, where he built a larger cyclotron; during World War II he investigated the possibility of using this machine as a source of radioactive materials. Livingston became a full professor at MIT in 1952, and in 1956 was appointed director of the Cambridge Electron Accelerator, which was built jointly by MIT and Harvard University. Livingston retired from MIT in 1970. In 1952 Courant, Livingston and Hartland S. Snyder, working at Brookhaven, realized that by alternating magnets of opposite gradients one could achieve both horizontal and vertical focusing in the accelerator, which they referred to as "strong" focusing because there appeared to be no limit to the strength of focusing that was possible. Nicholas Christofilos, a Greek engineer and inventor, independently came upon the same principle. His patent was dated 1949.

Wilson was cited "for building the first strong-focusing synchrotron and for his pioneering role in the development of high-energy accelerators." Wilson received his PhD in physics in 1940 from the University of California at Berkeley, working under Lawrence. He then held teaching and research positions at Princeton University (1940–46), where he studied proton–proton scattering. In 1941 he invented the isotron method of separating uranium isotopes. He joined Los Alamos in 1942, where he served as director of the cyclotron group and later as head of the experimental-nuclear-physics division. In 1946 he was an associate professor at Harvard. In 1947 Wilson became professor of physics and director of the nuclear-studies laboratory at Cornell, where he and his colleagues became the first to incorporate the strong-focusing principle in an accelerator, an electron synchrotron. Wilson remained at Cornell until 1967, when he joined the physics department and the Enrico Fermi Institute for Nuclear Studies at the University of Chicago. He was the founding director of the Fermi National Accelerator Laboratory, where the first synchrotron operating in the energy range of hundreds of GeV was built. Wilson served as director of Fermilab for 1967–78. He became Michael Pupin Professor at Columbia in 1980.

Edwards was honored "for essential contributions in making the world's first superconducting synchrotron a reality." Edwards received her PhD in physics in 1966 from Cornell. She remained there as a research associate in the Laboratory for Nuclear Studies until 1970, and was primarily responsible for commissioning Cornell's 12-GeV electron synchrotron in 1967. In 1970, Edwards joined Fermilab, working first with the Booster Group, which she headed until the commissioning of the booster in 1971. She then undertook studies to optimize the operating characteristics of the 200-GeV main accelerator. Under her direction, an extraction efficiency of 98–99% was achieved, together with energies of 500 GeV and proton intensities exceeding 3.3×10^{13} particles per pulse. In 1979 Edwards became cohead of the team responsible for building the Tevatron, which was first operated in July 1983. Since then the Tevatron has achieved intensities exceeding 1.2×10^{13} protons per pulse, an energy of 800 GeV and, more recently, the first proton–antiproton collisions at 1.6-TeV center-of-mass energies (see page 23).

Madey was cited "for the invention and demonstration of the free-electron laser." He received his PhD in 1970 from Stanford, and continued there as an AFOSR–NRC fellow (1970–71) and as a research associate in high-energy physics (1971). In 1976 Madey and his coworkers demonstrated the first free-electron laser oscillator—in which gain was provided by a relativistic electron beam traveling through a spatially periodic transverse magnetic field. This first instrument generated an infrared beam; Madey and his colleagues have recently achieved lasing in the visible, using an electron beam from the ACO electron-storage ring at the LURE laboratory in Paris (see PHYSICS TODAY, December 1983, page 17).

Madey became a senior research associate at Stanford in 1975, and in 1983 was made a research professor in electrical engineering. More recently, in October 1985, the Madey group completed tests of a broadly tunable compact infrared free-electron laser, thus advancing the device from a laboratory demonstration experiment to a practical research source of ir radiation. The group is also working on a very-short-wavelength free-electron laser and hopes to achieve a coherent ultraviolet source tunable in the range 500–1500 Å, and perhaps to frequencies as low as 200 Å.