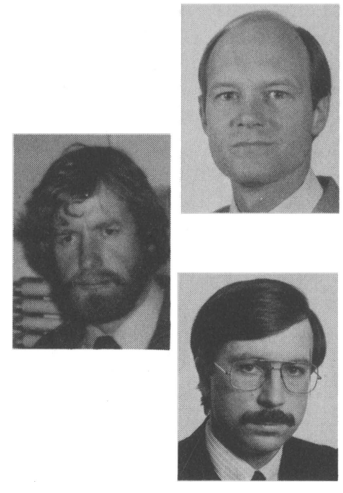
nuclear technology®

AUTHORS — SEPTEMBER 1982

FISSION REACTORS

PARTICLE BED HEAT REMOVAL WITH SUBCOOLED SODIUM: D-4 RESULTS AND ANALYSIS

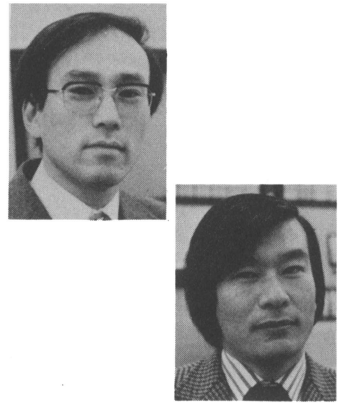
Ronald J. Lipinski
John E. Gronager
Michel Schwarz



Ronald J. Lipinski (top) (BS, physics, California Institute of Technology, 1971; MS, 1973, and PhD, 1976, nuclear engineering, University of Illinois, Urbana-Champaign) has been at Sandia National Laboratories (SNL) since 1977. His recent past experience and current interest is in modeling boiling and dryout in porous media. **John E. Gronager** (center) (BS, engineering science, State University of New York, Buffalo, 1973; MS, 1975, and PhD, 1978, nuclear engineering, University of Illinois, Urbana-Champaign) joined SNL in 1978. He was the lead experimenter in the in-pile debris test D-4 and is currently the lead experimenter for future D-series tests. **Michel Schwarz** (bottom) (Dipl. Ing., Ecole Centrale des Arts et Manufactures de Paris, 1972) was on assignment at SNL from the Commissariat à l'Energie Atomique in France. He is currently working in the Safety Department at Cadarache and is involved in code development and experiment analysis regarding the French Fast Reactor Safety Program. His interests include thermohydraulics and computational methods.

AN AUTO-TUNING METHOD FOR CONTROL SYSTEM PARAMETERS IN NUCLEAR POWER PLANTS

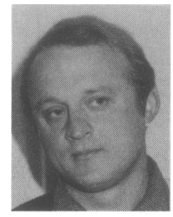
Satoshi Suzuki
Kohyu Fukunishi

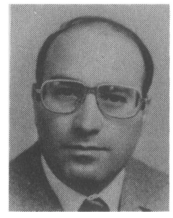


Satoshi Suzuki (top) (MS, electrical engineering, Tokyo Metropolitan University, Japan, 1973) is a researcher at the Energy Research Laboratory (ERL), Hitachi Ltd., Japan. He is working in the area of monitoring and control of nuclear power plants. His current interests are in the field of system identification and optimization problems. **Kohyu Fukunishi** (PhD, control engineering, Osaka University, Japan, 1977) has engaged in the control engineering and data processing of nuclear power plants and also in the control engineering of the nuclear fusion facility at ERL, Hitachi Ltd. He was visiting researcher at the U.K. Atomic Energy Authority's Culham Laboratory from 1979 to 1980. His current interests are in CAD of control system and diagnostic analysis of nuclear power plants.

EPITHERMAL-THERMAL Pu-Th AND ^{233}U-U REACTOR SYSTEMS

Alex Galperin
Yigal Ronen

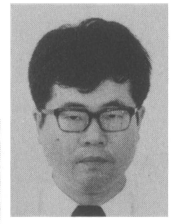


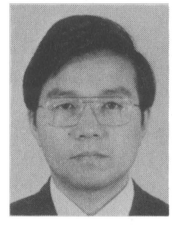


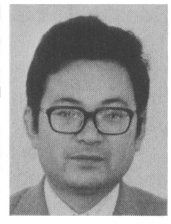
Alex Galperin (top) (MS, engineering physics, Leningrad Polytechnical Institute, USSR, 1969; PhD, nuclear engineering, Ben-Gurion University of the Negev, Beer Sheva, Israel, 1979) is lecturer in the Department of Nuclear Engineering of the Ben-Gurion University. His research interests are in the field of nuclear fuel cycle analysis and particularly improvements in fuel utilization. **Yigal Ronen** (BS, mechanical engineering, and MS, nuclear engineering, 1967, Technion-Israel Institute of Technology; PhD, nuclear engineering, Cornell University, 1970) is associate professor of nuclear engineering at Ben-Gurion University. His research interests include advanced concepts of nuclear reactors and problems in uncertainty analysis.

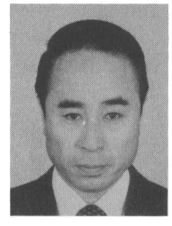
DEVELOPMENT OF A SPONGE METAL CATALYST FOR A RECOMBINER

Hiroyuki Tsuchiya
Yamato Asakura
Kunio Kamiya
Hideo Yusa
Masaki Takeshima







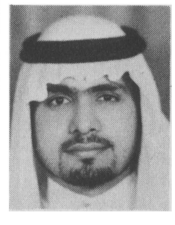


Hiroyuki Tsuchiya (top right) (MS, nuclear engineering, Tokyo Institute of Technology, 1972) has worked in the development of radwaste treatment systems and is currently involved in the uranium enrichment system at the Energy Research Laboratory (ERL) of Hitachi, Ltd. **Yamato Asakura** (top left) (MS, nuclear engineering, Nagoya University, 1975) has worked in the development of radiation reduction procedures in boiling water reactor (BWR) plants and is currently involved in deuterium-tritium isotope separation by chemical exchange reactions at ERL. **Kunio Kamiya** (bottom right) (BS, electrical engineering, Ibaraki University, 1967) has worked in the development of radwaste treatment systems at ERL. **Hideo Yusa** (bottom left) (BS, physics, Tohoku University, 1959; Dr. Eng., nuclear engineering, Osaka University, 1969) is a chief researcher in radwaste treatment development at ERL. **Masaki Takeshima** (not pictured) (MS, nuclear engineering, Tokyo University, 1968) is a senior engineer in the BWR plant design at the head office of Hitachi, Ltd.

NUCLEAR SAFETY

SITING OF NUCLEAR POWER PLANTS IN SAUDI ARABIA USING FUZZY DECISION ANALYSIS

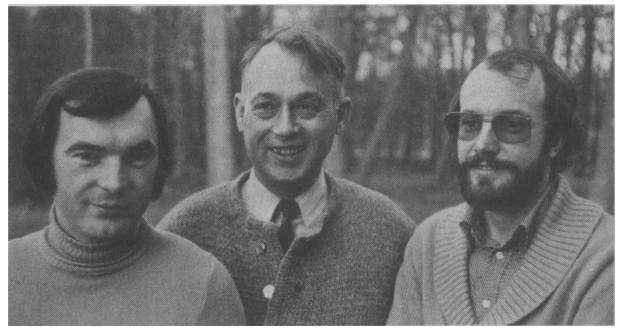
Abdul-Rahman Foad Abdul-Fattah
Waleed H. Abulfaraj



Abdul-Rahman Foad Abdul-Fattah (top) (PhD, nuclear engineering, Iowa State University, 1978) is an assistant professor of electrical engineering at King Saud University, Riyadh, Saudi Arabia. His technical interests currently include activation analysis, siting of nuclear power plants, nuclear desalination, and system analysis. **Waleed H. Abulfaraj** (MS, nuclear engineering, Iowa State University) is a PhD candidate in nuclear engineering at Iowa State University and on leave from the Nuclear Engineering Department at King Abdulaziz University, Jeddah, Saudi Arabia. His current research work is on planning a nuclear research center for Saudi Arabia.

REDUCING THE WORLD'S URANIUM REQUIREMENT BY THE THORIUM FUEL CYCLE IN HIGH TEMPERATURE REACTORS

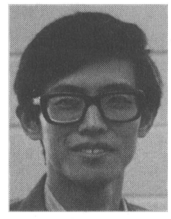
E. Teuchert
H. J. Rütten
H. Werner

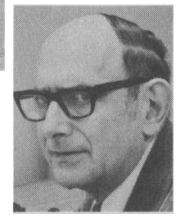


E. Teuchert (center) [PhD, theoretical physics, University of Cologne, Federal Republic of Germany (FRG)] has been employed by Kernforschungsanlage Jülich (KFA) since 1964. His current interests are computer code system development and analysis of high temperature reactors (HTRs) and HTR fuel cycles, preferably of the pebble bed reactor. **H. J. Rütten** (right) (PhD, engineering science, Technische Hochschule Aachen, FRG, 1976) joined KFA in 1972. He is working on HTR core design and fuel cycle, especially for the OTTO reactor. His current interests are burnup physics and the design of HTRs in a high converting fuel cycle. **H. Werner** (left) (PhD, engineering science, Technische Hochschule Aachen, FRG, 1975) joined KFA in 1971. His current interests are core design, burnup physics, and the fuel cycle of the HTR (OTTO, pebble bed reactor) within the PNP project.

EXTENDED BURNUP FUEL CYCLE OPTIMIZATION FOR PRESSURIZED WATER REACTORS

Alfred L. B. Ho
Alexander Sesonske

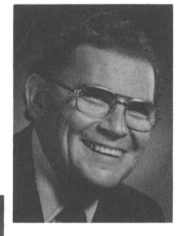


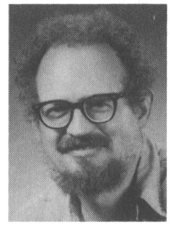


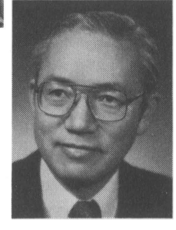
Alfred L. B. Ho (top) (BS, 1975, and MS, 1977, nuclear engineering, National Tsing Hua University, Taiwan; PhD, nuclear engineering, Purdue University, 1981) is working in the Neutronics and Fuel Management Section of Exxon Nuclear Company. His current interests are in the areas of in-core power monitoring, neutronic method development, and core management analysis. **Alexander Sesonske** (PhD, University of Delaware, 1950) is professor of nuclear engineering at Purdue University. In addition to nuclear fuel management, his interests include nuclear reactor engineering and liquid-metal heat transfer.

APEX NUCLEAR FUEL CYCLE FOR PRODUCTION OF LIGHT WATER REACTOR FUEL AND ELIMINATION OF RADIOACTIVE WASTE

Meyer Steinberg
James R. Powell
Hiroshi Takahashi



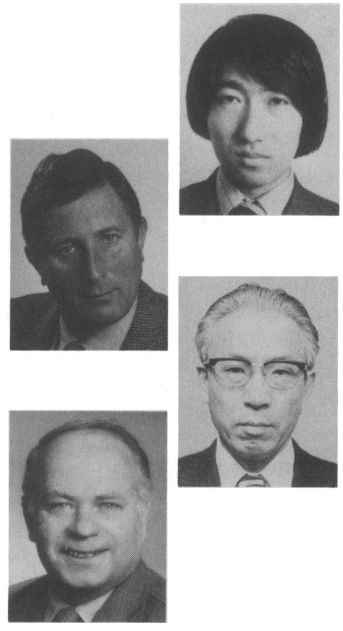




Meyer Steinberg (top) (BS, chemical engineering, Cooper Union, 1944; MS, Polytechnic Institute, 1949) is head of the Process Sciences Division at Brookhaven National Laboratory (BNL). He started his career in the Manhattan District on gaseous diffusion and plutonium recovery. At BNL he worked on radiation chemical processing and recently on coal conversion alone, and with the use of fission and fusion power for synthetic fuels. **James R. Powell** (center) (BS, chemical engineering, ScD, nuclear engineering, Massachusetts Institute of Technology, 1958) is head of the Reactor Systems Office in the Department of Nuclear Energy at BNL. He has worked on analyses of liquid-metal-fueled reactors, advanced reactor concepts for nuclear rocket propulsion, applications of superconductivity, ball lightning, fusion, and high temperature electrolysis. **Hiroshi Takahashi** (bottom) (PhD, electrical physics, Waseda University, 1959) has been working on physics and mathematics in the area of nuclear reactors at BNL, Japan Atomic Energy Research Institute, and Euratom Research Center at ISPRA and was a professor at the Tokyo Institute of Technology from 1964 to 1966. His current research interest at BNL is in accelerator reactors and the μ-catalyzed fusion reaction.

A STUDY OF PULSE COLUMNS FOR THORIUM FUEL REPROCESSING (I)

Hiromichi Fumoto
Erich Zimmer
Ryohei Kiyose
Erich R. Merz



Hiromichi Fumoto (top right) (BS and MS, nuclear chemical engineering, University of Tokyo) has been a doctoral research associate at the Institute for Chemical Technology of Kernforschungsanlage Jülich (KFA) since 1979. His current research is in extraction studies for the separation process of nuclear reprocessing. **Erich Zimmer** (top left) [Dr. rer. nat., chemistry, University of Mainz, Federal Republic of Germany (FRG), 1965] is a section head at the Institute for Chemical Technology of the KFA. He is involved in reprocessing, waste treatment, and refabrication developments. **Ryohei Kiyose** (bottom right) (BS, physics, 1952; MS, chemical engineering, 1954; and PhD, nuclear engineering, 1976, University of Tokyo) is a professor of nuclear chemical engineering at the University of Tokyo and is interested in reprocessing and waste management technology and safety aspects of nuclear fuel facilities. **Erich R. Merz** (bottom left) (Dr. rer. nat, nuclear chemistry, University of Mainz, FRG, 1957, professor of Nuclear Technology Rheinisch Westfälische Technische Hochschule Aachen, 1970) is director of the Institute for Chemical Technology of KFA since 1968. He is a member of the German Reactor Safety Commission. His work has been in the area of the backend of the nuclear fuel cycle including radioactive waste disposal.

IN-PILE MOLTEN FUEL-COOLANT INTERACTION TEST OF CARBIDE FUEL: TREAT TEST AX1

Robert C. Doerner
Theodore H. Bauer
Charles L. Fink
William F. Murphy
Arthur E. Wright

Robert C. Doerner (standing, left) (BS, physics, St. Johns University, 1949; PhD, physics, St. Louis University, 1954) is presently involved in light water reactor safety analysis and plant performance studies at Argonne National Laboratory (ANL) after previous participation in the ANL fast reactor safety experiments program. **Theodore H. Bauer** (sitting, left) (PhD, physics, Cornell University, 1970) has worked since 1977 on the analysis and planning of in-pile experiments for the RAS Division of ANL. His current interests lie in the effective use of experiments in the analysis of reactor safety issues. **Charles L. Fink** (standing, center) (BS, physics, 1966, and PhD, nuclear physics, 1971, University of Pittsburg) is a research physicist whose current work at ANL involves analysis of hodoscope data, development of new mathematical models to describe the hodoscope system, and testing of new fuel motion detectors. **William F. Murphy** (sitting, right) (BS, 1937, and MS, 1939, chemistry, Syracuse University; BS, metallurgy, Carnegie Institute of Technology, 1945) is a metallurgist in the Materials Science Division of ANL where he has studied radiation effects on fuels and structural materials and conducted hot cell examinations since 1949. For the past ten years he has performed posttest examinations on TREAT experiments. **Arthur E. Wright** (standing, right) (BS, science engineering, Northwestern University, 1966; MS, 1969, and PhD,

1972, nuclear engineering, Massachusetts Institute of Technology) has for ten years been involved in the planning, preparation, and analysis of in-reactor liquid-metal fast breeder reactor safety experiments at ANL.

ON THE VIBRATIONAL BEHAVIOR OF PRESSURIZED WATER REACTOR FUEL RODS

André Preumont

André Preumont (Ingénieur Civil des Constructions Aéronautiques, 1973, and Docteur en Sciences Appliquées, 1981, University of Liège, Belgium) is currently an independent consultant at Belgonucleaire, where he has been involved for several years in the mechanical design of pressurized water reactor RCC (Zircaloy) fuel assemblies. He is in charge of the seismic analysis of liquid-metal fast breeder reactor cores for which his research involves the time integration of impacting structures and fluid-structure interaction. His other research interests are mainly in random vibration and earthquake simulation.

ANALYSIS OF FISSION GAS DISPOSITION IN LIGHT WATER REACTOR STEADY-STATE OPERATION

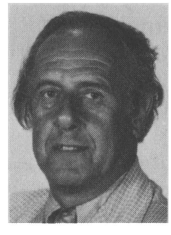
Antonio Villalobos
A. R. Wazzan
D. Okrent

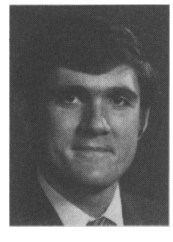
Antonio Villalobos (top) [BA, physics, California State University, San Diego, 1973; MS, physics, 1975, and PhD, nuclear engineering, 1981, University of California, Los Angeles (UCLA)] is a research scientist in the Department of Nuclear Energy at the Instituto de Investigaciones Eléctricas. His current interests are simulation of nuclear systems, reliability studies, and fission gas behavior. **A. R. Wazzan** (center) (PhD, engineering science, University of California, Berkeley, 1963) is a professor in the Department of Chemical, Nuclear and Thermal Engineering at UCLA. His current fields of interest include light water reactor and fast breeder reactor fuel element modeling, thermal hydraulics of pressurized water reactors, and laminar boundary layers. **D. Okrent** (bottom) (PhD, physics, Harvard University, 1951) is a professor in the Department of Chemical, Nuclear and Thermal Engineering at UCLA. His current fields of interest include nuclear fuel element behavior, reactor safety, and risk benefit.

RADIOACTIVE WASTE MANAGEMENT

SUBSURFACE MIGRATION OF RADIOACTIVE WASTE MATERIALS BY PARTICULATE TRANSPORT

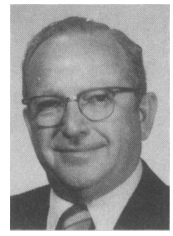
Geoffrey G. Eichholz
Barry G. Wahlig
Gregory F. Powell
T. F. Craft





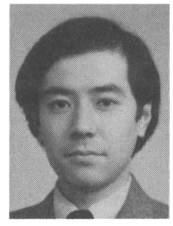
Geoffrey G. Eichholz (top) (PhD, physics, University of Leeds, 1948) is Regents' professor of nuclear engineering at the Georgia Institute of Technology (GIT), where he has conducted research over a broad spectrum of radiation technology, including radiation detectors, radiotracer methodology, environmental aspects of nuclear power waste disposal, and radiation effects on materials. **Barry G. Wahlig** (bottom) (BS, engineering science, Louisiana State University, 1974; MS, 1975, and PhD, 1980, nuclear engineering, GIT) has done research concerning the

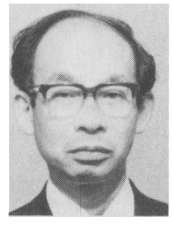
migration of water-suspended mineral particles in rock formations. His present professional interest is the application of published research to the regulatory problems of nuclear utilities, especially in the area of emergency response planning. **Gregory F. Powell** (not pictured) (BS, physics, Auburn University, 1979; MS, health physics, GIT, 1980) is presently a graduate student in the field of medical physics in the Department of Radiology at the University of Chicago. His present research interests include digital radiography and radiation cancer therapy using fast neutron beams. **T. F. Craft** (right) (MA, chemistry, Emory University, 1947; MS, sanitary engineering, 1965, and PhD, nuclear engineering, 1969, Georgia Tech) is senior research scientist at the School of Nuclear Engineering and Health Physics at GIT. His professional and research interests concern water quality, migration of pollutants and radiotracers in subsurface and surface waters, water treatment, and radiation qualification of technical equipment.



ADSORPTION OF GASEOUS $^{131}I_2$ AND $CH_3{}^{131}I$ ONTO GEOLOGICAL MATERIALS

Toshiaki Ohe
Akira Nakaoka
Shinji Takagi



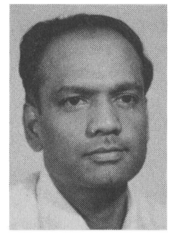


Toshiaki Ohe (top) (BE, 1975, and ME, 1977, environmental chemistry, Keio University, Japan) is a research chemist at the Energy and Environment Laboratory of the Central Research Institute of Electric Power Industry (CRIEPI), Japan. His current interest includes the geochemical behavior of radionuclides, particularly chemisorption. **Akira Nakaoka** (center) (BE, applied chemistry, Seikei University, Japan, 1969) is a senior research chemist at the Energy and Environment Laboratory of CRIEPI. His current interest is in radionuclide behavior analysis on both natural and artificial nuclides in the environment. **Shinji Takagi** (bottom) (BS, 1956; MS, 1958; and PhD, 1961, spectrochemical analysis, University of Tokyo, Japan) is a fellow research chemist at the Energy and Environment Laboratory of CRIEPI. His current interest is in the safety assessment of nuclear materials, especially in nuclear fuel transport.

MATERIALS

LOW CYCLE FATIGUE CHARACTERISTICS OF IRRADIATED TYPE 304 STAINLESS STEEL

K. L. Murty
J. R. Holland

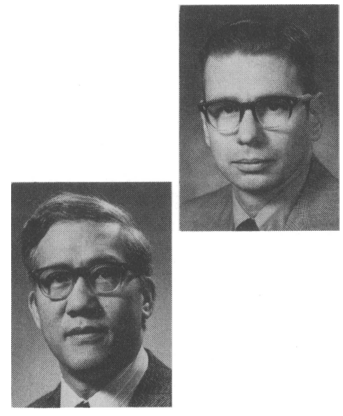


K. L. Murty (top) (MSc, physics, Andhra University, India, 1963; MS, materials science and engineering, Cornell University, 1967; PhD, applied physics and materials science, Cornell University, 1970) has been a senior engineer in the Nuclear Materials Department at the Westinghouse Research and Development Center since 1979 where the research work reported in this article was performed. Since 1979, he has been involved with the development of constitutive equations for deformation and fracture of metals; physical and mechanical metallurgy of Zircaloy materials; fracture behavior, radiation embrittlement, and corrosion fatigue of nuclear pressure vessel steels; and anisotropic deformation behavior of textured materials. **J. R. Holland** (BS, metallurgical engineering, University of Kentucky, 1953; MMet, physical metallurgy, University of Sheffield, England, 1954; PhD, physical metallurgy, University of Kentucky, 1962) is director of the School of Mines and

energy development at the University of Alabama. Previously, he was manager of nuclear reactor materials research for Westinghouse Research Laboratories where his activities included studies of radiation damage in reactor pressure vessel steels, simulation of 14-MeV neutron damage in fusion reactor first-wall materials, development of fuel pellets for commercial scale inertial confinement fusion reactors, development of better alloys for duct cladding required for fast breeder reactors and mechanical behavior of reactor materials.

FATIGUE BEHAVIOR OF TYPE 316 STAINLESS STEEL IRRADIATED IN A MIXED SPECTRUM FISSION REACTOR FORMING HELIUM

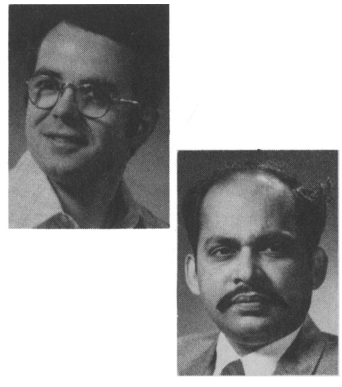
Martin L. Grossbeck
Kenneth C. Liu



Martin L. Grossbeck (top) (BS, physics, Rensselaer Polytechnic Institute, 1966; MS, physics, Cornell University, 1968; PhD, University of Illinois, 1975) is at Oak Ridge National Laboratory (ORNL) where he is leader of the research effort in radiation damage of fusion reactor first-wall materials. His own research is in the area of the effects of radiation on fatigue and tensile properties of materials. From 1967 to 1971, he served as instructor of reactor physics at the U.S. Naval Nuclear Power School. He has worked in the area of hydrogen embrittlement, refractory metals, fracture behavior, and radiation creep. **Kenneth C. Liu** (BS, National Taiwan University, Tapei, Taiwan; PhD, engineering and applied science, Yale University) is a research staff member with the Metals and Ceramics Division of ORNL. He has contributed to theoretical and experimental studies of plasticity, multiaxial extensometry for high temperature applications, and fatigue of metals in multiaxial loading.

RADIATION-INDUCED CORROSION OF MILD STEEL IN CONTACT WITH ION-EXCHANGE MATERIALS

T. E. Gangwer
K. K. S. Pillay



T. E. Gangwer (top) (PhD, physical chemistry, Notre Dame University, 1973) is an associate chemist at the Brookhaven National Laboratory. His technical interests are in radiation chemistry and nuclear waste management. **K. K. S. Pillay** (PhD, nuclear chemistry, The Pennsylvania State University, 1965) is a member of the staff of the Nuclear Safeguards Systems Group at the Los Alamos National Laboratory. He was an associate professor of nuclear engineering at The Pennsylvania State University. His professional interests are in process chemistry of nuclear materials and radioactive waste management.