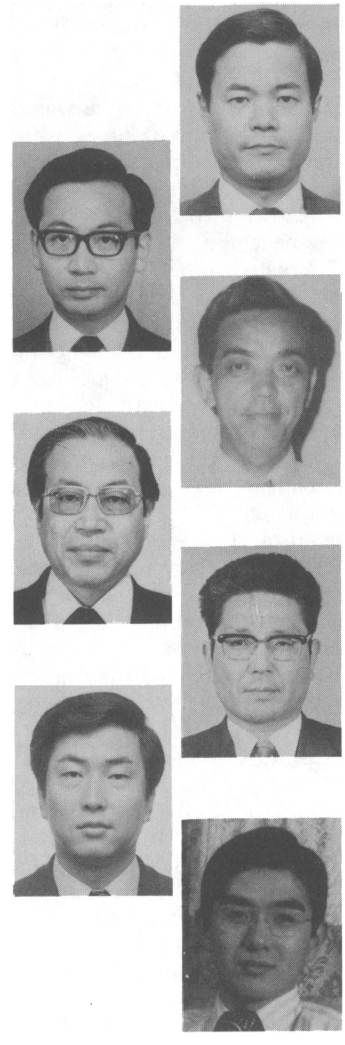
nuclear technology®

AUTHORS — JULY 1982

FISSION REACTORS

ON-LINE TEST OF POWER DISTRIBUTION PREDICTION SYSTEM FOR BOILING WATER REACTORS

Yasuo Nishizawa
Takashi Kiguchi
Setsuo Kobayashi
Kenji Takumi
Michiro Yokomi
Ryohsuke Tsutsumi
Harukuni Tanaka



Yasuo Nishizawa (top right) (BSc, nuclear engineering, Kyoto University, Japan, 1970) has studied the core characteristics of light water reactors (LWRs), especially the power distribution calculation techniques, at Hitachi, Ltd., since 1970. He has been a senior researcher at the Institute of Applied Energy since 1980, with current technical interests in nuclear power plant decommissioning. **Takashi Kiguchi** (top left) (PhD, nuclear engineering, Tokyo University, Japan, 1975) has been engaged in the development of boiling water reactor (BWR) core management systems and plant monitoring systems since 1969. He is presently a senior researcher at the Energy Research Laboratory (ERL), Hitachi, Ltd., with current interests in on-line plant diagnosis and man-machine communication in nuclear reactor control systems. **Setsuo Kobayashi** (second from top right) (PhD, physics, Kyoto University, Japan, 1966) has been doing nuclear technology research and development work since 1958. He was a technical leader at the Power Reactor and Nuclear Fuel Development Corporation with technical interests in fast reactor physics (1968 to 1974), and is presently a division head at ERL with technical interests in core design and control for LWRs, fast breeder reactors, and fusion. **Kenji Takumi** (center left) (PhD, nuclear engineering, Tokyo University, Japan, 1961) is a deputy general manager of the Nuclear Power Generation Division, Hitachi, Ltd., and is responsible for nuclear power plant control and instrumentation. His current interests include a plant operation instruction system for operator guidance. **Michiro Yokomi** (second from bottom right) (BSc, physics, Tokyo University, Japan, 1957) is a deputy chief engineer at the Nuclear Power Generation Division, Hitachi, Ltd., and is a leader of the core design, management, and safety group of BWRs. **Ryohsuke Tsutsumi** (bottom left) (BSc, nuclear engineering, Tokyo University, Japan, 1967) has studied core management and safety analysis of nuclear reactors at the Tokyo Electric Power Company (TEPCO) since 1967. He is an assistant manager of the Nuclear Power Plant Planning Division of TEPCO, with current interests in LWR safety. **Harukuni Tanaka** (bottom right) (BSc, nuclear engineering, Tokyo University, Japan, 1976) has been engaged in reactor core management at TEPCO since 1976. He is presently an engineer at the Nuclear Power Plant Engineering Division of TEPCO, with current interests in LWR safety.

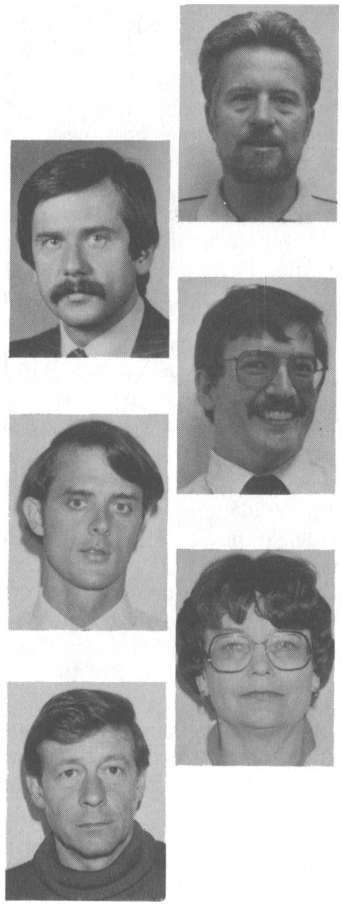
ON THE FLEXIBILITY OF HIGH TEMPERATURE REACTOR CORES FOR HIGH- AND LOW-ENRICHED FUEL

Siegfried Brandes
Günter Lohnert

Siegfried Brandes (top) (mechanical and nuclear engineering, 1964, and Dr.-Ing., nuclear engineering, TH Aachen, 1966) joined Hochtemperatur-Reaktorbau GmbH in 1968. He worked in nuclear fuel cycles and nuclear design of high temperature reactors (HTRs). He is currently head of the Department of Nuclear Design/Shielding. **Günter Lohnert** (PhD, nuclear sciences, University of Florida, 1971) has been employed since 1974 by GHT/INTERATOM Company in Germany in the fields of core design, core analysis, and the conceptional design of HTRs. Since 1978 he has been visiting associate professor at the University of Florida, Department of Nuclear Sciences and Engineering.

UNIRRADIATED HIGH TEMPERATURE REACTOR FUEL ELEMENT HEAD-END REPROCESSING TESTS

Folkmar A. Schwarz
Heinz E. Tischer
Ronald N. Drake
William S. Rickman
Nadine D. Holder
James B. Strand

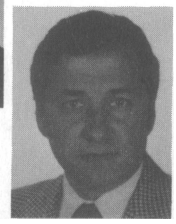


Folkmar A. Schwarz (top right) [BS, chemical process engineering, Staatl, Jugenieurschule für Maschinenwesen Essen, Federal Republic of Germany (FRG), 1964] is the technical lead engineer for the high temperature reactor (HTR) Joint Fuel Processing Demonstration as a staff engineer at NUKEM GmbH, Hanau. Prior to this, he was responsible for the shakedown and initial operation of large gasification plants and the lead engineer for the development and fabrication of plutonium fuels for light water reactors (LWRs) and fast breeder reactors at ALKEM. In addition to his duties in HTR reprocessing, he is involved in the development of nuclear waste treatment processes. **Heinz E. Tischer** (top left) (MS, mathematics and political economy, University of Cologne; PhD, nuclear and chemical engineering, University of Aachen, FRG, 1975) has been involved as a group leader in basic and applied scientific research in the development of HTR fuel reprocessing at Kernforschungsanlage Jülich (KFA-Jülich), Institute of Chemical Technology. He is currently a project manager for UHDE GmbH, Dortmund, for LWR reprocessing plants. **Ronald N. Drake** (center right) (BS, chemical engineering, Montana State University, 1972) is employed by the German nuclear research facility, KFA-Jülich, as project manager for high temperature gas-cooled reactor (HTGR) fuel cycle reprocessing and waste treatment development. His previous work at the Idaho National Engineering Laboratory centered on the development of head-end reprocessing and waste treatment technology for several graphite-based HTGR and nuclear rocket fuels. **William S. Rickman** (center left) (BS, chemical engineering, Tennessee Technological University, 1971) is manager of process technology at General Atomic Company (GAC). His technical background includes fluid bed combustion of graphite-based nuclear fuel and a wide range of fossil fuels. **Nadine D. Holder** (bottom right) (BA, anthropology, San Diego State University, 1972) is currently a staff engineer at GAC. She has technical lead responsibility for the joint fuel processing demonstration of U.S./FRG HTR fuels. She has worked for several years on various aspects of HTR fuel cycles at GAC. **James B. Strand** (bottom left) (BS, chemistry, Bradley University, 1963) is the U.S. coordinator of the U.S./FRG cooperative program on HTR spent fuel treatment development. He has been involved in research and

development projects on LWR and gas-cooled reactor fuel manufacture and reprocessing for the past 18 years at Argonne National Laboratory, Westinghouse's Nuclear Fuel Division, and GAC. He has coauthored several reports on fuel reprocessing techniques.

THE ECONOMICS OF PLUTONIUM-URANIUM RECYCLING TO THE NUCLEAR PROGRAM IN THE COUNTRY OF SPAIN

Warren F. Witzig
Vincente Serradell

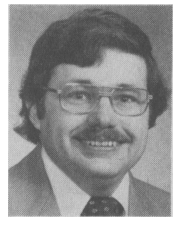


Warren F. Witzig (top) is a professor of nuclear engineering and head of the Nuclear Engineering Department at The Pennsylvania State University. **Vincente Serradell** is a professor and head of the Nuclear Engineering Department at Universidad Politecnica de Valencia, Catedra de Tecnologia Nuclear in Spain.

CHEMICAL PROCESSING

STUDIES ON THE REACTION OF NITRIC ACID AND SUGAR

C. S. MacDougall
C. K. Bayne
R. B. Roberson

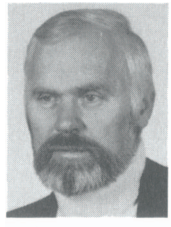


C. S. MacDougall (photo not available) (BS, chemistry, Michigan State University, 1964; MS, chemistry, University of Illinois, 1975) is a research staff member of the Analytical Chemistry Division of Oak Ridge National Laboratory, which is operated by Union Carbide Corporation. She is currently working on the assays of environmental samples for solid and volatile pollutants. **C. K. Bayne** (right) (BA, mathematics and chemistry, Blackburn College, 1966; MS, applied mathematics, Washington University, 1968; PhD, statistics, North Carolina State University, 1974) is a research staff member of the Computer Sciences Division of Union Carbide Corporation, Nuclear Division. His current interests focus on cluster analysis, experimental design, and data analysis. **R. B. Roberson** (photo not available) (BS, chemistry, College of Notre Dame of Maryland, 1980).

NUCLEAR FUELS

SIMULATION OF NUCLEAR FUEL RODS BY ELECTRICALLY HEATED RODS

Siegfried Malang
Klaus Rust

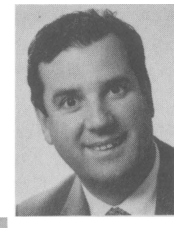


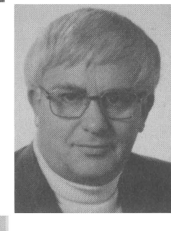
Siegfried Malang (top) [Dipl.-Ing., nuclear engineering, Technische Universität Karlsruhe, Federal Republic of Germany (FRG), 1966] is a research staff member at the Nuclear Research Center Karlsruhe (KfK). He has been involved in fuel rod simulations at KfK as well as during assignments to Oak Ridge National Laboratory and Idaho National Engineering Laboratory. He is currently working on the analysis of experiments simulating loss-of-coolant accidents (LOCAs) in pressurized water reactors (PWRs). **Klaus Rust** (Dipl.-Ing., mechanical engineering, Technische Universität Karlsruhe, FRG, 1958) is currently a research staff member at KfK. His main efforts in

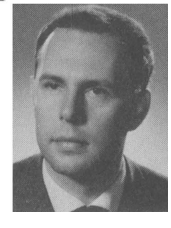
the last few years have been the study of the effects of spacer grids and blockages in fuel rod subchannels on the cooling efficiency of the reflooding phase of a large break LOCA in a PWR.

HOT IMPACT DENSIFICATION: A NEW METHOD FOR PRODUCING HIGH DENSITY CERAMIC PELLETS WITH CLOSE SHAPE TOLERANCES

Milan Hrovat
Hans Huschka
Lothar Rachor
Günter Mühling
Heinz Zimmerman





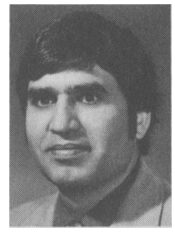


Milan Hrovat (top right) (Dr.-Ing., TH Aachen, MS University Ljubljana, Yugoslavia) is head of the Development Department for Ceramic Material at Nukem. He joined Nukem in 1962, where he developed molded graphite fuel spheres and molded graphite fuel blocks for high temperature gas-cooled reactors (HTGRs). His current activities include conditioning of high-activity waste in a highly dense graphite nickel sulfide matrix, development of ThO_2-based fuel pellets for light water reactors and development of aluminum plate-type dispersion fuels suitable for application of low-enriched uranium in materials testing reactors (MTRs). **Hans Huschka** (top left) (PhD, University Wien, Austria) is head of the Research and Development Department at Nukem. He has over 20 years of experience in nuclear business, particularly with regard to fuel cycle requirements. His current responsibilities include finite element development for high temperature reactors, liquid-metal fast breeder reactors, and MTRs as well as high-, medium-, and low-activity waste management. **Lothar Rachor** (center right) joined Nukem in 1962 after some years in the machine tool and chemical industries. He invented the Arbeitsgemeinschaft Versuchs Reaktor hollow-sphere technology and designed and erected the thorium high temperature reactor molded sphere production line as well as the pilot plant for HTGR molded block fuel elements. Further activities are in-pile and out-of-pile fuel testing facilities. At present he is working on equipment for ceramic materials for the fuel and waste sectors. **Günter Mühling** (bottom left) [Dr. rer. nat., inorganic chemistry, University of Karlsruhe, Federal Republic of Germany (FRG), 1962] has been working since 1972 on the project staff of the German Fast Breeder Programme at Kernforschungszentrum Karlsruhe (KfK), where he is involved with development work for fast breeder fuels and fuel elements. Before coming to KfK, he spent 11 years in industry, primarily dealing with fabrication of ceramic fuel materials. **Heinz Zimmermann** (bottom right) (Dr.-Ing., mechanical engineering, University of Karlsruhe, FRG, 1977) has been involved with various aspects of the fuel cycle since 1964 at KfK. For the past few years, his primary areas of activity have been fuel pin postirradiation examination, fission gas behavior, and fuel swelling. His current interest is in mechanical behavior of oxide fuel.

RADIOACTIVE WASTE MANAGEMENT

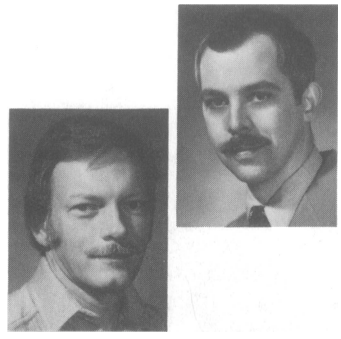
NEPTUNIUM CONCENTRATIONS IN SOLUTIONS CONTACTING ACTINIDE-DOPED GLASS

Dhanpat Rai
Richard G. Strickert
Gary L. McVay



Dhanpat Rai (right) (PhD, soil chemistry, Oregon State University, 1970) is a senior research scientist and technical leader in the Earth Sciences Section at Pacific Northwest Laboratory (PNL). His research at PNL has dealt with environmental chemistry of plutonium, neptunium, and americium, specifically as

it applies to radioactive waste disposal in geologic repositories. **Richard G. Strickert** (top) (PhD, chemistry, Washington University, St. Louis, 1976) is a research scientist in the Earth Sciences Section at PNL. His past research has involved hot atom and radiochemistry. His research at PNL has dealt with characterizing the behavior of various actinides in groundwater systems. **Gary L. McVay** (bottom) (PhD, ceramic engineering, University of Missouri, Rolla, 1970) is a staff scientist and technical leader in the Ceramics Research Section at PNL. His interests and activities are in developing an understanding of glass and ceramic interactions with aqueous solutions.

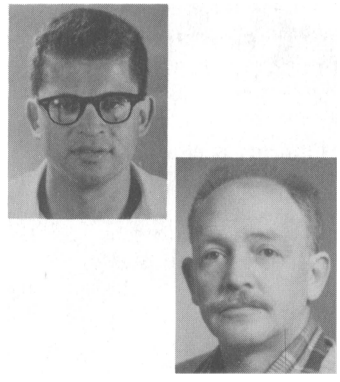


MATERIALS

ALPHA-RECOIL DAMAGE IN MONAZITE: PREFERENTIAL DISSOLUTION OF THE RADIOGENIC ACTINIDE ISOTOPES

Yehuda Eyal
Aaron Kaufman

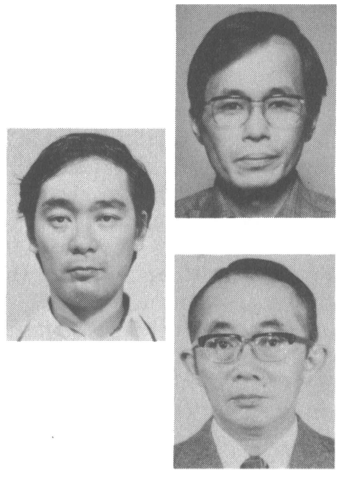
Yehuda Eyal (top) (PhD, nuclear chemistry and physics, Weizmann Institute of Science, Rehovot, Israel, 1971) is a senior lecturer in the Department of Nuclear Engineering, Technion, Israel. In recent years he has been engaged in studies of fission and complex nuclear reactions induced by very heavy ions. His present research interests include the study of radiation effects in the nuclear fuel cycle as well as radiation effects in natural analogs for nuclear waste forms. **Aaron Kaufman** (PhD, geology, Columbia University, 1964) is a nuclear geochemist in the Isotope Research Department of the Weizmann Institute of Science, Israel. His research interests include the study of naturally caused radioactive disequilibrium among uranium and thorium series nuclides in geological materials.



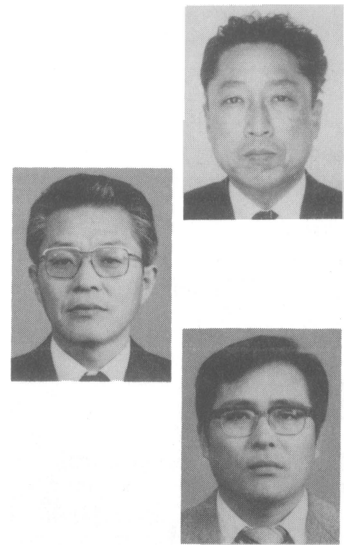
DESTRUCTIVE EXAMINATIONS OF A REGENERATED LARGE COLD TRAP

Yoshiaki Himeno
Kazuo Mukai
Tatsuro Iguchi
Ken Yamamoto
Fumio Nagai
Masao Fujita

Yoshiaki Himeno (top) (MS, nuclear engineering, Tohoku University, 1970) has been working on research and development with sodium components for the experimental fast reactor, Joyo, and the prototype fast breeder reactor, Monju, since he joined Oarai Engineering Center (OEC) in 1970. He is an assistant senior engineer at OEC of the Power Reactor and Nuclear Fuel Development Corporation (PNC). His current technical interests include cover gas aerosol behavior, in particular, sodium mist behavior in liquid-metal fast breeder reactor (LMFBR) components. **Kazuo Mukai** (center) (MS, nuclear engineering, Osaka University, 1973) worked on experiments on sodium components for LMFBRs from 1973 to 1976, when he was at OEC. Currently he works for the Fast Breeder Reactor Development Project at PNC headquarters, his technical interests including construction and development of fast reactors. **Tatsuro Iguchi** (bottom) (BSc, mechanical engineering, Nagoya University, 1962) was a technical group leader at

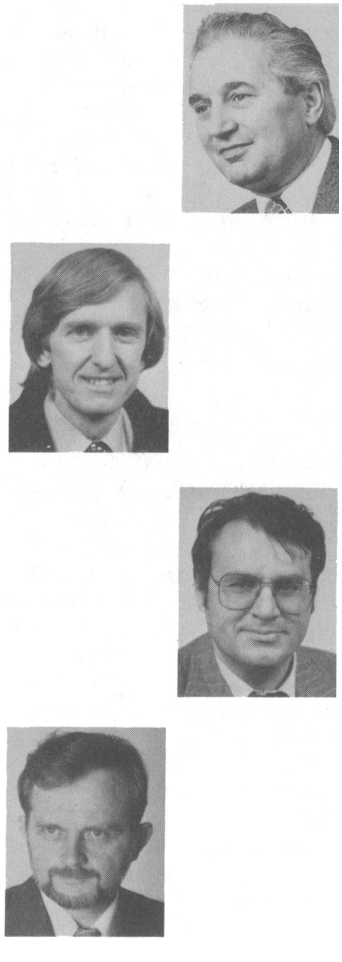


Toshiba Company and had participated in the Fermi Project at Atomic Power Development Associates Inc. from 1969 to 1971. He is currently a manager of OEC, PNC, with technical interests in components for LMFBR coolant systems. **Ken Yamamoto** (top) (MC, mechanical engineering, Keio University, 1959) has many years of experience with sodium technology. Currently he is a manager of the Sodium Components Section of OEC, PNC, with current technical interests in the development of large components for LMFBRs. **Fumio Nagai** (center) (BSc, electrical engineering, Nihon University, 1962) has been supporting the construction and the commissioning of Joyo. As a senior engineer at the Advanced Reactor Department of Hitachi Ltd. since 1977, he is now designing components for the Monju auxiliary system. **Masao Fujita** (bottom) (BSc, nuclear engineering, Ibaraki Technical College, 1968) has been researching reactor engineering at Japan Atomic Energy Research Institute. He also worked on the design of components for the Joyo auxiliary system during the past five years. He is now an engineer at the Advanced Reactor Department of Hitachi Ltd.



QUALIFICATION OF METALLIC MATERIALS FOR APPLICATION IN ADVANCED HIGH TEMPERATURE GAS-COOLED REACTORS

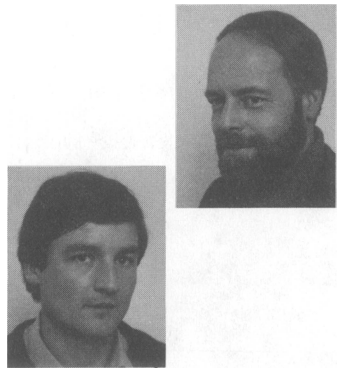
Hubertus Nickel
Philip J. Ennis
Florian Schubert
Hans Schuster



Hubertus Nickel (top right) [Dr. rer. nat., physical chemistry, Technical University of Aachen, Federal Republic of Germany (FRG), 1959] is head of the Institute for Reaktor Materials (IRM) at Kernforschungsanlage-Jülich (KFA-Jülich), FRG. He is also a full professor of reactor materials and nuclear fuel elements at the Technical University of Aachen and is a member of the German Reactor Safety Commission. **Philip J. Ennis** (top left) (BSc, physical metallurgy, University of Birmingham, United Kingdom, 1965) is a research metallurgist at IRM, KFA-Jülich. Prior to joining KFA in 1976, he was with INCO Europe Limited for 11 years and worked on the development of nonferrous nickel-containing alloys. His current interests are the mechanical properties of high temperature alloys in high temperature reactor (HTR) environments and the influence of corrosion on mechanical behavior. **Florian Schubert** (bottom right) (Dipl.-Physicist, University of Saarland, FRG, 1968; Dr. rer. nat., Technical University of Aachen, FRG, 1974) is head of the materials evaluation office of IRM, KFA-Jülich. He is chairman of the working group "Materials" of the German Research and Development Company for HTR, Entwicklungsgemeinschaft HTR. Before joining KFA he was involved in the research and development of high temperature superalloys at Thyssen Special Steel Work and Thyssen Investment Casting Work, both in the field of metallurgy and processing. His current work concentrates on materials problems in the framework of developing a design code for high temperatures, like multiaxial creep, creep ratchetting, creep buckling, and lifetime prediction. **Hans Schuster** (bottom left) (Dr.-Ing., Technical University of Aachen, FRG, 1968) is the section head of IRM at KFA-Jülich. Prior to this assignment at IRM, he performed basic studies of irradiation effects in high purity metals at RWTH. At IRM, after working in the field of irradiation effects on graphitic core materials for the HTR, his interest has been in mechanical properties and corrosion effects on high temperature alloys.

DETERMINATION OF SINGLE COMPONENT VELOCITIES IN TWO-PHASE FLOW SYSTEMS USING CORRELATION METHODS

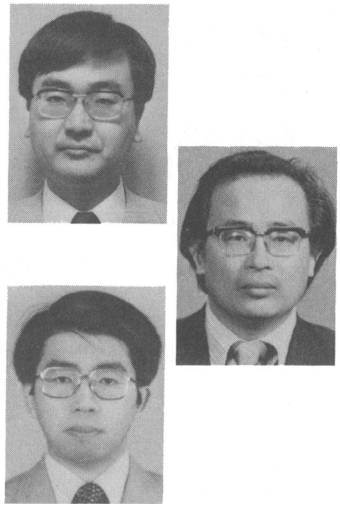
Dieter Barschdorff
Dietmar Wetzlar



Dieter Barschdorff (top) [Dr.-Ing. habil., electrical engineering, University of Karlsruhe, Federal Republic of Germany (FRG), 1972] is professor of electrical measurement at the University of Paderborn, FRG. Formerly at the University of Karlsruhe, he spent the 1970-1971 academic year at the Department of Engineering and Applied Sciences, Yale University, working on two-phase flow research. His current interests include digital signal processing as well as pattern recognition methods for diagnosis purposes. **Dietmar Wetzlar** (Dipl.-Ing., electrical engineering, University of Karlsruhe, FRG, 1979) is scientific associate for electrical measurement at the University of Paderborn. His research interests include digital processing of stochastic signals and application of correlation methods for flow velocity determination.

PRINCIPLES FOR CONTROL ROD WITHDRAWAL STRATEGY DURING THE STARTUP OF BOILING WATER REACTORS

Yasunori Bessho
Hiroshi Motoda
Mitsutaka Watanabe



Yasunori Bessho (top) (MS, nuclear engineering, Kyoto University, Japan, 1975) has worked in the area of the boiling water reactor (BWR) core management for six years at Energy Research Laboratory, Hitachi, Ltd. He is currently working in the area of the BWR nuclear-thermal-hydraulic stability. **Hiroshi Motoda** (center) (PhD, nuclear engineering, University of Tokyo, Japan, 1972) has worked for ten years in the area of the core management optimization for BWRs at Energy Research Laboratory, Hitachi, Ltd. He is currently working on a knowledge-based system for reactor operator guidance. **Mitsutaka Watanabe** (bottom) (BS, nuclear engineering, Tohoku University, Japan, 1979) is on the staff of the Consulting Engineering Section, Hitachi Engineering, Ltd. He is currently working at the Power Reactor and Nuclear Fuel Development Corporation on liquid-metal fast breeder reactor dynamic analysis. His current interest includes fast breeder reactor safety.