



AUTHORS — NOVEMBER 1987

NUCLEAR POWER PLANTS FOR GENERATION OF HEAT

HTR-100 INDUSTRIAL NUCLEAR POWER PLANT FOR GENERATION OF HEAT AND ELECTRICITY

Siegfried Brandes (top) [mechanical and nuclear engineering, 1964, and Dr.-Ing., nuclear engineering, 1966, Technische Hochschule, Aachen, Federal Republic of Germany (FRG)] joined Hochtemperaturreaktorbau 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 and project leader of the Development Consortium HTR-100. **Wolfgang Kohl** (PhD, physics, Heidelberg University, FRG, 1978) has been employed by Brown, Boveri & Cie AG, Mannheim, in the Department of Nuclear Project Management since 1978. From 1980 to 1984, he was one of the engineering managers for the 1300-MW nuclear power plant Mülheim-Kärlich. Later he was in charge of HTR-100.

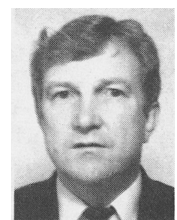
*Siegfried Brandes
Wolfgang Kohl*



DESIGN PRINCIPLES OF A SIMPLE AND SAFE 200-MW(thermal) NUCLEAR DISTRICT HEATING PLANT

Claus Goetzmann (top) [Dipl.-Ing., electrical engineering, Technische Hochschule, Aachen, Federal Republic of Germany (FRG), 1960] participated in safety analyses for D₂O and CO₂ reactors at Siemens Reactor Division from 1960 through 1964. He then joined General Atomic Company, San Diego, California, to perform research and development work for gas-cooled thermal and fast reactors. In 1969, he returned to the FRG to manage the Siemens/Kraftwerk Union (KWU) gas-cooled fast reactor program until its termination in 1979. He is currently subdivision manager for advanced reactor concepts, being responsible for the development of large tight lattice high-conversion pressurized water reactors and dedicated small reactors for supplying district heat. His special professional interest concerns the relationship between size and costs of various reactor types. **Dietmar Bittermann** (bottom) (Dipl.-Ing., mechanical engineering, Technische Hochschule, Darmstadt, FRG, 1970) joined Siemens in 1970. For the development of the gas-cooled fast reactor, he worked on the design of steam generators, blowers, and steam cycles and on plant safety and reliability analyses. From 1977 to 1980, he was a member of KWU's project management teams for the nuclear power plant (NPP) Isfahan 1/2 and NPP 4/5, Brazil, where he participated in the coordination of the technical proposal, safety analysis reports, and manufacturing of heavy components. In 1980, he began

*Claus Goetzmann
Dietmar Bittermann
Andreas Göbel*



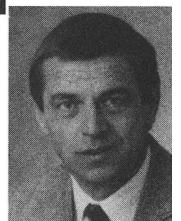
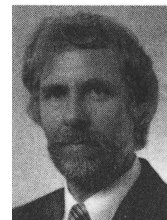
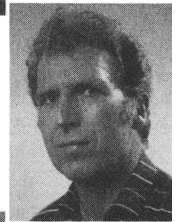
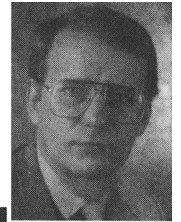
work on the development of advanced light water reactor (LWR) concepts. Since 1982, he has been department manager of small reactors, his main task being the coordination of the development of the heating reactor. **Andreas Göbel** (right) (Dipl.-Ing., process engineering, Technische Universität, Braunschweig, FRG, 1982) joined KWU immediately after obtaining his degree. He has participated in design and safety analysis work for the heating reactor, and his main task is the development and coordination of the safety concept for this novel LWR application heating reactor.



ASSESSMENT OF SAFETY-RELEVANT ASPECTS OF KRAFTWERK UNION'S 200-MW(thermal) NUCLEAR DISTRICT HEATING PLANT CONCEPT

Peter Erlenwein (top right) [PhD, Technical University of Berlin, Federal Republic of Germany (FRG), 1977] joined the Gesellschaft für Reaktorsicherheit (GRS), Garching, FRG, in 1978, where he worked in the field of safety analyses for nuclear reactors and fuel cycle facilities. Currently, he is working for the research management division of GRS. **Willi Frisch** (top left) (Dipl. Ing., electrical engineering, Technical University of Darmstadt, FRG; Dr. Ing., nuclear engineering, Technical University of Karlsruhe, FRG) has more than 20 years of professional experience in reactor dynamics and safety analyses at Kernforschungszentrum Karlsruhe, Westinghouse, and GRS. Presently, he is engaged in code development and safety analysis for light water reactors (LWRs) in national and international projects as head of the Reactor Dynamics Section of GRS. **Peter Kafka** (center right) (MS, mechanical engineering, 1961; PhD, Technical University of Graz, Austria, 1967) joined the Siemens/Kraftwerk Union AG, Erlangen, FRG, reactor development in 1962. There he worked in systems engineering and thermohydraulics for 9 years. Since 1971, he has been working for GRS in the field of reliability and risk analysis. His broad experience and interests lie mainly in development and application of probabilistic methods for various nuclear systems. **Rudolf E. Kirmse** (bottom left) (PhD, mechanical engineering, Technical University of Munich, FRG, 1976) earned his PhD through experimental investigations of pulsating turbulent flow with a laser-Doppler anemometer. He joined the GRS in 1977, where he worked in the fields of thermohydraulic research and licensing of nuclear LWRs. His current technical interest is accident analysis. **Siegfried Langenbuch** (bottom right) (Dipl. Phys., theoretical physics, Ludwig-Maximilian University, Munich, FRG, 1969; Dr. rer. nat., Technical University of Munich, FRG, 1976) has, since 1970, worked for the LRA and then the GRS. He is working in the field of code development for static and transient LWR core models and is engaged in safety review of nuclear and thermal design for various national and international projects.

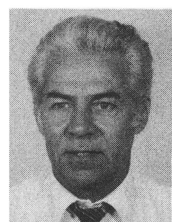
*Peter Erlenwein
Willi Frisch
Peter Kafka
Rudolf E. Kirmse
Siegfried Langenbuch*



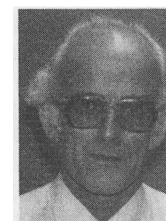
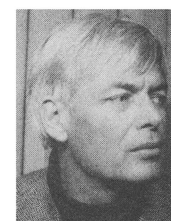
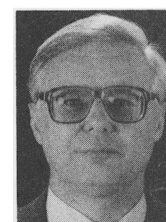
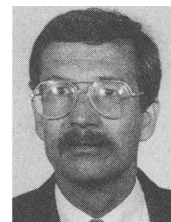
THE SWISS HEATING REACTOR FOR DISTRICT HEATING OF SMALL COMMUNITIES

Peter Burgsmüller (right) [MS, aerodynamics, Technical University of Munich, Federal Republic of Germany (FRG), 1960] joined the nuclear department of Sulzer Brothers Limited in 1965, working on core thermohydraulics of CO₂-cooled reactors. From 1969 to 1974, he headed the safety analysis group

*Peter Burgsmüller
Andreas Jacobi, Jr.
Jean-François Jaeger
Max J. Kläntschi
Walter Seifritz
François Vuilleumier
Ferdinand Wegmann*



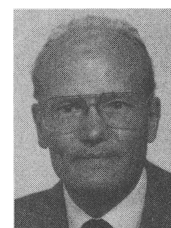
within the European Gas-Cooled Breeder Association in Brussels. Since 1975, he has been responsible for the coordination of Sulzer's high-temperature gas-cooled reactor activities and is now manager of advanced reactor systems. **Andreas Jacobi, Jr.** (top right) [MSc, mechanical engineering, Swiss Federal Institute of Technology (EIR), Zurich, Switzerland, 1969] is an assistant vice president of Electrowatt Engineering Services, Ltd. He has been acting as the task force head for safety and licensing for the Swiss Heating Reactor (SHR) project. He is presently studying safety and reliability of several nuclear installations. **Jean-François Jaeger** (top left) (MA, mechanical sciences, and PhD, electrical engineering, London, 1961) works in safety and dynamic analysis and control of reactors and steam generators at English Electric Company, Whetstone and Sulzer Bros. AG, Winterthur, Switzerland. He joined the Fusion Technology Group at EIR in 1978 and has been involved in the stress analysis of the large coil task, in fusion blanket design, liquid-metal fast breeder reactor stress analysis, and heating reactor shielding. **Max J. Kläntschi** (second from top right) (Dipl.-Eng., mechanical engineering, Eidgenössische Technische Hochschule, Zurich, Switzerland, 1946; further studies, nuclear technology and radiation protection, Eidgenössische Technische Hochschule, Switzerland, 1963) has served as project manager for Motor-Columbus Consulting Engineers, Inc. for nuclear power plants such as Lauberg (heavy water), Muhleberg (boiling water), and Kaiseraugst (boiling water) in Switzerland. He is currently a technical representative for electrical utilities, manufacturers, and consulting engineering firms in Europe and the United States. He is responsible for the work from the initial inquiry up to and including completion of contracts for nuclear and conventional power stations, construction surveillance, and delivery. **Walter Seifritz** (second from top left) (Dr. Ing., nuclear technology, University of Hanover, FRG) is head of the Physics Division at EIR. Since 1964, he has been engaged in research on reactor noise analysis, reactor physics and dynamics, general energy problems, hydrogen energy, and nuclear fusion. He has worked with the Kernforschungszentrum Karlsruhe, the University of Hanover, and the Organization for Cooperation and Development Halden Reactor Project. His current research interests include the role of nuclear fission energy in the heat market. **François Vuilleumier** (bottom right) (MSCE, 1968, and PhD, 1978, civil engineering, EIR) is head of the Department for Geotechnical and Foundation Engineering at Bonnard & Gardel Consulting Engineers, Ltd., Lausanne, Switzerland. He has served as manager of several projects including the Helium High-Temperature Reactor and the SHR (10- and 50-MW nuclear power plants for heating purposes). **Ferdinand Wegmann** (bottom left) (mechanical engineering, Ingenieurschule Munich, FRG, 1948) is a senior project engineer at BBC Brown, Boveri AG, Baden, Switzerland. He worked in the project management groups for the sale and erection of two Swiss nuclear power stations (one twin pressurized water reactor and one boiling water reactor).



THE SECURE HEATING REACTOR

Christen Pind (MS, mechanics, Technical University of Denmark, 1951) is a senior engineer at ASEA-ATOM. He was manager of process systems engineering and manager for the startup of the Oskarshamn 1 nuclear power plant and is currently project leader for the SECURE-H reactor. His interests include systems design, thermal hydraulics, and safety.

Christen Pind



DESIGN AND TESTING OF THE REACTOR-INTERNAL HYDRAULIC CONTROL ROD DRIVE FOR THE NUCLEAR HEATING PLANT

*Pramod Batheja
Werner Jakob Meier
Peter Josef Rau*



Pramod Batheja (top) [MS, chemical engineering, Friedrich Alexander University, Erlangen, Federal Republic of Germany (FRG), 1978] joined Kraftwerk Union AG (KWU) in 1978. He has worked on the analysis of short-term transients in boiling water reactors and on the development and economic analysis of new coal gasification processes, especially those utilizing process energy from nuclear reactors. He is presently involved in the development of a dedicated nuclear reactor for district heating purposes and is responsible for the research and development of the hydraulically driven control rod drive system. **Werner Jakob Meier** (center) (MS, mechanical engineering, Fachhochschule Nürnberg, FRG, 1977) has been employed at KWU, Erlangen, FRG, since 1978. His major tasks concern the design of reactor pressure vessel internals including control rod drive mechanisms and alternative shutdown systems of a gas-cooled breeder reactor. Since 1982 he has worked on the development of the hydraulic control rod drive mechanism for a heating reactor. He is also involved in the design of test samples of fuel rod storage, high-pressure coal gasifier, and ultraviolet-excimer laser development. **Peter Josef Rau** (bottom) (MS, mechanical engineering, Ohm Polytechnikum Nürnberg, FRG, 1965) joined Siemens (now KWU) nuclear reactor development in Erlangen, FRG, in 1965. He was engaged in the mechanical design of primary systems of water and gas-cooled reactors, test facilities, and test samples. Since 1983 he has concentrated on heating reactors and hydraulic control rod drives.



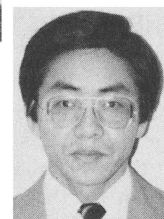
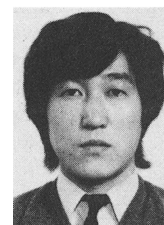
FISSION REACTORS

OPTIMIZATION OF FUEL EXCHANGE MACHINE OPERATION FOR BOILING WATER REACTORS USING AN ARTIFICIAL INTELLIGENCE TECHNIQUE

*Koichi Sekimizu
Tsuneyasu Araki
Shin-ichiro Tatemichi*



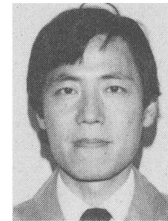
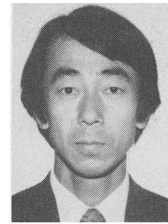
Koichi Sekimizu (top) (PhD, nuclear engineering, Tokyo Institute of Technology, Japan, 1979) has worked at the Nippon Atomic Industry Group Nuclear Research Laboratory since 1971. He has worked on fuel management optimization research and development of the on-line reactor core prediction system. In his current position, he is focusing on applications of artificial intelligence techniques to nuclear power plant operation. **Tsuneyasu Araki** (center) (MS, nuclear engineering, Osaka University, Japan, 1980) has been employed at the Nippon Atomic Industry Group Nuclear Research Laboratory since 1980, where he has worked on the development of the load following system. He is presently working in the field of reactor core analysis during fuel exchange. **Shin-ichiro Tatemichi** (bottom) (BS, nuclear engineering, Tokyo University, Japan, 1974) is deputy manager of the reactor design engineering department at Toshiba Corporation. He has worked in the fields of core management and nuclear technology development. He is currently responsible for core and fuel design and licensing.



CAORSO LIMIT CYCLE OSCILLATION ANALYSIS WITH THREE-DIMENSIONAL TRANSIENT CODE TOSDYN-2

Yukio Takigawa (top right) (BS, physics, University of Tokyo, Japan, 1973) is a researcher at the nuclear research laboratory of Nippon Atomic Industry Group Company, Limited (NAIG), where he works on transient and stability code development and analysis. **Yutaka Takeuchi** (top left) (MS, nuclear engineering, University of Kyoto, Japan, 1982) is a research engineer at the NAIG nuclear research laboratory, where he works on three-dimensional stability analysis. **Shigeaki Tsunoyama** (center right) (BS, physics; PhD, nuclear engineering, University of Tokyo, Japan, 1985) is a senior researcher at the NAIG nuclear research laboratory, where he is primarily engaged in the development of safety and dynamics methods. **Shigeo Ebata** (center left) (MS, electrical engineering, University of Nagoya, Japan, 1975) is an engineer in the Reactor Control and Dynamics Section of Toshiba Corporation, where he works on the transient analysis and system design of boiling water reactors (BWRs). **Kai C. Chan** (bottom right) (BS, Northwestern University; PhD, nuclear engineering, University of California-Berkeley, 1979) works in the safety and thermal-hydraulic methods group at General Electric Company in San Jose, California. **Carlo Tricoli** (bottom left) (technical degree, nuclear engineering, University of Rome, Italy, 1980) worked at Ansaldo SpA in Genova, Italy, where he was involved in BWR core design and operation, as well as dynamics method development. He also attended training and international meetings on reactor noise and participated in nuclear tests to investigate the dynamic response of the Caorso BWR nuclear plant. He currently works for the European Nuclear Energy Agency-DISP, Rome, Italy, where he is concerned with reactor core performance and safety. He also collaborates with the University of Rome in the reactor physics field.

*Yukio Takigawa
Yutaka Takeuchi
Shigeaki Tsunoyama
Shigeo Ebata
Kai C. Chan
Carlo Tricoli*



PROBABILISTIC FRACTURE EVALUATION OF A FAST BREEDER REACTOR COVER

Sadao Hattori (top) (MS, nuclear engineering, Tokyo Institute of Technology, Japan, 1959; graduate, Reactor Hazard Evaluation Course, Oak Ridge National Laboratory, 1960) has had experience in design, safety, and licensing of light water reactors for the Chubu Electric Power Company, and in design, licensing, and construction of the Fugen nuclear power plant for the Power Reactor and Nuclear Fuel Development Corporation. He is currently director of the liquid-metal fast breeder reactor (LMFBR) research project at the Central Research Institute of Electric Power Industry of Japan. **Norihiko Handa** (MS, nuclear engineering, Tokyo University, Japan, 1976) is a senior engineer in the Department of Advanced Reactor Engineering, Toshiba Corporation. He has worked on probabilistic safety and on seismic and structural analysis. He is presently working on the overall plant design of an LMFBR.

*Sadao Hattori
Norihiko Handa*

