

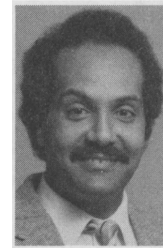
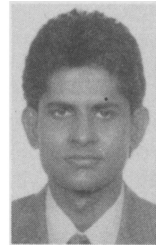
AUTHORS — JUNE 1990

RELAP/MOD2

MODELING AND LOSS-OF-COOLANT ACCIDENT ANALYSIS OF A NUCLEAR POWER PLANT USING RELAP5/MOD2

Parvez Salim (top) (BSc, mechanical engineering, Aligarh Muslim University, India, 1985; MS, nuclear engineering, Texas A&M University, 1989) is a graduate student in nuclear engineering at Texas A&M University. He has been working on the computational and modeling aspects of the thermal hydraulics of nuclear reactor systems. **Yassin A. Hassan** (BS, nuclear engineering, University of Alexandria, Egypt, 1968; MS, nuclear engineering, University of Illinois, 1975; MS, mechanical engineering, University of Virginia; PhD, nuclear engineering, University of Illinois, 1979) is on the faculty of the Department of Nuclear Engineering at Texas A&M University. He was previously with Babcock & Wilcox for 7 years. His interests include computational and experimental fluid flow, two-phase flows, and nuclear reactor safety.

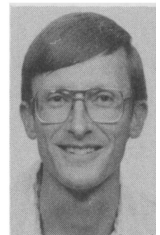
*Parvez Salim
Yassin A. Hassan*



PUMP CAVITATION IN SAVANNAH RIVER REACTORS DURING LOSS-OF-COOLANT ACCIDENTS

Cliff B. Davis (BS, mathematics, Utah State University, 1973; MS, mechanical engineering, University of Idaho, 1981) is a senior engineering specialist at the Idaho National Engineering Laboratory. Since 1973, he has been involved in thermal-hydraulic analysis of nuclear systems, including experimental and commercial reactors. His current interest is in the analysis of the production reactors at Savannah River.

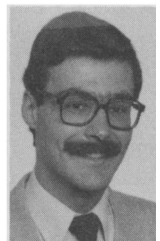
Cliff B. Davis



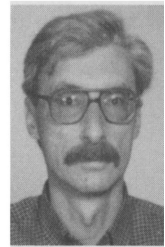
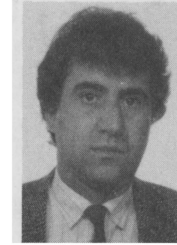
TRANSIENT ANALYSIS IN THE ASCÓ NUCLEAR POWER PLANT USING RELAP5/MOD2

Francesc Reventós (left) (Dr. Eng., nuclear engineering, National Polytechnic Institute of Grenoble, France, 1982) has worked in the nuclear field since 1975. His current professional responsibility is plant dynamics analysis. He is also an associate professor in thermal hydraulics of nuclear systems at the Polytechnic University of Catalunya. **José Sánchez-Baptista** (right) (nuclear engineering, Polytechnic University of Barcelona, Spain,

*Francesc Reventós
José Sánchez-Baptista
Alberto Pérez Navas
Pablo Moreno*



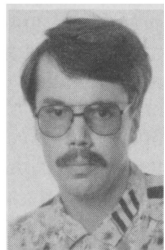
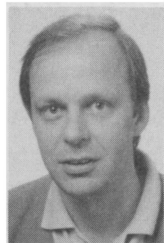
1979) worked on licensing and radwaste systems for the Ascó nuclear power plant design. He is now involved in plant dynamics analysis, thermal-hydraulic studies, and the Ascó reracking project. **Alberto Pérez Navas** (top) [MSc, nuclear engineering, Massachusetts Institute of Technology (MIT), 1976] is responsible for the nuclear fuel management and engineering team for the Ascó nuclear power plant, and he is now developing a model for dynamic analysis of that plant. He has also worked on neutronics, thermal-hydraulics, and economics aspects of nuclear power. **Pablo Moreno** (bottom) (nuclear engineering, MIT, 1976; Dr. Ing. Ind., Escuela Tecnica Superior de Ingenieros Industriales, Spain, 1980) is director general of Pablo Moreno S.A. His research interests include thermal-hydraulic core and system analysis simulation, neutron noise analysis, numerical modeling of atmospheric processes, and wind energy studies.



APPLICATION OF RELAP5/MOD2 TO LOVIISA NUCLEAR POWER PLANT OVERCOOLING TRANSIENTS

Heikki Kantee (top) [MS, mechanical engineering, Helsinki University of Technology (HUT), Finland, 1977] has been a nuclear safety engineer at Imatran Voima Oy (IVO) since 1985. He previously worked in the Nuclear Engineering Laboratory at the Technical Research Center of Finland (VTT) as a research engineer. Currently he is mainly involved in performing accident analyses for IVO's Loviisa plants. **Harri Tuomisto** (center) (Dr. Tech., 1988, and MS, 1976, engineering physics, HUT, Finland) is a safety analysis group leader at IVO. His current activities include severe accident management research, accident analyses, and thermal-hydraulic experiments. **Vesa Yrjölä** (bottom) (MS, mechanical engineering, Lappeenranta University of Technology, Finland, 1975) has been a senior research engineer in the Nuclear Engineering Laboratory at VTT since 1974. He has worked in the areas of experimental facilities and instrumentation. His current work is mainly in accident analyses.

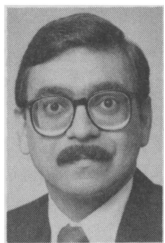
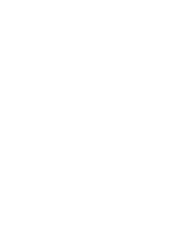
*Heikki Kantee
Harri Tuomisto
Vesa Yrjölä*



THE RELAP5-FORCE MOD2 CODE, A HYDRODYNAMIC FORCING FUNCTION CALCULATION VERSION OF RELAP5

Juan M. Cajigas (BS, chemical engineering, 1973, and MS, nuclear engineering, 1975, University of Puerto Rico) is a senior engineering consultant with Gilbert/Commonwealth, where for 10 years he has been a member of the applied engineering analysis group. His primary responsibilities include the application of thermal-hydraulic and heat transfer methods and computer codes as related to nuclear power plant design and operation. His current interests include the development and application of microprocessor-based computer codes for thermal-hydraulic evaluation of fluid transients with emphasis on water hammer analysis.

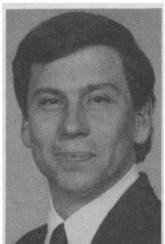
Juan M. Cajigas



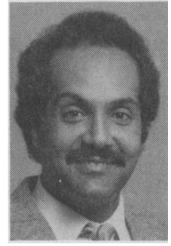
A COMPARISON STUDY OF THE WESTINGHOUSE MODEL E STEAM GENERATOR USING RELAP5/MOD2 AND RE-TRAN-02 COMPUTER CODES

Thomas K. Blanchat (right) (BS, 1987, and MS, 1988, nuclear engineering, Texas A&M University) is a graduate student of nuclear engineering at Texas A&M University. His research areas include heat transfer correlations used in reactor transient analysis codes and determining interfacial drag by quantitative flow

*Thomas K. Blanchat
Yassin A. Hassan*



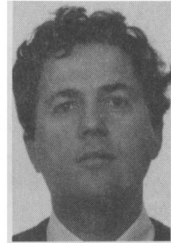
visualization using pulsed laser velocimetry. **Yassin A. Hassan** (right) (BS, nuclear engineering, University of Alexandria, Egypt, 1968; MS, nuclear engineering, University of Illinois, 1975; MS, mechanical engineering, University of Virginia; PhD, nuclear engineering, University of Illinois, 1979) is on the faculty of the Department of Nuclear Engineering at Texas A&M University. He was previously with Babcock & Wilcox for 7 years. His interests include computational and experimental fluid flow, two-phase flows, and nuclear reactor safety.



ASSESSMENT OF THE RELAP5/MOD2 CODE ON THE BASIS OF EXPERIMENTS PERFORMED IN THE LOBI FACILITY

*Francesco D'Auria
Giorgio Maria Galassi*

Francesco D'Auria (top) [deg., nuclear engineering, 1978, and postdoctoral deg., nuclear reactor safety, 1980, University of Pisa (UP), Italy] is an assistant professor at UP. His research interests include nuclear reactor thermal hydraulics, especially the assessment of system codes and the design and analysis of experiments performed in large-scale facilities. **Giorgio Maria Galassi** (deg., nuclear engineering, 1980, and PhD, nuclear reactor safety, 1987, UP) is a senior engineer at "Regione Toscana" in Florence. His research interests include the assessment of large system codes and environmental modeling.

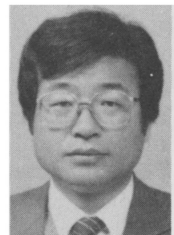
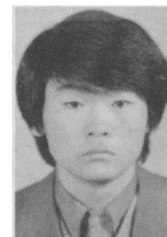
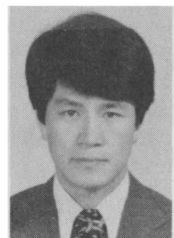
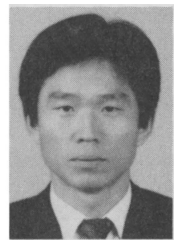
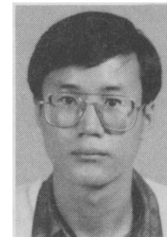


FISSION REACTORS

FISA-2/WS, A COMPACT REAL-TIME SIMULATOR FOR TWO-LOOP PRESSURIZED WATER REACTOR PLANTS

*Jae Jun Jeong
Deog Yeon Oh
Hee Cheon No
Soon Heung Chang
Sung Jae Cho
Hwang Yong Jun
Yong Kwan Lee*

Jae Jun Jeong (top right) [MS, nuclear engineering, Korea Advanced Institute of Science and Technology (KAIST), 1986] is a PhD candidate at KAIST. His current interests include modeling of power plant system dynamics and numerical simulation of engineering problems. **Deog Yeon Oh** (top left) (MS, nuclear engineering, KAIST, Korea, 1987) is in the PhD program at KAIST. His research interests include computer graphics, instrument failure detection, space-time nuclear reactor kinetics, and optimal detector location in nuclear reactors. **Hee Cheon No** (center right) [PhD, nuclear engineering, Massachusetts Institute of Technology (MIT), 1983] is an associate professor in the Department of Nuclear Engineering at KAIST. His current research areas include fundamentals of two-phase flow, thermal-hydraulic safety analysis of light water reactors, and application of modern control theory to nuclear power plants. **Soon Heung Chang** (center left) (PhD, nuclear engineering, MIT, 1981) is an associate professor in the Department of Nuclear Engineering at KAIST. His research activities include nuclear reactor thermal hydraulics, probabilistic risk assessment, and computer-aided operation. **Sung Jae Cho** (bottom right) (MS, nuclear engineering, Seoul National University, Korea, 1983) is a principal researcher in the Nuclear Division, Research Center, Korea Electric Power Corporation (KEPCO). He is responsible for accident analysis and development of microsimulators for power plant operator training. He is also in the PhD program at KAIST. **Hwang Yong Jun** (bottom left) (MS, nuclear engineering, KAIST, Korea, 1987) is a senior researcher in the Research Center at



KEPCO. He has worked in the area of nuclear power plant accident analysis since 1984. He is currently involved in the international Cathare code assessment group in Grenoble, France. **Yong Kwan Lee** (right) (BS, physics, Yon-Sei University, Korea, 1975) is a senior engineer in the Research Center at KEPCO. He has been engaged in planning and has been a training instructor of nuclear power plant simulators since 1979. His current interests include the development of microsimulators.

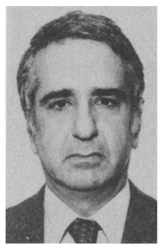
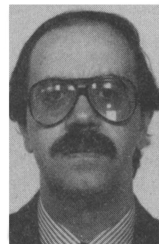


NUCLEAR SAFETY

AN ANALYSIS OF THE PHYSICAL CAUSES OF THE CHERNOBYL ACCIDENT

José M. Martínez-Val (top right) [MSc, 1973, and PhD, 1977, nuclear engineering, Madrid Polytechnic University (UPM), Spain] is a professor of nuclear technology and vice director of the Institute of Nuclear Fusion at UPM. He is a former president of the Spanish Nuclear Society and former member of the European Nuclear Society Steering Committee. His current interest is neutronics of both fission and fusion systems. **José M. Aragonés** (top left) (BS and MS, 1969, industrial engineering, and PhD, 1977, nuclear engineering, UPM, Spain) is a professor and head of the nuclear engineering department at UPM. His interests are in the development of methods and codes for light water reactor fuel management and core design and for physics of inertial confinement fusion (ICF). **Emilio Mínguez** (center right) (BS, 1973, and PhD, 1981, nuclear engineering, UPM, Spain) is an associate professor of nuclear engineering in the Institute of Nuclear Fusion at UPM. He was a research scientist at the Spanish Nuclear Centre from 1973 to 1981 in the area of nuclear reactor physics. His interests include theoretical analysis of targets for ICF and the development of computer codes related to atomic processes in hot dense matter. **José M. Perlado** (bottom left) (MSc, 1973, and PhD, 1980, nuclear engineering, UPM, Spain) is a professor of nuclear physics at UPM. His main interests are neutron transport theory, ICF, and material damage in fusion environments. **Guillermo Velarde** (bottom right) (PhD, aeronautical engineering, UPM, Spain) is chair of nuclear physics at UPM and director of the Institute of Nuclear Fusion. He has worked in neutron transport theory and ICF.

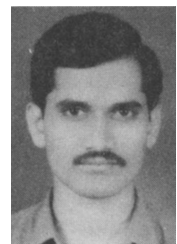
*José M. Martínez-Val
José M. Aragonés
Emilio Mínguez
José M. Perlado
Guillermo Velarde*



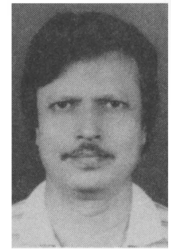
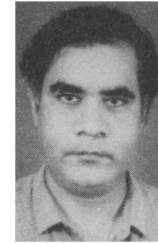
OPTIMIZATION OF EDDY-CURRENT PROBES FOR DETECTION OF GARTER SPRINGS IN PRESSURIZED HEAVY WATER REACTORS

Bhagi Purna Chandra Rao (top) (deg., metallurgical engineering, Andhra University, India, 1985) joined Indira Gandhi Center for Atomic Research (IGCAR) in India in 1986. He is currently engaged in pre- and in-service inspection of nuclear components and numerical modeling of eddy-current nondestructive testing (NDT) phenomena. **Mandayam Tondanur Shyamsunder** (bottom) (deg., metallurgical engineering, Maharaja Sayajirao University, India, 1983) has been a scientific officer with IGCAR since 1984. He is engaged in research and development (R&D) on eddy-current testing, image analysis, laser holography, and

*Bhagi Purna Chandra Rao
Mandayam Tondanur Shyamsunder
Dipak Kumar Bhattacharya
Baldev Raj*



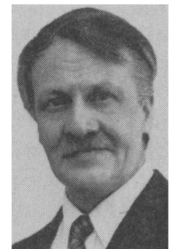
pre- and in-service inspection of nuclear components. **Dipak Kumar Bhattacharya** (top) (deg., metallurgical engineering, University of Calcutta, India, 1969) is head of the R&D Section, Division for Postirradiation Examination (PIE) and NDT Development, IGCAR. He joined Bhabha Atomic Research Center (BARC) in India in 1970 and has worked on PIE of nuclear fuels. Since 1974, he has worked at IGCAR on the development of nondestructive evaluation (NDE) techniques for pre- and in-service inspection of nuclear components, mainly in radiography, eddy-current testing, and magnetic methods. **Baldev Raj** (bottom) (deg., metallurgical engineering, Ravishanker University, India, 1969) is head of the Division for PIE and NDT Development at IGCAR. He joined BARC in 1970 and came to IGCAR in 1974. He specializes in advanced NDE techniques, failure analysis, and structural integrity evaluation.



EXPERIMENTAL VERIFICATION OF HYGROSCOPIC AEROSOL GROWTH IN REACTOR ACCIDENT CONDITIONS

Jorma Jokiniemi (top) (MS, 1984, and PhD, 1990, physics, University of Helsinki, Finland) is a scientist in the Nuclear Engineering Laboratory at the Technical Research Center of Finland, where he has been involved in the field of fission product release and transport from a degraded light water reactor core for the past 6 years. **Kimmo Koistinen** (center) (MS, environmental sciences, University of Kuopio, Finland, 1990) is a scientist in the Laboratory for Atmospheric Physics and Chemistry at the University of Kuopio, where he has studied the behavior of hygroscopic aerosols during the past 3 years. **Taisto Raunemaa** (bottom) (deg., physics, University of Helsinki, Finland, 1975) is an associate professor in environmental sciences at the University of Kuopio, Finland. Since 1975, he has been working in the fields of nuclear physics, analytical chemistry, atmospheric science, and energy problems. He is currently acting head of the Department of Environmental Health at the University of Kuopio and its Laboratory for Atmospheric Physics and Chemistry.

*Jorma Jokiniemi
Kimmo Koistinen
Taisto Raunemaa*

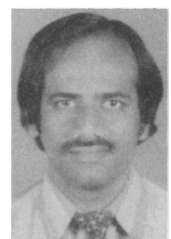
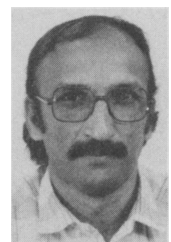
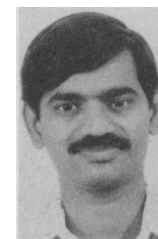


MATERIALS

AN ELECTROCHEMICAL HYDROGEN METER FOR MEASUREMENT OF DISSOLVED HYDROGEN IN LIQUID SODIUM

Thiagarajan Gnanasekaran (top) (MSc, chemistry, 1973, and PhD, chemistry, 1988, University of Madras, India) has been with the Indira Gandhi Center for Atomic Research (IGCAR) since 1974. He has worked in the chemistry of alkali metals in areas related to the development of on-line monitors and with thermodynamics of binary and ternary systems involving alkali metals and sodium batteries. His present interests include the development of ceramic sensors. He was a guest scientist at Kernforschungszentrum Karlsruhe (KfK) from 1979 to 1981. **Kandhalu Hari Mahendran** (center) (MSc, chemistry, Annamalai University, India, 1988) has been with IGCAR since 1983. He has worked in the chemistry of alkali metals with a special emphasis on the development of on-line meters and studies on ternary oxides of sodium. **Raghavachary Sridharan** (bottom) (MSc, chemistry, Indian Institute of Technology, India, 1979)

*Thiagarajan Gnanasekaran
Kandhalu Hari Mahendran
Raghavachary Sridharan
Vedaraman Ganesan
Govindaswami Periaswami
Cherian K. Mathews*



has been with IGCAR since 1980. His research work includes the development of on-line meters for nonmetallic impurities in liquid sodium and the thermodynamic aspects of ternary oxides that are important in sodium corrosion. **Vedaraman Ganesan** (top) (MSc, chemistry, University of Madras, India, 1974) has been with IGCAR since 1975. He has worked on the design and development of operating sodium systems, the development of on-line monitors, and the chemistry of sodium and potassium systems. He was a delegate to KfK and Interatom from 1983 to 1985. He is currently engaged in the study of activity transport in fast reactor coolant circuits. **Govindaswami Periaswami** (center) (PhD, chemistry, University of Madras, India, 1989) is a chemist in the radiochemistry program at IGCAR. In addition to sodium coolant chemistry, his current interests include the development of sensors and sodium batteries. **Cherian K. Mathews** (bottom) (PhD, chemistry, McMaster University, Canada, 1964) was previously with the Bhabha Atomic Research Center and is currently at IGCAR where he is head of the radiochemistry program. His research interests include the chemistry of fast reactor materials, especially fuel and liquid sodium.



HEAT TRANSFER AND FLUID FLOW

A COMPARISON OF PREDICTION AND TAPUCU EXPERIMENTAL DATA FOR DETERMINATION OF THE AXIAL VELOCITY IN THE GAP REGION

A. Cihat Baytaş (BSc, mechanical engineering, 1981; MSc, 1984, and PhD, 1988, nuclear engineering) is a research assistant at the Institute for Nuclear Energy, Istanbul Technical University. His current interests include thermal-hydraulic analysis of water reactors, heat transfer, and modeling of natural convection systems.

A. Cihat Baytaş

