



## AUTHORS — JULY 1984

### PLASMA HEATING SYSTEMS

#### RADIO-FREQUENCY-ASSISTED CURRENT STARTUP IN THE FUSION ENGINEERING DEVICE

**Stanley K. Borowski** (top) [PhD, nuclear engineering, University of Michigan (UM), 1983] joined the Fusion Energy Division of Oak Ridge National Laboratory (ORNL) as a scientific staff member with the Fusion Engineering Design Center (FEDC). His research work has included tokamak power reactor studies and ring power balance assessments for the ELMO Bumpy Torus concept. Present research activities involve the study and computational modeling of both inductive and noninductive modes of current startup in tokamak plasmas. **Y-K. Martin Peng** (center) (BS, electrical engineering, National Taiwan University, 1967; MS, 1971, and PhD, 1974, applied physics, Stanford University) is a member of the Fusion Energy Division at ORNL and the manager of the Plasma Engineering Branch of FEDC. His research efforts include plasma engineering studies of both advanced tokamak and tandem mirror reactor concepts. **Terry Kammash** (bottom) (BS, aeronautical engineering, Pennsylvania State University, 1952; PhD, nuclear engineering, UM, 1958) served as a consultant on controlled fusion research at Lawrence Livermore National Laboratory, Argonne National Laboratory, ORNL, and Battelle Pacific Northwest Laboratories.

*Stanley K. Borowski  
Y-K. Martin Peng  
Terry Kammash*



### PLASMA ENGINEERING

#### NONSPHERICAL PELLET ABLATION IN TOKAMAK PLASMA

**Gerardo G. Zavala** (top) [BS, chemical engineering, University of Guanajuato, Mexico, 1977; MS, nuclear engineering, University of Michigan (UM), 1983] is currently a doctoral student in nuclear engineering at the UM doing research in the area of pellet ablation in magnetically confined plasmas. **Terry Kammash** (BS, aeronautical engineering, Pennsylvania State University, 1952; PhD, nuclear engineering, UM, 1958) served as a consultant on controlled fusion research at Lawrence Livermore National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, and Battelle Pacific Northwest Laboratories.

*Gerardo G. Zavala  
Terry Kammash*



## COMPUTER SIMULATION ON DOUBLE LAYERS FOR INERTIAL-ELECTROSTATIC CONFINEMENT OF PLASMA

**Inki Oh** (top) (BS, 1960, and MS, 1962, Yonsei University; PhD, University of Colorado, 1970) is head of the Denver Nuclear Technology Division, Stone & Webster Engineering Corporation (SWEC). He is a registered professional nuclear engineer. He has been engaged in nuclear engineering work relative to criticality, shielding, nuclear safety, and electrostatic confinement of plasma. **William L. Schrader** (center) (BS, Colorado State University, 1960; MS, University of Idaho, 1969) is a nuclear scientist with SWEC. His work is in the field of criticality, shielding, radiation safety, and plasma engineering. He has 14 years of experience in this field. **Robert W. Bass** (bottom) (BA, 1950, and PhD, 1955, Johns Hopkins University; MA, Oxford University, 1952) is director and vice-president of Applied Fusion Research Corporation. He has 25 years of experience in the field of magnetic and inertial confinement of plasma including invention of Topolotron and Plasmasphere fusion reactors.

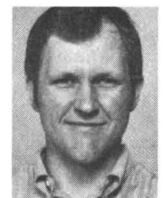
*Inki Oh  
William L. Schrader  
Robert W. Bass*



## NUMERICAL SIMULATION OF THE PLASMA CURRENT QUENCH FOLLOWING A DISRUPTIVE ENERGY LOSS

**Dennis J. Strickler** (top right) (MA, mathematics, University of Kentucky, 1973) is in the Computer Sciences Division (CSD) at Oak Ridge National Laboratory (ORNL). He is a member of the Plasma Engineering Branch of the Fusion Engineering Design Center (FEDC) and works in the areas of magnetohydrodynamic (MHD) equilibrium and stability applied to tokamak plasma magnetics and poloidal field coil design. **Y-K. Martin Peng** (top left) (BS, electrical engineering, National Taiwan University, 1967; MS, 1971, and PhD, 1974, applied physics, Stanford University) is a member of the Fusion Energy Division at ORNL and the manager of the Plasma Engineering Branch of FEDC. His research efforts include plasma engineering studies of both advanced tokamak and tandem mirror reactor concepts. **John B. Miller** (center right) (BS and M. Eng., nuclear engineering and science, Rensselaer Polytechnic Institute) has served in the U.S. Navy and worked for Wyle Laboratories. He is currently a student in the Fusion Engineering Program at the University of Tennessee. **Kristin E. Rothe** (bottom left) (BS, mathematics and physics, University of Wisconsin at River Falls, 1974) is a computer analyst in the CSD of ORNL. She is involved in MHD equilibrium calculations with applications to tokamak poloidal field system, tokamak system modeling, and computer coordinator for the FEDC, overseeing the Engineering Test Facility account with the National Magnetic Fusion Energy Computer Center. **Jeff A. Holmes** (bottom right) (PhD, physics, California Institute of Technology, 1976) is a computational physicist in the CSD at ORNL. He is a member of the MHD group with experience in equilibrium, stability, and resistive MHD calculations applied to tokamaks, stellarators, and reversed field pinch devices.

*Dennis J. Strickler  
Y-K. Martin Peng  
John B. Miller  
Kristin E. Rothe  
Jeff A. Holmes*



## THE REACTOR PLASMA PHYSICS OF TANDEM MIRROR STARTUP AND FRACTIONAL POWER OPERATION

**Robert W. Conn** (right) (PhD, California Institute of Technology, 1968) spent one year at the Joint Euratom Nuclear Research Center at Ispra, Italy, and a year at the Brookhaven National Laboratory before joining the University of Wisconsin (UW) in 1970. While at UW, he served as a professor of nuclear

*Robert W. Conn  
Farrokh Najmabadi  
Frank D. Kantrowitz  
Marc A. Firestone  
Dan M. Goebel  
Tak Kuen Mau*



engineering and as director of the Fusion Engineering Program. Since 1980, he has been a member of the University of California, Los Angeles (UCLA) faculty as a professor of engineering and applied science. His primary research interests include fusion reactor physics and technology, plasma physics, neutron transport and nuclear reactor physics, reactor plasma analysis, and surface physics. **Farrokh Najmabadi** (top right) (PhD, nuclear engineering, University of California, Berkeley, 1982) is currently a senior development engineer in the Fusion Engineering and Physics Program at (UCLA). His primary research interests are applied plasma physics and fusion research physics and technology. **Frank D. Kantrowitz** (top left) (PhD, UCLA, 1983) is currently working at Hughes Aircraft Company. His primary research interest is microwave tubes. **Marc A. Firestone** (center right) (PhD, physics, The University of Michigan, 1974) is a research staff member in the Fusion Engineering and Physics Program at UCLA. He is currently involved with physics system studies of tandem mirrors and tokamak reactors. From 1978 to 1982 he was at the Princeton Plasma Physics Laboratory where he worked on various physics issues impacting Tokamak Fusion Test Reactor and International Tokamak Reactor design concepts. He was a National Aeronautics and Space Administration contractor (Computer Science Corporation and OAO Corporation) from 1974 to 1978. In addition to the physics of fusion reactors, his research has included experimental nuclear physics, satellite orbital dynamics and control, and the application of modern optimal control theory to tokamak plasmas. **Dan M. Goebel** (bottom left) (PhD, electrical engineering, UCLA, 1981) is presently a principal development engineer in the Fusion Engineering and Physics Program at UCLA. For the past two years he has been employed at UCLA and TRW where he works on advanced neutral beam designs and fusion reactor studies. His primary areas of research include experimental plasma surface interaction studies and tokamak edge plasma diagnostics associated with a pump limiter experiment in the Federal Republic of Germany. **Tak Kuen Mau** (bottom right) (PhD, electrical engineering, UW, 1977) is currently an assistant research engineer in the Fusion Engineering and Physics Program at UCLA. He spent two years (1978/1979) as a research associate in the Nuclear Engineering Department at UW in Madison. His main research interests include wave propagation and heating in reactor plasmas, antenna design, radio-frequency current drive, and numerical modeling.



## SHIELDING

### DIRECT INTEGRATION METHOD FOR NUMERICAL SOLUTION OF THE RADIATION TRANSPORT EQUATION IN AXISYMMETRIC TOROIDAL GEOMETRY

**Toshio Ida** (top) [MS, nuclear engineering, University of Tokyo (UT), 1982] is enrolled in the doctor of engineering course at UT. His current interests include radiation transport analysis in complicated geometries and nuclear design of fusion reactors. **Shunsuke Kondo** (center) (Dr. Eng., nuclear engineering, UT, 1970) is an associate professor in the Department of Nuclear Engineering at UT. He has been active in R&D in various areas, including nuclear reactor core design, optimal programming, nuclear reactor safety analysis, system reliability, R&D policy analysis, etc. He has been involved in fusion reactor design study since 1973. **Yasumasa Togo** (bottom) (BS, 1951, and Dr. Eng., electrical engineering, UT) joined Japan Atomic Energy Research

*Toshio Ida  
Shunsuke Kondo  
Yasumasa Togo*



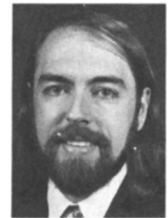
Institute in 1956 and worked on Japan Power Demonstration Reactor. He became an associate professor in the Department of Nuclear Engineering at UT in 1963 and a professor in 1968. His special field is reactor design and nuclear safety. Presently, he is a chairman of the advisory committee on nuclear power plants that reports to MITI.

## FUSION REACTORS

### TIME-DEPENDENT ENERGY DEPOSITION IN INERTIAL CONFINEMENT FUSION-FISSION HYBRID REACTORS

**Allen L. Camp** (top) [BS, 1976, and MS, 1977, nuclear engineering, University of Missouri-Rolla; PhD, nuclear engineering, University of New Mexico (UNM)] is a member of the technical staff in the Reactor Safety Technology Division at Sandia National Laboratories. He has worked in the light water reactor safety field as project leader for the hydrogen behavior program. His current research involves the analysis of postulated severe reactor accidents. **Gary W. Cooper** (PhD, nuclear engineering, University of Illinois, 1976) has been an assistant professor in chemical and nuclear engineering at the UNM since 1979. His present research interests include fusion reactor conceptual design studies, laser physics, and plasma chemistry.

*Allen L. Camp  
Gary W. Cooper*

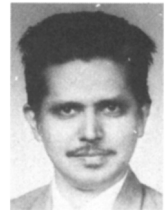


## BLANKET ENGINEERING

### NEUTRON MULTIPLICATION MEASUREMENT IN BeO FOR 14-MeV NEUTRONS

**Vijay R. Nargundkar** (top) (MSc, physics, Karnataka University, 1956; PhD, pulsed neutron studies, University of Bombay, 1966) has been working at Bhabha Atomic Research Centre (BARC) since 1957. He has worked in the field of fission physics at Atomic Energy of Canada, Limited, Chalk River, Canada (1961 and 1962), pulsed fast reactors at the Joint Institute for Nuclear Research, Dubna, Soviet Union (1972), and fusion blanket neutronics at the Institute of Reactor Development (IRD), Jülich, Federal Republic of Germany (FRG) (1977 and 1978). He has been the facility supervisor of the Purnima Critical Facility. His current interest is theoretical and experimental studies of fusion blanket neutronics. **Tejen Kumar Basu** (center) (BS, physics, Kurukshetra University, 1969; graduate, BARC Training School, 1970; PhD, physics, University of Bombay, 1980) has been associated with the experimental program of the Purnima fast reactor facility. He worked at the IRD, Jülich, FRG from 1977 to 1978 in fusion blanket neutronics. His current interests include neutron transport calculations in micropellets and the experimental investigation of neutron multipliers. **Om Prakash Joneja** (bottom) (MSc, Punjabi University, 1966; graduate, BARC Training School, 1967; PhD, physics, University of Bombay, 1976) has been actively working on fast neutron spectrometry and development of Monte Carlo codes. His present interest includes development of new experimental techniques for on-line measurement of tritium breeding in fusion blankets. He has worked at the IRD, Jülich, FRG, from 1972 to 1974 in the field of fast neutron spectrometry and recently, from 1979 to 1980 in

*Vijay R. Nargundkar  
Tejen Kumar Basu  
Om Prakash Joneja  
Madhukar Ramchandra Phiske  
Sripad Krishnaji Sadavarte*





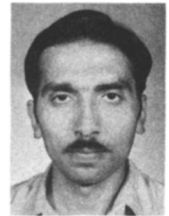
the same institute on  $\text{LiAlO}_2$  blanket assembly for measuring tritium production. **Madhukar Ramchandra Phiske** (top) (BS, physics, Pune University, 1956) joined BARC in 1961. He is associated with the experimental program using the 14-MeV neutron generator. **Sripad Krishnaji Sadavarte** (bottom) (BS, physics, Pune University, 1956) joined BARC in 1958 and has been associated with the design and construction of a deuterium-tritium neutron generator. His present interests include accelerators and ion sources.



#### NEUTRONICS ANALYSIS OF DEUTERIUM-TRITIUM-DRIVEN EXPERIMENTAL HYBRID BLANKETS

**Sümer Şahin** (top) (MS, mechanical engineering, 1967, and PhD, nuclear engineering, 1970, University of Stuttgart, Federal Republic of Germany; Habilitation, physics, University of Ankara, Turkey, 1973) is currently a professor at the King Saud University, Riyadh, Saudi Arabia. His research field covers fusion-fission (hybrid) reactors, thermionic space craft reactors, radiation shielding, and nonproliferation. **Anil Kumar** (BS, 1971, and MS, 1973, physics, Agra University, India; PhD, nuclear engineering, University of Bombay, 1981) is currently senior scientist at Ecole Polytechnique Federale de Lausanne, Switzerland. His main interest is in the field of fusion blanket neutronics with an emphasis on optimum utilization of  $^{232}\text{Th}$  in fusion-fission hybrid reactors.

*Sümer Şahin  
Anil Kumar*



#### AN ENGINEERING EVALUATION OF ORGANIC COOLANTS FOR TOKAMAK FUSION POWER REACTORS

**Jacob B. Romero** (BS, chemical engineering, University of New Mexico, 1954; PhD, University of Washington, 1959) worked in research for 11 years at the Boeing Company in the areas of advanced propulsion, cryogenics, and high power lasers. From 1966 to 1969, he was associate professor of chemical and nuclear engineering at the University of Idaho. He joined The Evergreen State College in 1972 where he is now professor of applied sciences. His current research interests are in applications of solar energy and in conceptual studies of fusion systems.

*Jacob B. Romero*



### MATERIALS ENGINEERING

#### TRANSPORT OF BERYLLIUM-7 IN A LITHIUM LOOP

**Hiroji Katsuta** (top) (PhD, engineering of metallic materials, Tohoku University, 1969) is a research scientist at the Molten Materials Laboratory, Japan Atomic Energy Research Institute. His interests are in nonmetallic impurity behavior in liquid metals and molten salts, the effect of impurities on compatibility, and hydrogen (tritium) permeation through metal membranes in contact with molten materials. **R. P. Anantatmula** (bottom) (PhD, engineering science, Washington State University, 1973) is a staff scientist in the Basalt Waste Isolation Project (BWIP) at Rockwell Hanford Operations. He was a task group leader at Westinghouse Hanford Corporation (WHC) involved in research on liquid sodium compatibility of fuel cladding/duct materials

*Hiroji Katsuta  
R. P. Anantatmula  
Rebecca A. Bechtold  
William F. Brehm*



for breeder reactors. His research at WHC also included radio-nuclide transport and inventories in liquid-metal systems, and liquid lithium compatibility of metallic materials. He is currently supervising research in the area of corrosion of nuclear waste container materials for the BWIP. **Rebecca A. Bechtold** (top) (BS, chemistry, Marietta College, 1967; PhD, inorganic chemistry, Tufts University, 1974; post-doctoral, organoboranes and homogeneous catalysis, Washington State University) is employed by the WHC and has worked in the field of liquid-metal technology since 1978. She was the lead investigator for the beryllium transport program and studies of lithium materials compatibility for three years. She was also a team member involved with developing decontamination processes for reactor components. Currently, she is the operations chemist at the Fast Flux Test Facility and is responsible for administering the sodium and cover gas monitoring program. **William F. Brehm** (bottom) (BS, metallurgy, Massachusetts Institute of Technology; MS and PhD, materials science, Cornell University) is presently manager of the Liquid Metals Systems Development Group at WHC. During his career at Battelle Pacific Northwest Laboratories and WHC, he conducted R&D programs on interactions of materials with sodium, lithium, pressurized water, and steam, with an emphasis on mass transport of radioactive materials in nuclear heat transport systems.



## PLASMA ENGINEERING

### HEAVY ION INJECTION FOR ELECTRIC FIELD GENERATION IN TOKAMAKS

**Wesley B. Downum** (top) (BA, physics, University of Colorado, 1973; PhD, physics, University of Illinois, 1981) has worked with the Oak Ridge National Laboratory Fusion Energy Program. In 1983 he moved to Bell Telephone Laboratories, and, with the breakup of the Bell System, to Bell Communications Research, Inc. He is currently developing computerized models to optimize use of the telephone network under heavy calling loads. **George H. Miley** (PhD, University of Michigan, 1958) is professor and chairman of the Nuclear Engineering Program at the University of Illinois. In addition to research on fusion, he is well known for his research on energy conversion and nuclear-pumped lasers.

*Wesley B. Downum  
George H. Miley*

