



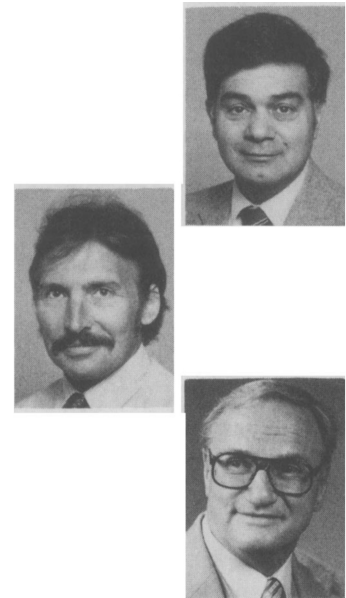
AUTHORS — NOVEMBER 1981

MATERIALS PERFORMANCE IN NUCLEAR STEAM GENERATORS

FABRICATION TECHNOLOGY—LIQUID-METAL FAST BREEDER REACTOR STEAM GENERATORS

C. N. Spalaris (top) (PhD, physical chemistry, Oregon State University, 1956) is manager of plant materials engineering, General Electric Company (GE), Advanced Reactor Systems Department, San Jose, California. He has been engaged in the nuclear industry for over 25 years, all with GE. His primary interests and experience have been the application, design, and fabrication of fuels and materials in boiling water, graphite-moderated, and liquid-metal fast breeder reactors (LMFBRs). **Peter J. Ring** (center) (BS, metallurgy, 1963, AMCST, University of Manchester; MsC, metallurgical engineering, 1965, ACT, Surrey University) has 14 years of experience in the nuclear energy industry in both the United Kingdom and the U.S. His early experience was directed toward irradiation effects on materials and the design and initiation of reactor experiments. For the last six years, he has been manager of a group at GE, San Jose. He is responsible for all materials and technical aspects of LMFBR steam generator fabrication. **Edward A. Wright** (bottom) (BSME, Auburn University, 1948) is chief of the Reactor and Plant Components Branch, U.S. Department of Energy, Clinch River Breeder Reactor, Oak Ridge, Tennessee. His primary interests and experience have been with the manufacturing of nuclear components and tubing.

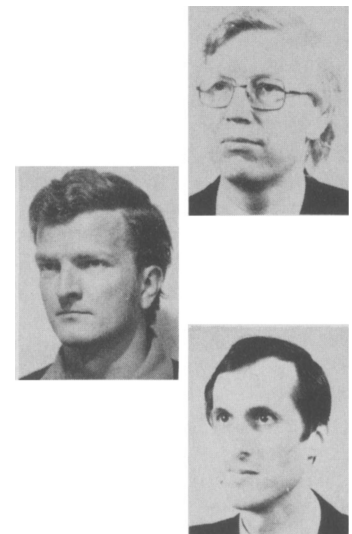
*C. N. Spalaris
P. J. Ring
E. A. Wright*



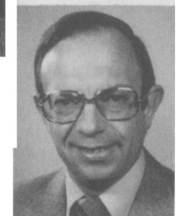
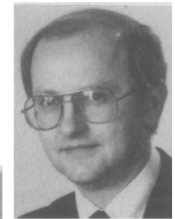
MATERIAL SELECTION AND OPTIMIZATION FOR POST-SNR-300 STEAM GENERATORS

J. Vrijen (top) (MSc, physics, Groningen University, 1973; PhD, materials science, Utrecht University, 1977) spent four years at the Netherlands Energy Research Foundation ECN at Petten. He investigated decomposition phenomena in alloys by means of diffuse neutron scattering. He joined Neratoom, The Hague, The Netherlands, in 1978, worked on several materials research subjects, and since 1980 has been manager of the department for research and development of materials, fabrication technology, and nondestructive testing techniques. **J. K. van Westenbrugge** (center) (MSc, mechanical engineering, Technical University of Eindhoven, 1969) is coordinator of liquid-metal fast breeder reactor (LMFBR) steam generator development at Neratoom. He joined Neratoom in 1971 and has held his present position since 1976. **L. van der Wiel** (bottom) (MSc, metallurgy, Delft University of Technology, 1978) is a materials expert. He joined Neratoom in 1978. He is working on a program on selection and optimization of materials

*J. Vrijen
J. K. van Westenbrugge
L. van der Wiel
P. L. F. Rademakers
C. P. Scheepens
J. W. Schinkel*



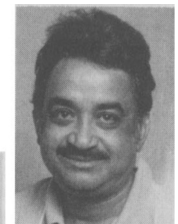
and joint techniques for future LMFBR steam generators. On behalf of this program, he has been detached to Metaalstituut TNO (MI-TNO) during 1979. **P. L. F. Rademakers** (top) (MSc, chemistry, Eindhoven University of Technology) joined the MI-TNO after his graduation in 1970. He started in the field of seawater resistant materials. As senior scientist, he is concerned with corrosion in liquid metals and corrosion in water/steam, both in relation to nuclear power generation. Currently, he is also concerned with high temperature corrosion in fossil energy installations. **C. P. Scheepens** (center) (Engineer, metallurgy, Utrecht University) is expert in the field of alloy steels and worked in the laboratory of a special steel manufacturing company. He joined the MI-TNO in 1967. He has been involved in materials research projects for energy installations, including the SNR project. **J. W. Schinkel** (bottom) (MSc, metallurgy, Delft University of Technology) joined the MI-TNO in 1966. He has been involved in applied research on metallurgy and mechanical properties of structural steels. Since 1972 he has acted as program coordinator for the materials research at TNO for the SNR project. He is currently deputy-director of the MI-TNO.



SOME ASPECTS OF MATERIALS DEVELOPMENT FOR SODIUM-HEATED STEAM GENERATORS

Prodyot Roy (top) (PhD, University of California, Berkeley; research fellow, Max Planck Institute) is a manager of the technical staff of the Advanced Reactor Systems Department at the General Electric Company (GE). His interests are in sodium coolant chemistry, mass transfer, and materials behavior in sodium. **C. N. Spalaris** (PhD, physical chemistry, Oregon State University, 1956) is manager of plant materials engineering at GE's Advanced Reactor Systems Department. He has been engaged in the nuclear industry for over 25 years, all with GE. His primary interests and experience have been the application, design, and fabrication of fuels and materials in boiling water, graphite-moderated, and liquid-metal breeder reactors.

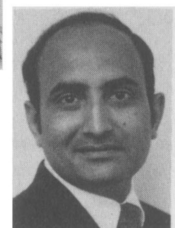
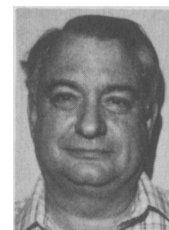
*Prodyot Roy
C. N. Spalaris*



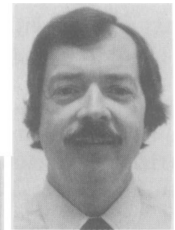
MATERIALS DEVELOPMENT FOR A FAST BREEDER REACTOR STEAM GENERATOR CONCEPT

C. E. Sessions (top) (PhD, metallurgical engineering, University of Tennessee, 1970) is a principal engineer with the Breeder Reactor Components Project (BRCP) of the Westinghouse Nuclear Components Division in Tampa, Florida. He has been involved in materials development for advanced fast breeder reactor steam generators for the past ten years. Prior experience and current interests include the areas of mechanical behavior, alloying effects, corrosion, and radiation damage of engineering materials. **S. D. Reynolds, Jr.** (center) (BS, metallurgical engineering, Lehigh University, 1953), a former employee of Westinghouse, is currently working for the U.S. Nuclear Regulatory Commission. He is a former Drexel Evening College instructor and has contributed many papers on heat exchanger welding and corrosion problems. **M. A. Hebbbar** (bottom) (MS, materials science, University of Delaware, 1970) is materials and processes manager, BRCP, Westinghouse Nuclear Components Division, Tampa, Florida. His technical interest is in materials and processes for advanced energy systems, and prior to 1977 he was involved with turbine materials

*C. E. Sessions
S. D. Reynolds, Jr.
M. A. Hebbbar
J. F. Lewis
J. H. Kiefer*



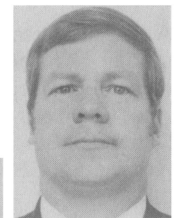
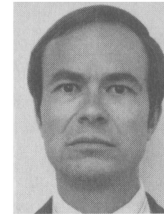
development at Westinghouse Steam Turbine Division, Lester, Pennsylvania. **J. F. Lewis** (top) (BS, mechanical engineering, Marquette University, 1961) is a senior engineer in the Materials and Process Group at the Tampa Plant of Westinghouse. Since 1974, he has been involved with component fabrications for the Breeder Reactor Program in regard to materials and processes. Prior to 1974, he worked in the same area with an aerospace firm. **J. H. Kiefer** (bottom) [BS, welding engineering, Ohio State University (OSU), 1977] has been involved in the welding industry since 1971. His work prior to attending OSU included welder training, heavy construction equipment production welding, and welding process development. He is presently with the Westinghouse Breeder Component Project Materials and Process Development Group.



STEAM GENERATOR TUBING DEVELOPMENT FOR COMMERCIAL FAST BREEDER REACTORS

*C. E. Sessions
C. F. Uber*

C. E. Sessions (top) (PhD, metallurgical engineering, University of Tennessee, 1970) is a principal engineer with the Breeder Reactor Components Project of the Westinghouse Nuclear Components Division in Tampa, Florida. He has been involved in materials development for advanced fast breeder reactor steam generators for the past ten years. Prior experience and current interests include the areas of mechanical behavior, alloying effects, corrosion, and radiation damage of engineering materials. **Craig F. Uber** (MS, physics, University of Pittsburgh, 1970) is a senior engineer at Westinghouse in Tampa, Florida. Since 1977 he has been engaged in high temperature structural analysis of breeder reactor steam generators. Prior to 1977, he developed structural mechanics computer programs for Westinghouse and the Newport News Shipbuilding and Dry Dock Company.



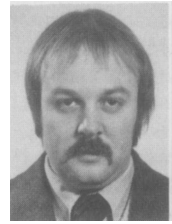
METALLURGICAL EXAMINATION OF TUBE-TO-TUBE-PLATE WELDS REMOVED FROM DOUNREAY PROTOTYPE FAST REACTOR EVAPORATORS

*G. R. Kirkland
E. R. Davies
M. E. Lambert
E. J. Kennett*

G. R. Kirkland (top) (C. Eng. M.I.M., metallurgy, Sir John Cass College, London, 1952) served five years of apprenticeship with the Ministry of Defence, followed by two years in the Royal Air Force. He subsequently progressed through a career that included three years as a metallurgist at A. V. Roe & Co. Ltd. working on fabrication problems of aircraft materials, followed by 22 years at the U.K. Atomic Energy Authority (UKAEA), Risley Nuclear Laboratories, where he worked on welding and materials problems in the construction of reactors and associated chemical plant. **E. R. Davies** (center) (BSc, metallurgy, University College of Wales, 1949) served for six years in the Royal Air Force. For six years he was employed as process metallurgist connected with the working and heat treatment of aluminum and its alloys for wire and conductor cable production. On joining the UKAEA, he became involved in the quality control assurance of Magnox production as canning material for the civil gas-cooled reactor. He is currently employed in a metallurgical advisory capacity generally concerned with the quality control, assessment, and investigation into failures in chemical processing and in particular in prototype fast reactor plants. **M. E. Lambert** (bottom) joined the UKAEA in 1958, where she has been a member of the Analytical Chemistry Group and was associated with the gas-cooled reactor and water-cooled reactor program. After three years of



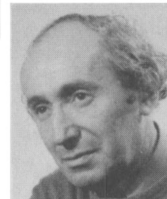
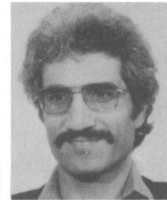
experience with the electron probe microanalyzer, she joined the Materials Physics Group in 1972, with responsibility for scanning electron microscopy. She is currently involved with the fast reactor program, where her main interests are failure analysis, fractography, and weld investigations. **E. J. Kennett** (right) (BSc, metallurgy, Newcastle, 1974) joined the UKAEA in September 1975 working on welding and materials problems in reactors and chemical plants. He resigned from the UKAEA in August 1980 to join the Ministry of Defence.



EFFECT OF DECARBURIZATION ON STRUCTURAL AND MECHANICAL PROPERTIES OF FERRITIC STEELS

A. A. Tavassoli (top) (PhD, metallurgy and materials technology, University of Surrey, England) is with the Materials Mechanics Group of the Applied Metallurgy Research Service (SRMA), Department of Technology, Commissariat per l'Energie Nucleare (CEN)-Saclay Commissariat à l'Energie Atomique (CEA), France. He joined this group in 1976 after one year of post-doctoral research on the development of constant modulus alloys at the University of Surrey, two years of research at the U.S. National Aeronautics and Space Administration Marshall Space Flight Center on the thermal protection system of the space shuttle, and three and one-half years as associate professor and head of the Metallurgical Engineering Department at the University of Technology, Teheran, Iran. His primary research interests include structural and mechanical properties of materials, alloy development, and irradiation effects. **H. Touron** (center) (Ingénieur diplômée, l'Ecole Polytechnique Féminine, 1960) is with the Applied Reactor Metallurgy Group of the Department of Technology at CEN-Saclay. **Michel Weisz** (bottom) (Thèse d'état, Ecole Centrale, France, 1950) is the head of the SRMA of the Department of Technology of CEN-Saclay. He joined CEA in 1958 after three years of research on the fatigue of steels at the "Institut de Recherche Sidérurgique." He headed the CEA section dealing with structural metals from 1962 to 1965 and since 1965 has been head of the SRMA. While at CEA, he has studied the effect of irradiation on the embrittlement of ferritic steels at low temperatures and cladding materials for gas graphite and EL4 reactors. His main recent and current interests have been in study, selection, and application of materials in fast breeder reactors.

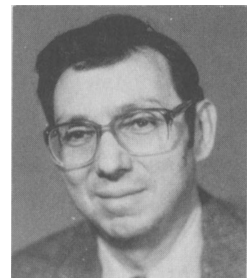
*A. A. Tavassoli
H. Touron
M. Weisz*



FLOW-INDUCED VIBRATION AND WEAR OF STEAM GENERATOR TUBES

H. J. Connors (PhD, mechanical engineering, University of Pittsburgh, 1969) joined the Westinghouse Research Laboratories in 1952 and is an advisory engineer in the Mechanics Department. Since 1967 he has investigated flow-induced vibration phenomena. Prior to that, his work was concerned with bearings and lubrication, shock, and vibration.

H. J. Connors



MATERIALS PROPERTY REQUIREMENTS FOR STEAM GENERATOR COMPONENTS IN THE CREEP RANGE

D. S. Wood (BSc, metallurgy, Manchester University, 1951, and PhD, creep of metals, Manchester University, 1954) is the section leader of mechanical properties at the Risley Nuclear Laboratories of the U.K. Atomic Energy Authority (UKAEA). He has worked on mechanical properties of reactor structural materials since joining the UKAEA in 1958. Recent work is related to structural materials for sodium-cooled fast breeder reactors.

D. S. Wood



WATER CHEMISTRY OF BREEDER REACTOR STEAM GENERATORS

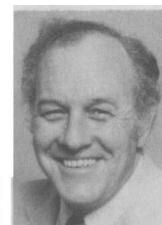
J. L. Simpson (top right) (BS, chemistry, San Jose State University, 1963) is manager of coolant systems chemistry at the General Electric Company (GE) Advanced Reactor Systems Department. He has been involved in the nuclear industry for over 18 years, all with GE. His experiences have included liquid-metal technology, mixed-oxide fuel quality, analytical instrumentation development for manufacturing, testing, and power generating, and water chemistry application. **M. N. Robles** (top left) (BS, chemistry, California Polytechnic State University, 1963) is a senior chemist of coolant systems chemistry at GE's Advanced Reactor Systems Department. Most of his 18 years in the nuclear industry have been with GE, where he has worked in providing analytical chemistry support for nuclear fuels reprocessing, fabrication, and the development of instrumentation to measure trace impurities in power plant water/steam systems. **C. N. Spalaris** (bottom right) (PhD, physical chemistry, Oregon State University, 1956) is manager of plant materials engineering at GE's Advanced Reactor Systems Department. He has been engaged in the nuclear industry for over 25 years, all with GE. His primary interests and experience have been the application, design, and fabrication of fuels and materials in boiling water, graphite-moderated, and liquid-metal breeder reactors. **S. A. Moss** (bottom left) (BS, chemistry, Hampton Institute, 1964) is a chemist in coolant systems chemistry at GE's Advanced Reactor Systems Department. She has been involved in the nuclear industry for approximately eight years. Her experience has been in the Boiling Water Reactor (BWR) Projects Group, BWR fuel cycle analysis, and water chemistry support for programs related to the Clinch River Breeder Reactor and BWRs.

J. L. Simpson

M. N. Robles

C. N. Spalaris

S. A. Moss



A CHEMICAL CLEANING PROCESS FOR NUCLEAR STEAM GENERATORS

P. V. Balakrishnan (top) (MA, chemistry, University of Madras, India, 1961; PhD, chemistry, McMaster University, 1971) was a scientific officer at Bhabha Atomic Research Centre, Trombay, India. He has been with Atomic Energy of Canada Limited Research Company, Chalk River Nuclear Laboratories since 1971. He has been involved with studies on water chemistry in power reactor coolant systems, his current interests being steam generator water chemistry and chemical cleaning of steam generators. **P. McSweeney** (bottom) (BSc, chemistry, University College, Cork, Ireland, 1961) was a station chemist at the Electricity Supply Board of Ireland. He joined Ontario Hydro's Research Division in 1974 where he

P. V. Balakrishnan

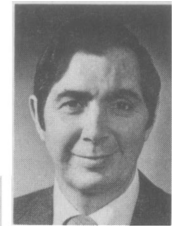
P. McSweeney

C. R. Frost

P. Walmsley



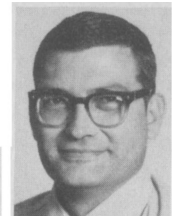
has studied steam generator corrosion and chemical cleaning. He is at present working on the development of solvents to clean the secondary sides of Ontario Hydro's nuclear steam generators. **Colin Frost** (top) (PhD, nuclear technology, Imperial College, 1968) has worked for ten years at Ontario Hydro on the chemical control of nuclear power plants. He joined Ontario Hydro after working on a World Health Organization water supply project for two years. His previous work includes research and development on radioactive waste management for five years with the Australian Atomic Energy Commission. **Peter Walmsley** (bottom) (BTech, mechanical engineering, University of Bradford, 1966) was a research officer with the U.K. Central Electricity Generating Board before joining Ontario Hydro in 1969. He was leader of the project to specify a process and clean the Nuclear Power Demonstration (NPD) boiler in 1979. He is currently a shift supervisor at Ontario Hydro's NPD Nuclear Generating Station.



EDDY CURRENT INSPECTION OF A 17-YEAR-OLD NUCLEAR STEAM GENERATOR

Gary Van Drunen (top) (PhD, metallurgical engineering, Queen's University, 1972) joined the Quality Control Branch at the Atomic Energy of Canada, Ltd. Chalk River Nuclear Laboratories (CRNL) in 1978. He previously worked in the Turbine and Generator Division of Westinghouse Canada. His present work concerns eddy current testing, particularly the development of techniques for ferromagnetic materials. **V. S. Cecco** (MS, mechanical engineering, University of Waterloo, 1971) has been in the Quality Control Branch at CRNL since 1972. He has done development work in the eddy current nondestructive testing method for *in situ* inspection of steam generators, heat exchangers, and fuel channels. He holds two patents on probe design.

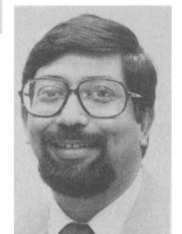
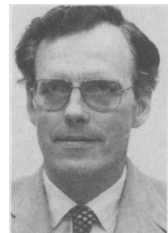
*G. Van Drunen
V. S. Cecco*



REPLACEMENT OF DAMAGED STEAM GENERATOR TUBING IN 600-MW(electric) CANADIAN DEUTERIUM URANIUM NUCLEAR PLANTS

R. H. Renshaw (top) (graduate, mechanical engineering, University of British Columbia, Canada, 1953) spent two years working in the nuclear power program in England, and a similar period in the Chalk River Nuclear Laboratories of Atomic Energy of Canada Limited (AECL). In 1958, he joined the AECL group responsible for nuclear power plant design, and from that time until the present has specialized in the design of nuclear systems. Renshaw is presently chief engineer of the Design and Development Division of the AECL Engineering Company. **S. Roy** (BE, University of Jadavpur, India, 1965; MSc, thermodynamics and related studies, University of Birmingham, U.K., 1973) joined AECL in 1976 and has been involved in engineering of steam generators for various projects. He was the AECL engineering group leader for the retubing of 600-MW steam generators. Roy is currently the manager of the Process Equipment Branch in the Process Engineering Department of AECL. In his present capacity he is in charge of the engineering of steam generators, pressurizers, heat exchangers, and other related equipment.

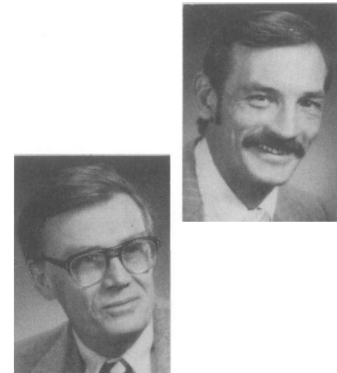
*R. H. Renshaw
S. Roy*



EFFECT OF ENVIRONMENTAL VARIABLES ON THE STRESS CORROSION CRACKING OF INCONEL 600 STEAM GENERATOR TUBING

*T. S. Bulischeck
D. van Rooyen*

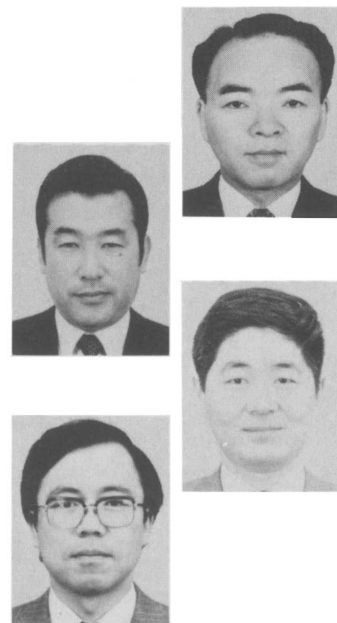
T. S. Bulischeck (top) has spent 23 years in the area of high-temperature high-pressure research with metals and water chemistry. During most of this time, he was with Westinghouse Research and Development (R&D) Center in Pittsburgh, although he started his career at the Westinghouse Bettis Atomic Power Laboratory. At Westinghouse, his activities included the design and construction of high temperature high pressure research equipment, as well as use of these in research into the behavior of chemicals in solution as well as the stress corrosion cracking (SCC) of metals in high temperature electrolytes. Much of this work was related to atomic power generation, and he specifically concentrated on chemistry conditions in steam generators as also effected by condenser inleakage. In the area of SCC, he concentrated on Inconel 600 and Type 304 stainless steel. In addition to these, he was involved in research required to design and install desalination plants and also in studies that involved crud transportation. He has recently transferred to NUS Corporation following four years of R&D into SCC of Inconel while at Brookhaven National Laboratory (BNL). **Daniel van Rooyen** (PhD, corrosion, University of Cambridge, England) has, since his arrival in the U.S. in 1957, been involved in a variety of research programs dealing with metallic corrosion and has published on pitting corrosion, crevice corrosion, SCC, dezincification, as well as inhibitors, cathodic protection, alloy development, and general corrosion in high temperature aqueous media. He has spent about nine years each with Inco and Westinghouse, the latter at both the R&D Center and the Bettis Atomic Power Laboratory. He joined the Corrosion Science Group at BNL in the position of scientist in 1975, and has since been promoted to senior scientist.



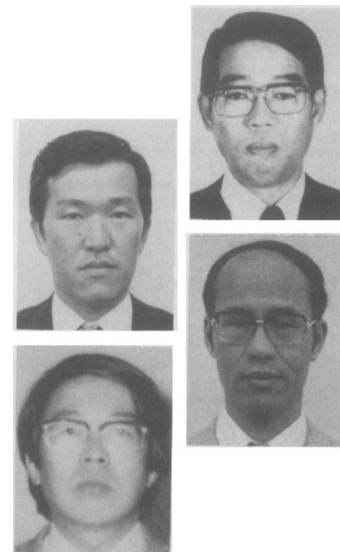
EFFECT OF HEAT TREATMENT ON THE SUSCEPTIBILITY TO STRESS CORROSION CRACKING OF ALLOY 600

*M. Kowaka
H. Nagano
T. Kudo
Y. Okada
M. Yagi
O. Takaba
T. Yonezawa
K. Arioka*

Masamichi Kowaka (top right) (BS, physics, Kyoto University, 1947; Dr., science, Osaka University, 1960) is a principal research scientist of Central Research Laboratories, Sumitomo Metal Industries, Ltd., responsible for research and development (R&D) of corrosion-resistant steels for chemical and atomic energy industries. His experience includes corrosion of low alloy steels, pitting and crevice corrosion of stainless steels for sea-water use, sulfide stress corrosion cracking (SCC) of OCTG and line pipe steels and chloride SCC of high nickel alloys for chemical and atomic energy industries. **Hiroo Nagano** (top left) (BS, chemistry, Nagoya University, 1962; Dr., engineering, Kyoto University, 1976) is a senior research engineer of Central Research Laboratories, Sumitomo Metal Industries, Ltd. His interests are in the areas of development of corrosion-resistant alloys for atomic energy industries and study on electrochemical behaviors of stainless steels. **Takeo Kudo** (bottom right) (MS, metallurgy, Kyoto University, 1970; Dr., engineering, Tokyo University, 1980) is a research engineer of Central Research Laboratories, Sumitomo Metal Industries, Ltd. His interests focus on the SCC of stainless steels and nickel-base alloys. **Yasutaka Okada** (bottom left) (MS, metal science and technology, Kyoto University, 1971) is a research engineer in the Mechanical Metallurgy Section of Central Research Laboratories, Sumitomo Metal Industries, Ltd. His special interests include strength, toughness, and precipitation



behavior of high alloy steels. **Motoo Yagi** (top right) (BS, mechanical engineering, Waseda University, 1960) is a deputy manager of metallurgical and process control in Sumitomo Metal Industries, Ltd., Steel Tube Works. His special interests include R&D of tubing materials for nuclear services. **Osamu Takaba** (top left) (BS, engineering, Kansai University, 1965) works for Mitsubishi Heavy Industries, Ltd. at Kobe, Japan. He is a group leader of the Nuclear Plant Engineering Department, mainly dealing with the design of a steam generator in pressurized water reactor (PWR) power plants. **Toshio Yonezawa** (bottom right) (BS, 1968, and MS, 1970, Waseda University) is a senior research engineer at the Materials Research Laboratory in Takasago Technical Institute, Mitsubishi Heavy Industries, Ltd. He is currently interested in the corrosion of steels and alloys for PWRs and fast breeder reactors. **Koji Arioka** (bottom left) (BS, 1971, and MS, 1973, Tohoku University) is a research member of Chemical Research Laboratory in Takasago Technical Institute, Mitsubishi Heavy Industries, Ltd. He is currently interested in corrosion as a mass transport phenomenon.



MODEL BOILER INHIBITION STUDIES OF THE NUCLEAR STEAM GENERATOR DENTING PHENOMENON

Clinton R. Wolfe (top right) (PhD, chemistry, University of New Mexico, 1966) joined Westinghouse Electric Corporation in 1966. Since 1978, he has been principal investigator on a number of tube support plate and tubesheet corrosion programs. He currently has responsibility for the conduct of all the single-tube model boiler corrosion programs. **John N. Esposito** (top left) (PhD, chemistry, Case Western Reserve University, 1966) has been actively involved in the study of the steam generator denting phenomenon since 1975. From 1976 until March 1981, Esposito was manager of chemistry technology, the group responsible for the successful execution of the single-tube model boiler programs. Currently, he is manager of steam generator programs. **D. Douglas Whyte** (second from top right) (BS, chemistry, Marietta College, 1943) is a principal corrosion engineer. His primary responsibilities include developing water chemistries for corrosion control for nuclear materials, determining corrosion properties of materials, and conducting failure analyses studies. **Joseph M. Gilkison** (center left) (MS, metallurgical engineering, University of Illinois, 1964) has been a senior engineer with Westinghouse since 1974. He has been involved with material selection and component failure analyses associated with power plant construction and operation, and he was involved in the metallographic analysis of test pieces from the single-tube model boiler program. **John R. Balavage** (third from top right) (MS, ChE, Pennsylvania State University, 1972) has been involved in virtually all phases of the single-tube model boiler program with particular emphasis on test piece design, data acquisition, data presentation, and operational trouble shooting. **M. John Wootten** (bottom left) (PhD, chemistry, University of Leicester, England, 1969) replaced Esposito as manager of chemistry technology in March 1981. Wootten has extensive experience in the area of high temperature aqueous corrosion of nuclear power plant materials and part of his prior work experience included responsibility for the Westinghouse Research and Development Laboratory effort on steam generator chemistry programs and the field development of boric acid as a denting inhibitor. **Susan M. Wozniak** (bottom right) (BS, ChE, University of Pittsburgh,

*C. R. Wolfe
J. N. Esposito
D. D. Whyte
J. M. Gilkison
J. R. Balavage
M. J. Wootten
S. M. Wozniak*

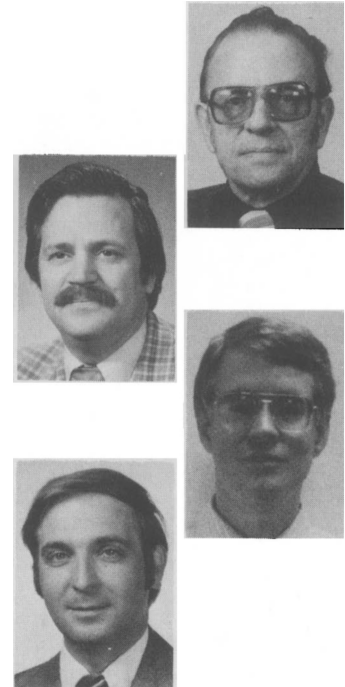


1976) has been involved with the single-tube model boiler program since 1977 with emphasis on chemistry data reduction and presentation and data acquisition.

MATERIALS MODEL BOILER TESTS FOR THE BABCOCK & WILCOX ONCE-THROUGH STEAM GENERATORS

R. H. Emanuelson (top right) (BS, metallurgical engineering, University of Minnesota, 1957; MS, engineering, Youngstown State University, 1973) has been a research metallurgist at the Babcock & Wilcox (B&W) Company's Alliance, Ohio, Research Center since 1958. His current interests and activities are in the determination of corrosion properties of materials for use in nuclear power generating systems. **Daniel F. Levstek** (top left) (BS, metallurgy, Case Western Institute of Technology, 1960) is manager of engineering technology for Babcock and Wilcox Canada Ltd., Cambridge, Ontario, and is involved in basic technology areas and research and development for both fossil and nuclear product lines. Prior to transferring to Babcock and Wilcox Canada in 1979, he was manager of the Materials, Chemistry and Codes Unit of the B&W Nuclear Power Generation Division, Lynchburg, Virginia. This unit was responsible for development and specification of materials and water chemistry related to B&W's nuclear systems. Levstek's area of emphasis at B&W, which he joined in 1967, was in nuclear steam generator materials engineering and corrosion and he has authored or co-authored five technical papers on this subject. **K. E. Moore** (bottom right) (BS, metallurgical engineering, San Jose State University, 1963) is a principal engineer at the B&W Nuclear Power Generation Division. His current interests include stress corrosion of austenitic alloys and irradiation-induced changes in the material properties of light water reactor pressure vessel steels. **G. J. Theus** (bottom left) (BS, metallurgy, Case Institute of Technology, 1966; PhD, metallurgical engineering, Ohio State University, 1972) is group supervisor in the Corrosion Technology Section at B&W's Alliance Research Center. His current responsibilities are directing corrosion research on advanced fossil, nuclear, and solar power generating systems. His research interests include the effect of metallurgical and environmental variables on the corrosion behavior of metals in aqueous solutions, fused salts, and gaseous environments.

*R. H. Emanuelson
D. F. Levstek
K. E. Moore
G. J. Theus*



A STRESS CORROSION CRACKING EVALUATION OF INCONEL 690 FOR STEAM GENERATOR TUBING APPLICATIONS

Geoffrey P. Airey (top) (B. Met., 1961, and PhD, 1964, metallurgy, Sheffield University, England) was a post-doctoral research fellow at the Swiss Federal Institute of Technology, Zurich from 1964 to 1966. Since 1967, he has worked at the Westinghouse Research and Development (R&D) Center and is currently a fellow engineer in the Nuclear Materials Department. He is interested in the correlation of metallurgical microstructure with materials properties and performance. For the last five years he has focused on the role of microstructure in the stress corrosion cracking performance of Inconel 600 and 690 for steam generator tubing applications. **Albert R. Vaia** (bottom) (MS, metallurgical engineering, University of Pittsburgh, 1975) is a senior engineer with the Nuclear Technology Division of Westinghouse Electric Corporation. He has worked in the fields of process development and materials corrosion

*G. P. Airey
A. R. Vaia
R. G. Aspden*



research as they relate to the nuclear industry and is presently working in nuclear steam generator system design and materials engineering. **Robert G. Aspden** (right) (PhD, metallurgical engineering, University of Pittsburgh, 1965) is an advisory engineer with the Westinghouse R&D Center. He is active in managing and conducting research in powder metallurgy, high temperature alloys, magnetic materials, and power generation materials.



THE STRESS CORROSION CRACKING OF $2\frac{1}{4}$ Cr-Mo FERRITIC STEEL IN CAUSTIC ENVIRONMENTS

P. Hurst (top) (BSc and PhD, chemistry, University of Liverpool) and **H. C. Cowen** (BSc and MSc, chemistry, and PhD, metallurgy, University of Manchester) are both principal scientific officers at the U.K. Atomic Energy Authority Risley Nuclear Laboratories. They have been concerned with compatibility problems in CO₂, water, and liquid-metal-cooled reactor systems. Their present interests are in the fields of general and localized aqueous corrosion processes, and a range of environmentally induced cracking phenomena.

*P. Hurst
H. C. Cowen*



FRETTING AND WEAR OF STAINLESS AND FERRITIC STEELS IN LIQUID-METAL FAST BREEDER REACTOR STEAM GENERATORS

Michael W. J. Lewis (top) (BSc, mechanical engineering, and MSc, tribology, University of Leeds, 1972) joined the National Centre of Tribology, U.K. Atomic Energy Authority (UKAEA), Risley, eight years ago and has been concerned with the fretting behavior of materials in high temperature gas and liquid sodium environments. **Charles S. Campbell** (MA, natural sciences, Cambridge University, U.K., 1945) has been involved with tribology in nuclear environments since 1970 at the National Centre of Tribology, UKAEA, Risley.

*Michael W. J. Lewis
Charles S. Campbell*



EXAMINATION OF LEAKING TUBE-TO-TUBE-PLATE WELDS FROM AN AUSTENITIC STEEL STEAM GENERATOR SUPERHEATER IN THE DOUNREAY PROTOTYPE FAST REACTOR

G. R. Kirkland (top) (C. Eng, M.I.M., metallurgy, Sir John Cass College, London, 1952) served five years of apprenticeship with the Ministry of Defence, followed by two years in the Royal Air Force. He subsequently progressed through a career that included three years as a metallurgist at A. V. Roe & Co. Ltd. working on fabrication problems of aircraft materials, followed by 22 years at the U.K. Atomic Energy Authority (UKAEA), Risley Nuclear Laboratories, where he worked on welding and materials problems in the construction of reactors and associated chemical plants. **E. R. Davies** (bottom) (BSc, metallurgy, University College of Wales, 1949) served for six years in the Royal Air Force. For six years he was employed as process metallurgist connected with the working and heat treatment of aluminum and its alloys for wire and conductor cable production. On joining the UKAEA, he became involved in the quality control assurance of Magnox production as canning material for the civil gas-cooled reactor. He is currently

*G. R. Kirkland
E. R. Davies
M. E. Lambert*



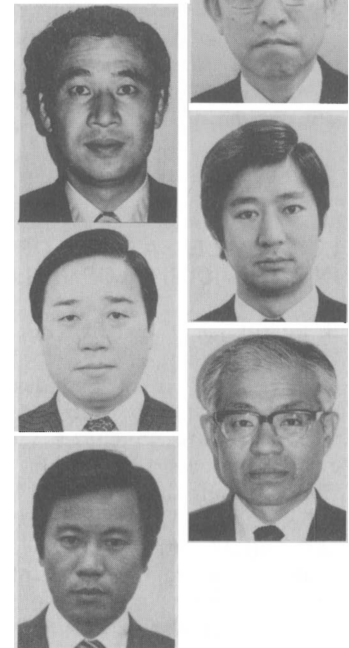
employed in a metallurgical advisory capacity generally concerned with the quality control, assessment, and investigation into failures in chemical processing and in particular prototype fast reactor plant. **M. E. Lambert** (right) joined the UKAEA in 1958, where she has been a member of the Analytical Chemistry Group and was associated with the gas-cooled reactor and water-cooled reactor programs. After three years of experience with the electron probe microanalyzer, she joined the Materials Physics Group in 1972, with responsibility for scanning electron microscopy. She is currently involved with the fast reactor program, where her main interests are failure analysis, fractography, and weld investigations.



CREEP BEHAVIOR EVALUATION OF HASTELLOY X WELDED JOINT

Kunihiko Satoh (top right) (Dr, naval architecture, University of Tokyo, 1947) is a professor of welding engineering at Osaka University. He was the president of the Japan Welding Society from 1976 to 1977. His current research interests include fracture toughness of high strength steel, creep behavior, and low cycle fatigue behavior of welded components. **Masao Toyoda** (top left) (Dr, welding engineering, Osaka University, 1972) is an associate professor of welding engineering at Osaka University. His current research interests include fracture toughness of high strength steel, creep, and low cycle fatigue behavior of welded components. **Shigetomo Matsui** (center right) (Dr, welding engineering, Osaka University, 1968) is a project manager in Welding Research Laboratory at Kawasaki Heavy Industries Ltd. He was an associate professor of welding engineering at Osaka University from 1968 to 1974. His current research interests include development of corrosion resistant line pipe and tube, and application of electron beam (EB) welding to various structures. **Eisuke Mori** (center left) (BS, metallurgy, Tohoku University, 1974) is a researcher in Welding Research Laboratory at Kawasaki Heavy Industries Ltd. His current research interests include EB welding of superalloys. **Shigeki Shimizu** (bottom right) (Dr, welding engineering, Osaka University, 1977) is a senior researcher in the Nuclear Systems Division at Kawasaki Heavy Industries Ltd. His current research interests include the study of weldability and materials properties of alloys for very high temperature reactor (VHTR) and fast breeder reactor (FBR) components. **Keisuke Satoh** (bottom left) (BS, mechanical engineering, Tokyo Institute of Technology, 1968) is a researcher in the Nuclear Systems Division at Kawasaki Heavy Industries Ltd. His current research interests include creep properties of alloys for VHTR and FBR components.

*Kunihiko Satoh
Masao Toyoda
Shigetomo Matsui
Eisuke Mori
Shigeki Shimizu
Keisuke Satoh*



ON THE TEMPER EMBRITTLEMENT OF MANGANESE-MOLYBDENUM-NICKEL STEELS

S. G. Druce (top) (PhD, physical metallurgy, University of Birmingham, England, 1977) is a senior scientific officer at the U.K. Atomic Energy Research Establishment (AERE), Harwell. Previously he worked in the field of fatigue and fracture for the British Steel Corporation. His current interests are elastic-plastic fracture mechanics, environmentally accelerated fatigue, and basic ferrous metallurgy, particularly in connection with pressure water reactor pressure vessel steels. **Barrie C. Edwards** (PhD, materials science, University of London, England, 1973)

*S. G. Druce
B. C. Edwards*



is a senior scientific officer at the U.K. AERE. He joined Harwell in 1975 after two years of post-doctoral research in polymer physics. His current research interests include the physical metallurgy and fracture behavior of ferritic steels with particular emphasis placed on the characterization of steels used in thermal and fast breeder reactors.

A STUDY OF CRACK INITIATION IN CORROSION FATIGUE OF AISI TYPE 316 STAINLESS STEEL BY DYNAMIC MEASUREMENT OF CORROSION CURRENT TRANSIENTS

J. W. Martin (top) (PhD, metallurgy, Brunel University, 1980) is a technologist at the British Petroleum Research Centre, Sunbury-on-Thames, England. He joined the company after two years with the Tube Investments Research Laboratories. His current interests are corrosion inhibitors and fatigue. **D. E. J. Talbot** (MSc, metallurgy, University of Wales, 1954) lectures in metallurgy at Brunel University, Uxbridge, Middlesex, England, which he joined in 1966 from The Research Laboratories of The British Aluminium Co. His current interests include corrosion, oxidation, fatigue, and hydrogen in metals.

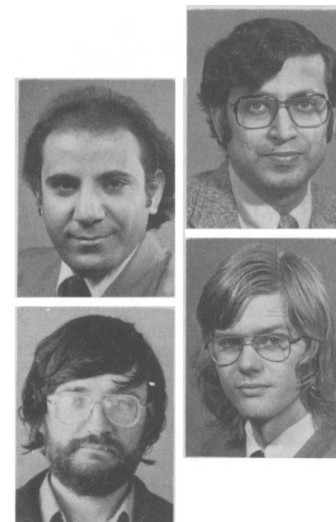
*J. W. Martin
D. E. J. Talbot*



LOW CYCLE FATIGUE OF STEAM GENERATOR TUBES IN THE VICINITY OF ROLL JOINTS

B. Mukherjee (top right) (BSc, DIC, Imperial College, London; PhD, University of Waterloo) currently leads a Fracture Mechanics Group in the Nondestructive and Fracture Evaluation Section of Ontario Hydro Research Laboratories. His current research interest includes fatigue and fracture of materials, environment-assisted cracking, and structural integrity evaluation of components. **M. H. El Haddad** (top left) (BSc, Cairo University; MSc and PhD, University of Waterloo) is an engineer at Ontario Hydro Research and also is an adjunct professor at the University of Waterloo, Canada. His research interests are in the areas of fatigue and fracture mechanics. **M. L. Vanderglas** (bottom right) (BSc and MSc, University of Waterloo) is an engineer at Ontario Hydro Research, working primarily on analytical and computational aspects in fracture mechanics. **D. V. Leemans** (bottom left) (BSc, University of Louvain, Belgium; PhD, Northwestern University) is a former research engineer with Ontario Hydro. His research interests include development of methods and equipments for in-service inspection using the techniques of acoustic emission and eddy current.

*B. Mukherjee
M. H. El Haddad
M. L. Vanderglas
D. V. Leemans*



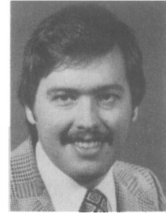
STUDIES OF DENTING OF STEAM GENERATORS WITH SIMULATED FRESH WATER IN-LEAKAGE

James Brown (top) (PhD, chemistry, University of Liverpool, 1968) joined the Ontario Hydro Research Division in 1969. He has had varied experience in analytical chemistry, high temperature aqueous chemistry, and corrosion, and is currently head of the Chemical Corrosion Research Unit. **Francisco Gonzalez** (bottom) (Licenciante, chemical technology, University of Barcelona, 1969; MSc, chemical engineering, University of Toronto, 1975) joined the Ontario Hydro Research

*James Brown
Francisco Gonzalez
David Iley
Alexandra McKay*



Division in 1979. His research interests include thermal hydraulics and corrosion in nuclear steam generators. **David Iley** (top) (MSc, chemistry, University of Waterloo, Canada, 1975) joined the Ontario Hydro Research Division in 1977, working in the field of steam generator water chemistry. He is currently assistant technical supervisor at the Ontario Hydro Bruce B Nuclear Generating Station. **Alexandra McKay** (bottom) (MAsc, chemical engineering, University of Toronto, Canada, 1978) joined the Ontario Hydro Research Division in 1978. Her research interests include feedwater chemistry and corrosion in fossil-fired and nuclear steam generators.



METALLURGICAL EXAMINATION OF CRACKED FEED-WATER PIPES FROM NINE PRESSURIZED WATER REACTORS

*Brijesh Vyas
Carl J. Czajkowski
John R. Weeks*

Brijesh Vyas (top) (PhD, materials science, State University of New York, 1975; BTech, Indian Institute of Technology, 1971) is currently a member of the technical staff of Bell Laboratories, Murray Hill, New Jersey. He joined Bell Laboratories in 1980 after four years at Brookhaven National Laboratory (BNL) in the Corrosion Science Group. His current interests are in the areas of research on energy storage systems. **Carl J. Czajkowski** (center) (BS, metallurgical engineering, University of Missouri at Rolla, 1971) is currently a research engineer at BNL involved in the failure analyses of reactor components for the U.S. Nuclear Regulatory Commission (NRC). Prior to his employ at BNL in 1980, he spent eight years in the commercial reactor industry involved in the construction of both boiling water and pressurized water reactors. His primary interests are failure analyses, welding, and nondestructive testing. **John R. Weeks** (bottom) (MetE, metallurgical engineering, Colorado School of Mines, 1949; PhD, metallurgy, University of Utah, 1953) joined the BNL staff in 1953, where he has remained, except for two years (1972 to 1974) as a corrosion specialist with the former U.S. Atomic Energy Commission's Directorate of Licensing. He is currently a senior metallurgist and head of the Corrosion Science Group. Presently, he is a technical advisor to the NRC in the area of corrosion and coolant chemistry in light water and reactors, and is involved with both basic and applied research programs on corrosion problems in energy generation.

