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BLANKET COMPARISON AND SELECTION STUDY

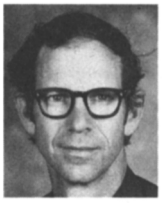
Dale L. Smith
Charles C. Baker
Dai Kai Sze
Grover D. Morgan
M. A. Abdou
Steven J. Piet
K. R. Schultz
Ralph W. Moir
James D. Gordon

OVERVIEW OF THE BLANKET COMPARISON AND SELECTION STUDY

Dale L. Smith (top right) (PhD, Iowa State University, 1966) is the associate director of the Fusion Power Program of Argonne National Laboratory (ANL) assisting in directing and planning all fusion activities at ANL. He also serves as program manager for the ANL Fusion Materials Program. He served as program manager for a multilaboratory Blanket Comparison and Selection Study. He currently serves as deputy manager of ANL's effort on the Tokamak Power Systems Study and as ANL representative for the INTOR study. **Charles C. Baker** (top left) [PhD, University of Wisconsin (UW), 1972] has overall responsibility for directing the ANL Fusion Power Program including activities in materials research, fusion reactor system and design studies, superconducting magnets and energy storage development, tritium technology, plasma engineering, atomic physics, and safety studies. He has been director of the program since 1977, and his responsibilities include long-range planning, program implementation, and budget administration. He serves on several advisory committees for the U.S. Department of Energy. He currently serves as manager of the STARFIRE Project, a design study of a commercial tokamak power reactor. **Dai Kai Sze** (bottom right) (BS, Taiwan University; MS and PhD, chemical engineering, Massachusetts Institute of Technology) is a staff member at ANL. His current research activities include blanket concept, blanket tritium systems, and transport phenomena. **Grover D. (Dave) Morgan** (bottom left) (BS, mechanical engineering, 1965, and MS, engineering mechanics, 1968, University of Missouri-Rolla) has been a systems integration analyst on the McDonnell Douglas Astronautics Company fusion energy staff since 1978. His primary interests have been first-wall and blanket engineering and design. He was deputy manager of the Blanket Comparison and Selection Study (BCSS), and was also

responsible for all solid breeder blanket design group activities. **M. A. Abdou** (top right) (PhD, nuclear engineering, UW, 1973) is associate director of the Fusion Power Program at ANL. He serves as the U.S. INTOR participant for nuclear systems. **Steven J. Piet** (top left) [BS, MS, 1979, and ScD, 1982, nuclear engineering, Massachusetts Institute of Technology (MIT)] is currently a member of the Fusion Safety Program of EG&G Idaho at the Idaho National Engineering Laboratory. His major interests and responsibilities include risk assessments, activation product behavior, and lithium compound reactions. He is participating in the BCSS. **Kenneth R. Schultz** (center right) (PhD, nuclear engineering sciences, University of Florida, 1971) is manager of fusion development and technology at GA Technologies. He is responsible for the fusion nuclear technology aspects of several reactor design study projects for tokamak, mirror, and inertial confinement reactor applications, with emphasis on blanket engineering. He also is involved with several small blanket technology experiments. **Ralph W. Moir** (bottom left) (ScD, nuclear engineering, MIT, 1967) worked in 1967 and 1968 on the magnetic fusion project at Fontenay-aux-Roses, France (Centre d'Etude de l'Energie Nucléaire-Commissariat à l'Energie Atomique). In 1968, he joined the Lawrence Livermore National Laboratory, where he has specialized in development of the direct conversion of fusion plasma energy to electrical energy and reactor design. At present, he is head of the fusion-fission hybrid reactor design study project and serves as associate program leader for advanced mirror systems. **James D. Gordon** (bottom right) (PhD, University of California-Los Angeles, 1972) joined TRW in 1968 and is currently manager of Fusion Reactor Engineering Programs. He was project manager for the BCSS and the Mirror Advanced Reactor Study and leads work in conceptual commercial reactor design, blanket design, and fusion technology development.




ENGINEERING FEASIBILITY EVALUATION OF BLANKET CONCEPTS FOR BLANKET COMPARISON AND SELECTION STUDY

Grover D. Morgan
David A. Bowers
David E. Ruester



Grover D. (Dave) Morgan (top) (BS, mechanical engineering, 1965, and MS, engineering mechanics, 1968, University of Missouri-Rolla) has been a systems integration analyst on the McDonnell Douglas Astronautics Company (MDAC) fusion energy staff since 1978. His primary interests have been first-wall and blanket engineering and design. He was deputy manager of the Blanket Comparison and Selection Study (BCSS), and was also responsible for all solid breeder blanket design group activities. **David A. Bowers** (center) (BS, mechanical engineering, Purdue University, 1965) has been the senior thermal-hydraulics analyst on the MDAC fusion energy staff since 1975. His primary interests have included the thermal analysis and design of various fusion devices and components, including vacuum vessel walls, limiters, antennas, Faraday shields, armor, neutral beam components, and other structural parts. He supervised thermal support for the Elmo Bumpy Torus proof-of-principle project at MDAC. **David E. Ruester** (bottom) (BS, 1978, and MS, 1983, civil engineering, University of Missouri-Rolla) is a member of the strength and mass properties department of MDAC. As part of the MDAC fusion energy staff, he has performed structural analyses for several major fusion studies, including STARFIRE, DEMO, and the BCSS.

ECONOMIC EVALUATION OF THE BLANKET COMPARISON AND SELECTION STUDY

Lester M. Waganer

Lester M. Waganer (MS, mechanical engineering, University of Missouri, 1963) has been with McDonnell Douglas Astronautics Company, St. Louis, Missouri, since 1970. He is a senior design specialist and is currently the project leader on an Electric Power Research Institute project to assess the technical risks of developing a deuterium-tritium fuel system for a commercial fusion power plant. Previously, he was the project engineer on the Elmo Bumpy Torus Reactor and power plant conceptual design study for Los Alamos National Laboratory, and was in charge of project engineering and system analysis activities for STARFIRE reactor design study.

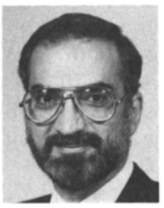
SAFETY EVALUATION OF THE BLANKET COMPARISON AND SELECTION STUDY

Steven J. Piet

Steven J. Piet (BS and MS, 1979, and ScD, 1982, nuclear engineering, Massachusetts Institute of Technology) is currently a member of the Fusion Safety Program of EG&G Idaho at the Idaho National Engineering Laboratory. His major interests and responsibilities include risk assessments, activation product behavior, and lithium compound reactions. He is participating in the Blanket Comparison and Selection Study.

DESIGN OF SELF-COOLED, LIQUID-METAL BLANKETS FOR TOKAMAK AND TANDEM MIRROR REACTORS

Yung Sheng Cha
Yousry Gohar
Ahmed M. Hassanei
Saurin Majumdar
Basil F. Picologlou
Dai Kai Sze
Dale L. Smith

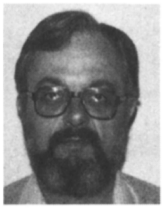


Yung Sheng Cha (top right) (PhD, Lehigh University, 1973) has been responsible for conducting thermal-hydraulic analysis and design of various first-wall, blanket, and impurity control systems of fusion reactors at Argonne National Laboratory (ANL) since 1981. His research interests include cavitation, heat transfer, fluid transient, and solar pond. **Yousry Gohar** (top left) (BS, 1967; MS, 1970; and PhD, 1974, nuclear engineering, Alexandria University, Egypt) is currently a member of the Fusion Power Program and Applied Physics Division at ANL. He has more than 18 years of experience in the field of nuclear engineering and computational methods. He worked on many aspects of light water reactors including core design, thermal hydraulics, operation, and maintenance at the Atomic Energy Establishment of Egypt for six years. Before joining ANL, he spent two years at the University of Wisconsin working on fusion reactor designs. He participated in most of the fusion reactor studies (UWMAK-III, TETR, INTOR, STARFIRE, DEMO, FED, TFCX, FPD, TPSS). His research interests include fusion reactor technology, blanket, shield, design studies, nuclear data, and computational method development. **Ahmed M. Hassanein** (center right) (BS, nuclear engineering, Alexandria University, 1974; MS, nuclear engineering, 1978, MS, physics, 1981, and PhD, nuclear engineering, 1982, University of Wisconsin) is interested in research on radiation damage, energy deposition, and thermal response of materials. His recent research interests include tritium behavior in materials and ion transport and related phenomena. **Saurin Majumdar** (bottom left) (PhD, University of Illinois, 1973) has been responsible for conducting stress and lifetime analyses of various fusion reactor blanket design studies conducted at ANL since 1974. **Basil F. Picologlou** (bottom right) (PhD, Purdue University, 1972) is responsible for the magnetohydrodynamic

(MHD) analysis of liquid-metal, self-cooled blankets and impurity control devices carried out at ANL. His current research interests include experimental and analytical investigations of high interaction parameter MHD and their application toward improved designs of liquid-metal-cooled blankets. **Dai Kai Sze** (top) (BS, Taiwan University; MS and PhD, chemical engineering, Massachusetts Institute of Technology) is a staff member at ANL. His current research activities include blanket concept, blanket tritium systems, and transport phenomena. **Dale L. Smith** (bottom) (PhD, Iowa State University, 1966) is the associate director of the Fusion Power Program at ANL assisting in directing and planning all fusion activities at ANL. He also serves as program manager for the ANL Fusion Materials Program. He served as program manager for a multilaboratory Blanket Comparison and Selection Study. He currently serves as deputy manager of ANL's effort on the Tokamak Power Systems Study and as ANL representative for the INTOR study.

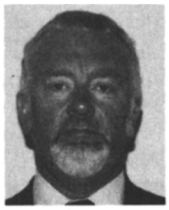
HELIUM-COOLED BLANKET DESIGNS

Clement P. C. Wong
Robert F. Bourque
Edward T. Cheng
R. Lewis Creedon
Isaac Maya
Robin H. Ryder
Kenneth R. Schultz



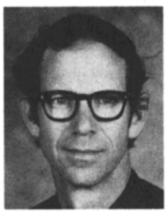
Clement P. C. Wong (top right) (BS and MS, nuclear engineering, University of Wisconsin; PhD, nuclear engineering, University of Texas) has been involved in blanket design on several different fusion reactor studies since joining GA Technologies Inc. (GA) in 1977. His research interests include fusion reactor blanket thermal hydraulics and magnetohydrodynamics effects and the assessment of tritium breeding materials. He has coordinated the blanket designs on various fusion and hybrid reactor studies. He led the material and design selection for the Lithium Blanket Module Study. He was the principal investigator, representing GA for the Fusion Breeder Program Reactor Study, and the Blanket Comparison and Selection Study. He is currently coordinating the elongated tokamak commercial reactor design. **Robert F. Bourque** (top left) (BS, mechanical engineering, Northeastern University, 1964; MS, 1965, and PhD, 1968, mechanical engineering, University of Connecticut) is responsible for reactor systems studies of the Ohmically Heated Toroidal Experiment, other compact fusion reactors, and for power conversion at GA, which he joined in 1975. Previously, he contributed to Plowshare-related projects at Lawrence Livermore National Laboratory and, while at SRI International, was project leader for several underground nuclear effects tests. **Edward T. Cheng** (center right) (PhD, nuclear engineering, University of Wisconsin, 1976) has been a member of the development and technology group in the Fusion Division of GA since 1978. He has been involved with various fusion blanket and reactor design studies, including fusion breeder and chemical production applications. His interests are primarily in neutronics, radioactivity, and blanket engineering. He is currently coordinating the nuclear data needs activities for the magnetically confined fusion energy development. **R. Lewis Creedon** (bottom left) (Higher National Certificate, mechanical/aeronautical engineering, Southampton University, England, 1951) has been involved in the design of many fusion-related structures. He has worked on diagnostics, superconducting magnets, and, in particular, blanket design. His interests in neutron-economical and swelling-tolerant characteristics of blanket structures have been applied to a series of reactor studies and test module designs in which unique fusion-related structures have been required, including the lithium blanket module for the tokamak fusion test reactor. **Isaac Maya** (bottom right) (PhD, nuclear engineering sciences, University of Florida) is a research engineer in the Fusion Division

of GA. He is currently project manager and principal investigator in the conceptual design and analysis of inertial confinement fusion reactor concepts and power conversion systems. Previously, he directed a program of experiments on high-temperature oxidation of structural alloys, and the design, procurement, fabrication, and testing of a 5-tonne superconducting magnet. He was the lead engineer in the design and analysis of the helium-cooled liquid-metal breeder blanket discussed in this paper. **Robin H. Ryder** (top) (BS, aeronautical engineering, University of London; MS, mechanical engineering, Cranfield College of Technology, United Kingdom) has been involved in the design, analysis, and testing of elevated temperature structures, including pressure vessels, piping, heat exchangers, and fusion reactor first-wall components since joining GA in 1972. He is currently engaged in the development of remaining-life estimation methods involving continuum and fracture mechanics. **Kenneth R. Schultz** (bottom) (PhD, nuclear engineering sciences, University of Florida, 1971) is manager of fusion development and technology at GA. He is responsible for the fusion nuclear technology aspects of several reactor design study projects for tokamak, mirror, and inertial confinement reactor applications, with emphasis on blanket engineering. He also is involved with several small blanket technology experiments.



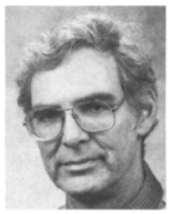
HELIUM-COOLED, FLIBE BREEDER, BERYLLIUM MULTIPLIER BLANKET

Ralph W. Moir
Joseph D. Lee
R. Carroll Maninger
William S. Neef, Jr.
Albert E. Sherwood
David H. Berwald
Jackson H. DeVan
Jungchung Jung



Ralph W. Moir (top right) [ScD, nuclear engineering, Massachussetts Institute of Technology (MIT), 1967] has worked on the magnetic fusion project at Fontenay-aux-Roses, France (Centre d'Etude de l'Energie Nucléaire-Commissariat à l'Energie Atomique). In 1968, he joined Lawrence Livermore National Laboratory (LLNL), where he has specialized in development of the direct conversion of fusion plasma energy to electrical energy and reactor design. At present, he is head of the fusion-fission hybrid reactor design study project and serves as associate program leader for advanced mirror systems. **Joseph D. (J. D.) Lee** (top left) (BS, electrical engineering, Duke University, 1961; MS, nuclear engineering, University of New Mexico) is a member of the Mirror (Fusion) Reactor Studies staff at LLNL. He started investigating the potential of fusion/fission in 1969 and is one of its principal spokesmen. He joined LLNL full time in 1966 to work on the SNAP 50 project after working two summers on LLNL's "Fran" and "Super Kukla" prompt burst reactors. He has been involved in LLNL's fusion program since 1968. **R. Carroll Maninger** (bottom right) (BS, California Institute of Technology, 1941) is a senior staff engineer in the Reactor Technology and Conceptual Design Group of the Magnetic Fusion Energy Program of the LLNL. His research interests include the generation, processing, and disposal of radioactive materials for both fission and fusion machines. His primary focus is devising methods to facilitate communication among scientists, engineers, and managers on the consequences of material selections with respect to occupational and public health and safety in the overall life cycle of reactors. **William S. Neef, Jr.** (bottom left) (BME and MS, mechanical engineering, Cornell University, 1954) is the project engineer for reactor technology and conceptual design at LLNL. From 1958 to 1967 he designed plasma physics experimental apparatus leading to the first "baseball" magnet geometry. After experience in LLNL's weapon test program and designing both gas and solid-state laser beamline components, he returned to magnetic fusion. He has worked on designs for tandem mirror

and field-reversed mirror reactors and has contributed to several tandem hybrid designs. **Albert E. Sherwood** (top right) (BS, business and engineering, and MS, chemical engineering, 1957, MIT; PhD, chemical engineering, University of California, Berkeley, 1963) has been a staff scientist at LLNL since 1965, working with tritium since 1976. His interests are in permeation, adsorption, catalysis, and thermodynamics applied to tritium technology, and in the engineering of large-scale low-level tritium capture systems. **David H. Berwald** (top left) (PhD, nuclear engineering, University of Michigan, 1977) is the technical program manager for fusion-fission hybrids at TRW, Inc. His research interests include nuclear design and shielding analysis, fusion technology, advanced fission reactor fuel cycles, applications of advanced isotope separation technologies, and high-level waste disposal. **Jackson H. DeVan** (bottom right) (BS, metallurgical engineering, Stanford University, 1952; MS, metallurgical engineering, University of Tennessee, 1960) is a group leader/research metallurgist in the Metals and Ceramics Division of Oak Ridge National Laboratory (ORNL). He has conducted high-temperature corrosion studies at ORNL since 1954. His areas of specialization include corrosion of alloys by lithium and by molten fluoride salts. **Jungchung Jung** (bottom left) (PhD, nuclear engineering, Kyoto University, Japan, 1974) is with the Fusion Power Program at Argonne National Laboratory. His current activities include nuclear analyses for the on-going Blanket Comparison and Selection Study, fusion materials recycle/waste management study, and lithium blanket neutronics/shielding experiment project. He is also responsible for general neutronics method/code development and nuclear data evaluation.




WATER-COOLED BLANKET CONCEPTS FOR THE BLANKET COMPARISON AND SELECTION STUDY

Grover D. Morgan
David A. Bowers
David E. Ruester
Jungchung Jung
Balabhadra Misra

Grover D. (Dave) Morgan (top right) (BS, mechanical engineering, 1965, and MS, engineering mechanics, 1968, University of Missouri-Rolla) has been a systems integration analyst on the McDonnell Douglas Astronautics Company (MDAC) fusion energy staff since 1978. His primary interests were first-wall and blanket engineering and design. He was deputy manager of the Blanket Comparison and Selection Study (BCSS), and was also responsible for all solid breeder blanket design group activities. **David A. Bowers** (top left) (BS, mechanical engineering, Purdue University, 1965) has been the senior thermal-hydraulic analyst on the MDAC fusion energy staff since 1975. His primary interests include the thermal analysis and design of various fusion devices and components, including vacuum vessel walls, limiters, antennae, Faraday shields, armor, neutral beam components, and other structural parts. He supervised thermal support for the Elmo Bumpy Torus Proof-of-Principle Project at MDAC. **David E. Ruester** (center right) (BS, 1978, and MS, 1983, civil engineering, University of Missouri-Rolla) is a member of the strength and mass properties department of MDAC. As part of the MDAC fusion energy staff, he has performed structural analyses for several major fusion studies, including STARFIRE, DEMO, and the BCSS. **Jungchung Jung** (bottom left) (PhD, nuclear engineering, Kyoto University, Japan, 1974) is with the Fusion Power Program at Argonne National Laboratory (ANL). His current activities include nuclear analyses for the on-going BCSS, fusion materials recycle/waste management study, and lithium blanket neutronics/shielding experiment project. He is also responsible for general neutronics method/code development and nuclear data evaluation. **Balabhadra Misra** (bottom right) (PhD, chemical engineering, Columbia University, 1957)





is a chemical engineer at ANL. He has conducted calculational and experimental studies of heat transfer and fluid flow in conjunction with the space program, the liquid-metal-cooled fast breeder reactor program, sodium technology program, and more recently, the controlled nuclear fusion program. His recent activities involve tritium technology and design/analysis of first-wall/blanket systems.

NITRATE-SALT-COOLED BLANKET CONCEPTS

James D. Gordon
James K. Garner
Wesley G. Steele
William D. Bjorndahl

James D. Gordon (top) [PhD, University of California-Los Angeles, (UCLA), 1972] joined TRW in 1968 and is currently manager of Fusion Reactor Engineering Programs. He was project manager for the Blanket Comparison and Selection Study and the Mirror Advanced Reactor Study and leads work in conceptual commercial reactor design, blanket design, and fusion technology development. **James K. Garner** (center) (BS, mechanical engineering, University of California-Santa Barbara, 1980; MS, mechanical engineering, UCLA, 1985) is head of the Design Analysis Section of the Energy Division at TRW in Redondo Beach, California. He has worked primarily in the area of fusion blanket design at TRW since 1980. **Wesley G. Steele** (bottom) (BS, MS, and PhD, 1980, nuclear engineering, UCLA) is a project engineer in the physical sciences center at TRW. His fusion background centers on cavity and blanket analyses, but extends to developmental aspects for inertial confinement fusion. He is currently leading the collector task team for the plasma separation process at TRW. **William D. Bjorndahl** (no photo available) (MS, 1978, and PhD, 1984, chemical engineering, UCLA) is head of the Metals and Ceramics Section at TRW, where he has worked since 1981. In the area of fusion technology, he has worked in modeling of corrosion product transport in liquid-metal coolant, corrosion of candidate first-wall materials, and various tritium containment and processing schemes.