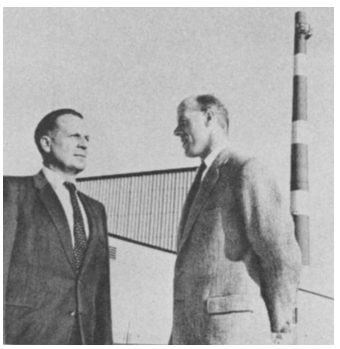
AUTHORS AND PAPERS

LIQUID METAL BREEDER REACTOR

The LIMB (Liquid Metal Breeder) reactor concept combines a uranium-bismuth solution fuel, a thorium bismuthide dispersion in a lead-bismuth fluid blanket, molten lead as a coolant, and a graphite moderator. To make the reactor critical a movable plunger displaces fuel up into the core, an arrangement which seems to overcome difficulties encountered with previous liquid-metal-fuel reactor designs.

Dr. Teitel was responsible for establishing the Liquid-Metal Research Laboratory at Douglas Aircraft Co., where he has been since 1961. As Chief, Nuclear Materials Branch, he directs all research on nuclear materials for application to space vehicles. Liquid-metal technology and development of new reactor concepts have been his main interests for over 15 years when he was also at Rocketdyne, Dow Chemical, and Brookhaven. His Sc.D. degree is from M. I. T. (1948) and his B.S. from Purdue (1944), both in metallurgical engineering. Mr. Brown was an electronic engineer with Convair Astrautics between receiving his M.S. degree in nuclear engineering (1962) and his B.S. in electrical engineering (1959), both from Iowa State. After a year as a designer with Douglas he is currently a graduate student in nuclear engineering at the University of Michigan.



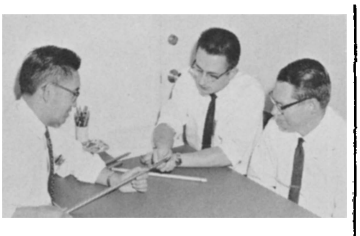
NPD PRESSURIZED D_2O REACTOR EXPERIENCE

The Canadian NPD reactor, a 20-MW(e) pressure-tube reactor, cooled and moderated with heavy water and fueled with natural uranium oxide, employed two innovations in its construction: the use of carbon steel piping and the exclusive use of heavy water during testing. Both proved successful, and two years' operating experience has shown the economic feasibility of pressurized D_2O as a reactor coolant.

Alex C. Hoyle is Supervising Engineer of the Thermal Systems Unit, Civilian Atomic Power Dept. of Canadian General Electric. With this department since its formation in 1955, he was responsible for the engineering design of the NPD heavy-water system. He has been in nuclear engineering with UKAEA, AECL, and CGE since his graduation from Glasgow University in 1947. George Howey, with the Ontario Hydro Electric Power Commission for eight years, is Assistant Superintendent of Training for its nuclear power program. He participated in the design, commissioning, and early operation of NPD. His M.A.Sc. degree was won from the University of British Columbia in 1949.

AN EXCURSION-LIMITING FUSE FOR THE MSCA

The Mixed Spectrum Critical Assembly, a nuclear mock-up of General Electric's Mixed Spectrum Superheating Reactor, has been provided with an excursion-limiting fuse device incorporated into the unmoderated region of the MSCA. This unique fuse drops fuel out of the uncooled fast core during all credible accidents, even with the safety system inoperative. Tests show it will not release fuel during normal operation.



K. Hikido, G. Brynsvold, and H. F. Johnston of General Electric, APED, are shown, l. to r., examining parts of the MSCA fuse fuel rod. Messrs. Hikido and Brynsvold are engineers and have been involved in the MSCA design and fabrication in addition to carrying out the fuse-development program. Dr. Johnston, an experimental physicist instrumental in the installation of the MSCA facility and the ensuing experimental program, carried out the excursion analysis to determine the effect of the fuse action of the MSCA, thereby establishing the operating procedures for the facility.

STRENGTH OF ZIRCALOY-4

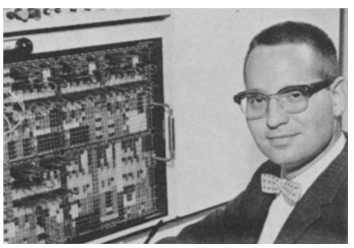
The bending fatigue strength of Zircaloy-4 is reduced significantly by a 1% superimposed mean strain and (at room temperature) by an oxide film. The reduction makes it inaccurate to employ the 0.2% static yield strength for making mean stress corrections in the fatigue analysis of unirradiated Zircaloy at elevated temperature.

For the past three years Mr. Mowbray has been engaged, at KAPL, in studying fatigue and brittle fracture of metals having nuclear application. An M.S. degree in mechanics of materials in 1962 and a B.S. degree in aeronautical engineering in 1960, both from the University of Minnesota, would seem to qualify Don well for the work described in his paper.

THRUSTOR-AUXILIARY POWER UNIT

Combining a thrustor with an auxiliary power generator appears to be a promising way of recovering some of the energy lost by the inefficiency imposed by the safety requirement that the temperature of a radioisotopic heat source never exceed its melting point. A study indicates that a 4-kW heat source can produce 0.1 lb. thrust at specific impulses > 750 sec and 50-150 W of auxiliary power.

Capt. David F. Berganini and Lt. Robert R. Barthelemy, scientists at the Air Force Aero Propulsion Laboratory, are carrying out studies in nuclear power and propulsion, and in magnetohydrodynamic power generation. Capt. Berganini holds a B.S. degree from Lawrence University, an M.S. from the U. of Michigan, and is currently studying for the Ph.D. at Ohio State, all in physics. Lt. Barthelemy has a B.S. in chemical engineering and an M.S. in nuclear engineering, both from M.I.T. and is a member of Tau Beta Pi, Phi Lambda Upsilon, and Sigma Xi.



FAST REACTOR FUEL BURNUP

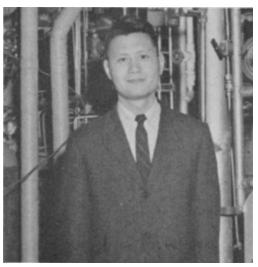
Equations for determining burnup in thermal reactors already exist. Similar equations, based on isotopic analysis of fuel, are now presented for determining fuel burnup in fast reactors. Initial concentration of $U^{235,\ 236,\ 238}$ and $Pu^{239,\ 240,\ 241}$ are assumed, and simplifying assumptions used to reduce the genealogical problem to two separate chains.

Fred Channon and Jack Luoma are working for their Ph.D. degrees in the Nuclear Engineering Departments of the University of Arizona and Northwestern University, respectively, having earned undergraduate degrees from the University of Michigan and Purdue, respectively. Major E. D. Frankhouser holds undergraduate degrees, in physics from Carnegie Tech. and in nuclear engineering from the University of Arizona and is currently an instructor in Nuclear Physics at West Point. A summer (1963) at Argonne brought these three together as students at the Engineering Practice School sponsored by Associated Midwest Universities, and the problem they worked on resulted in the present paper.

VOID FRACTION IN CAVITATING MERCURY

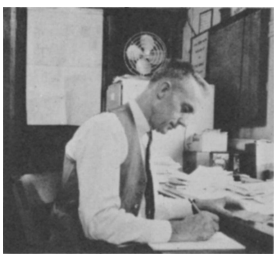
A gamma-ray densitometer is used to measure local density in a two-phase flow such as exists in cavitating mercury in a venturi (the particular case described). Other possible applications include characterizing the flow conditions in boilers, condensers, pumps and valves carrying liquid metals at elevated temperatures. The authors are also confident that, with a source of suitably soft gamma rays (instead of the Co^{60} used in the mercury case), the technique should be useful for low-density liquids, e.g. water and alkali metals.

The group picture shows, l. to r., Prof. Frederick G. Hammitt of the U. of Michigan and his students, Dr. Willy Smith, and Messrs. M. John Robinson and Richard D. Ivany. Prof. Hammitt supervises several research projects in fluid flow and heat transfer in the Nuclear Engineering Department and has had some ten years' industrial experience developing fluid-flow machinery. He has been at Michigan since receiving his Ph.D. degree in nuclear engineering there in 1958. Dr. Smith received his Ph.D. degree just two months ago. He and Mr. Ivany have had several years' laboratory experience in industry and government. Mr. Ian E. B. Lauchlan, a former student, shown separately, joined Canadian General Electric in 1963 on receiving his M.S. degree with a thesis closely related to the present paper.



STEAM FRACTION BY Sb-Be NEUTRONS

The combined moderation and attenuation of neutrons from an Sb-Be source is used to determine the steam fraction in a (simulated) boiling-water out-of-pile test section. Theoretical analysis and experimental verification indicate its applicability to multi-rod test sections and adequate sensitivity for steam fractions of 3-25%. The AEC has applied for a patent on this method.



Dr. William T. Sha is a Senior Scientist (Nuclear Core Design) at WAPD, where he went in 1960 after completing his course requirements for the doctorate in nuclear engineering at Columbia. A leave of absence enabled him to complete his dissertation of which the present paper is a part. Prof. Charles F. Bonilla, with long-time interests in boiling and nuclear engineering, is currently Director of the AEC Heat Transfer Facility at Columbia. He has been consultant to numerous organizations, is a director in two companies, and has served the government on various boards dating back to 1942. Except for three years at Johns Hopkins, he has been at Columbia since the middle twenties, receiving the A.B. degree there in 1928, the B.S. in 1930, and the Ph.D. in chemical engineering in 1933.

REACTOR OPERATOR EDUCATION AND TRAINING

Data compiled from questionnaires sent thirteen AEC contractors show some interesting statistics on the education, experience, training and certification procedures for several hundred reactor supervisors, operators and trainees employed at AEC-owned reactors. For example, they indicate a general trend toward increasing the minimum education requirements for reactor operators without a corresponding increase in the minimum requirements for supervisory personnel.

Whittie J. McCool, assistant director for reactor safety, USAEC Division of Operational Safety, came from Alco Products, Inc. in February 1963. At Alco, he was supervisor of reactor experiments. He received an M.S. degree in nuclear engineering from North Carolina State College in 1954 and was subsequently a senior experimental physicist at Pratt & Whitney Aircraft. Walter S. Wilgus has been a reactor safety specialist in the USAEC Division of Operational Safety since February 1963. Before this, he was an AEC reactor operator license examiner and reactor operating supervisor at the Westinghouse Testing Reactor. He received a B.S. degree in mechanical engineering from Case Institute of Technology in 1963.