HERBERT G. MACPHERSON

1911–1993

BY A. M. WEINBERG

HERBERT G. "MAC" MACPHERSON died suddenly in Guadalajara, Mexico, on January 26, 1993, at the age of eighty-one. Thus passed one of the most highly respected pioneers of nuclear energy.

MacPherson's scientific career began at the University of California, Berkeley, where he received the bachelor's degree in 1932 and the Ph.D. degree in physics in 1937. While at Berkeley he was much influenced by Professors R. B. Brode and Leonard Loeb. His first scientific paper (1934), of which he was the sole author, described a definitive experimental refutation of the so-called F. Allison magneto-optical method of chemical analysis. In this first paper MacPherson already displayed qualities of scientific common sense and impeccable responsibility that were the hallmarks of his entire career, both as a physicist and as an engineer. During this early period MacPherson worked on cosmic rays with Brode and M. A. Starr, and during a short stay at the Weather Bureau, he analyzed the accuracy of the Smithsonian Institution's measurements of the solar constant.

In 1937 when MacPherson joined the National Carbon Division of the Carbide and Carbon Chemicals Company, physicists in industrial companies were rare; indeed MacPherson was the first physicist hired by National Carbon. His first job was to investigate by sophisticated spectrophotometric methods, the properties of the carbon arc. Since the carbon arc was the light source used in professional motion-picture projectors, many of MacPherson's papers at this time were published in the *Journal of the Society of Motion Picture Engineers*.

The discovery of fission in 1939 launched MacPherson on his major lifework—nuclear energy, and particularly the role of graphite in nuclear reactors. MacPherson, in a talk he gave many years after fission was discovered, recounts his earliest involvement with graphite: "My first knowledge of the possible use of graphite to aid in sustaining a nuclear chain reaction came from reading an article [by R. B. Roberts and J. B. H. Kuiper] in the September 1939 issue of the *Journal of Applied Physics*. This article aroused speculation within the National Carbon Company about the role for graphite [in nuclear chain reactions]." By 1940 MacPherson met with Fermi, Szilard, and H. Anderson to discuss procurement of ton-lots of graphite of a purity that had never been produced commercially. MacPherson, with his knowledge of the spectra emitted by carbon arcs, was the first to realize that boron was the most significant impurity, because of both its high neutron absorption and its ubiquity in graphite. He, along with V. C. Hamister, developed a way of producing almost boron-free graphite on the scale needed for the huge graphite-moderated reactors at Oak Ridge and Hanford. This was described in the 1958 book *Production and Properties of Graphite for Reactors*, by L. M. Currie, V. C. Hamister, and H. G. MacPherson. Had it not been for MacPherson and Hamister's success in producing boron-free graphite, the plutonium-producing reactors at Hanford would not have chain-reacted. (This contrasts with the German rejection of graphite as a moderator because they had overestimated the absorption cross-section of carbon—presumably because German graphite was contaminated with boron).

MacPherson maintained his contact with nuclear energy by spending the year 1946–1947 attending the first sessions of the newly established Oak Ridge School of Reactor Technology (then known as the Clinch College of Nuclear Knowledge). Many of nuclear energy's most prominent engineers, including H. G. Rickover, attended these courses. I first met Mac as a student in my lectures on chain reactor theory; I quickly realized that he was the best student in the class.

MacPherson continued to work on graphite at National Carbon, serving as assistant director of research from 1950 to 1956. He then joined the Oak Ridge National Laboratory (ORNL), where he became the leading proponent of molten fluoride-fuelled, graphite-moderated reactors. Such reactors theoretically showed great promise as a cheap alternative to the mainline plutonium-fuelled liquid-metal-cooled fast breeder (LMFBR). Because the fuel in molten fluoride reactors was a liquid, chemical recycle to remove fission products was much simpler than the recycling of solid fuel elements, such as are used in the LMFBR. The promise of molten-fluoride breeders was recognized by the Atomic Energy Commission (AEC) in its 1962 report on civilian power; molten-salt breeders, based on thorium-U^{233} cycle, were given a priority equal to that of the LMFBR in this report.

During all of his fourteen years at ORNL, the last six years of which he served as the deputy director of the laboratory, MacPherson continued to be the intellectual force behind the molten-salt reactor. His ideas culminated in the very successful Molten Salt Reactor Experiment (MSRE). This reactor, operating at 7500 kW and 1200°F, consisted of a graphite cylinder through which circulated a molten fluoride salt containing U^{235} and Th^{232}. The MSRE operated remarkably well for three years beginning in 1966. During 1969 it operated with U^{233} as fuel, the first nuclear reactor to be fuelled with this isotope of uranium. The MSRE was perhaps the most ingenious and daring engineering experiment ever conducted at ORNL. But, largely for nontechnical reasons, molten-salt graphite-moderated reactors were eventually dropped by the AEC in favor of the LMFBR.

Mac himself, although he took this loss of support philosophically, left ORNL in 1970 to become professor of nuclear engineering at the University of Tennessee (UT). In December of 1973, with support from the White House's Federal Energy Office, I undertook to establish the Institute for Energy Analysis (IEA); but before I could start the institute, I was called to Washington to head the Office of Energy Research and Development (OERD). Fortunately Mac agreed to take leave from UT to serve as acting director of IEA. Upon him fell the onerous task of getting a completely new energy think tank going—everything from hiring the staff, guiding the program, and commuting to the White House each week to offer advice to OERD on national policy for energy research and development. This was the time of the first oil crisis, and energy policy was on center stage. Mac's common sense as well as sheer intellect contributed in innumerable ways toward setting our energy research policy on a sensible course.

I returned to direct IEA in 1975, but Mac remained as the wisest member of the staff, as well as continuing to teach nuclear engineering until 1976. Mac was a sort of in-house conscience for IEA. For example, he served as a member of the advisory committee that reviewed the IEA study *The Second Nuclear Era*, published in 1985. This study examined "inherently safe reactors" as a technical basis for a reborn nuclear energy. Mac's intellectual honesty was demonstrated by his arguing that the water-moderated PIUS (Process Inherent Ultimately Safe) reactor was more nearly inherently safe than was the high-temperature, graphite reactor despite the latter's being based on graphite, the material around which his technical life had been centered.

Mac finally "retired" in 1985—to become an expert in Mayan archeology. He learned how to read Mayan glyphs and even published a paper, "The Maya Lunar Season," in the 1987 volume of the British journal *Antiquity* . In this paper Mac resolved a logical inconsistency that had plagued students of the Dresden Codex "eclipse table." In the prior archeological literature the dates in the Dresden Codex were identified with occurrences of solar eclipses worldwide. Mac realized this could not be correct since most solar eclipses were not visible to the Maya. Instead, he demonstrated, by astronomical calculations, that the dates mentioned in the Dresden Codex coincided with the transit of the moon at sunset from north of the setting sun to south of the sun. These transits, he argued, were well within the observational capability of the Mayan astronomers.

Thus, even to the end of his life Mac displayed the independence of thought, confidence in his own judgment, and plain common sense that characterized his life. In my obituary at Mac's funeral, I referred to him as a "Prince of a Man." Mac was one of the most highly respected scientist/engineers to have worked at ORNL. He led an exemplary, fulfilled life—and his passing leaves a deep sense of loss in his many admirers who appreciated his unusual qualities of judgment and wisdom.