ATOMIC ENERGY DEVELOPMENT IN AUSTRALIA

THE Laboratories of the Australian Atomic Energy Commission and the first Australian nuclear reactor were opened on April 18 by the Prime Minister, the Right Hon. R. G. Menzies, before a gathering of a thousand distinguished citizens and members of the Diplomatic Corps. Situated at Lucas Heights, twenty miles south of Sydney, the new laboratories stand on a 160-acre site and comprise the steel shell reactor building itself (with supporting laboratories, workshops and experimental areas around the reactor), laboratories for chemistry and chemical engineering, library and administrative buildings, gatehouses, garages, stores, boiler house, liquid metal laboratory and effluent control laboratory.

The Australian Atomic Energy Commission was created in April 1953 by an Act of Parliament which gave it statutory powers within the constitutional authority of the Commonwealth Government. The present composition is: *Chairman*, Prof. J. P. Baxter; *Commissioners*, Sir Leslie Martin, Dr. H. G. Raggatt and Mr. H. M. Murray, with Mr. Alan McKnight as executive member. The Commission was charged with responsibility for the discovery and production of uranium and other nuclear materials such as thorium and beryllium, the development of atomic energy for industrial and other purposes, the development of scientific research within the Commission, and the training of scientists and engineers to meet the needs of nuclear technology in Australia.

In the early years of the Commission's activities, uranium production facilities were built at Rum Jungle and, through the South Australian Government, at Radium Hill, while more recently the Mary Kathleen field has been developed. Plans for the creation of the atomic energy research establishment were submitted to the Government in September 1954, and construction work was begun at Lucas Heights in October 1955. In recruiting staff, the Commission was fortunate in being able to draw on a reservoir of Australian and New Zealand personnel already having considerable research experience gained in United Kingdom, Canadian and American atomic energy establishments. While the laboratories were under construction, a vigorous group of workers, covering a wide range of disciplines, were accommodated at the Atomic Energy Research Establishment, Harwell, where further experience was obtained working on the British programme. When the decision was taken to build a high-flux research reactor for the work at Lucas Heights, it was natural for the group to turn to British experience. The design chosen is basically similar to Harwell's *DIDO*[1,2], full design information for which was made available by the United Kingdom Atomic Energy Authority and the Ministry of Works.

The Australian version of the reactor has some modifications and has been named *HIFAR* (High Flux Australian Reactor). It is rated at 10 MW. (heat), has a maximum flux of 10^{14} neutrons/cm.^{2}/sec., uses heavy water as moderator and primary coolant and ordinary water as secondary coolant, passing through cooling towers. A 60-cm. heavy-water reflector is supplemented by 60 cm. of graphite, and a barytes concrete shield 5 ft. in thickness provides biological protection. Enriched fuel is employed, the fuel elements being in the form of uranium–aluminium alloy plates arranged in an approximation to a cylinder of length 60 cm. and diameter 86 cm. The reactor core was constructed in England by Head Wrightson Processes, Ltd., and contains some 2·5 kgm. of uranium-235.

The necessary buildings, foundations and steel-work were begun in October 1955, and the first criticality tests were successfully carried out on the completed reactor on Australia Day (January 26, 1958). This work was under the direction of the Commission's chief scientist, Mr. C. N. Watson-Munro, who now has the unique distinction of being responsible for the first Canadian, first United Kingdom and first Australian reactors. Because only one reactor was planned for the preliminary phase of the research programme, a wide range of experimental facilities has been incorporated to enable radiation from the pile to be used and for subsequent examination of irradiated samples.

In particular, some sixty experimental holes have been provided, varying in size from 10 in. down to 2 in. in diameter. Holes 4 in. square pierce the thermal column and two 8 in. × 12 in. horizontal holes pass right through the graphite reflector. Thermal fluxes in these holes range from 4×10^{12} to 9×10^{13} n/cm.^{2}/sec., and the maximum epithermal fluxes are of the same order as the thermal flux for holes entering the heavy water, but are very much lower in the graphite reflector. High fast-neutron fluxes can be obtained by the use of a special uranium-235 thimble. The thermal column has a 1·6-m. square cross-section and is 1·3 m. long. The diffusion length of thermal neutrons in the graphite is some 50 cm., this resulting in a maximum thermal flux of 10^{12} n/cm.^{2}/sec. in the column. Nine 4 in. × 4 in. access holes are provided which are normally filled with graphite inserts. In due course, a neutron velocity selector, a crystal spectrometer, post-irradiation facilities, 'rabbits' and full-element irradiation facilities will be provided[3].

The research programme of the laboratory is aimed primarily at developing new types of power reactors for the economic production of nuclear energy (having in mind special Australian conditions), at studying problems associated with the large-scale handling of radioactive materials and the production and use of radioisotopes—especially those of short life which were unavailable in Australia prior to the completion of *HIFAR*[4].

Work has already been started on two power reactor systems which appear well suited to Australian conditions. One is a high-temperature gas-cooled system directed towards the development of a thermal breeder reactor with thorium as the fertile material and a highly enriched gas-cooled fuel element operating as much above 600° C. as may be possible. Beryllia, beryllium and graphite are being considered as moderators for the system. The second is a reactor

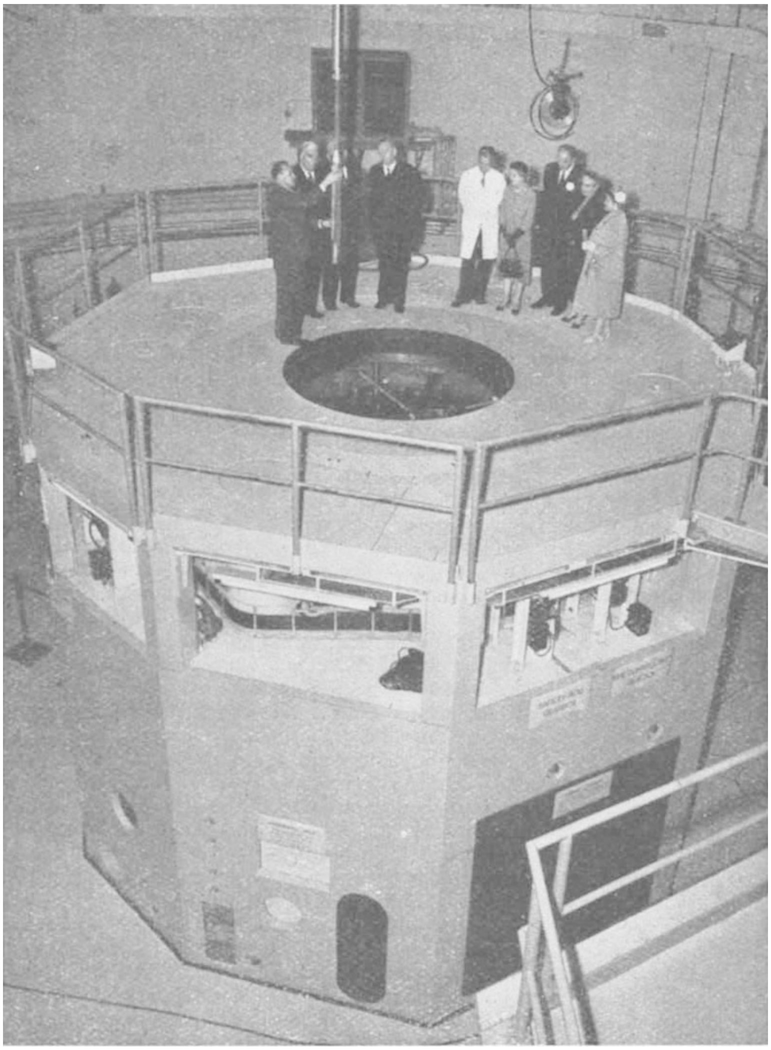

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Fig. 1. The Australian atomic reactor *HIFAR*

system with liquid metal, using a sodium slurry as a coolant and fuel carrier, with beryllium as the moderator.

Loop experiments relating to these systems will be carried out in high-flux regions of *HIFAR*, and irradiation effects on nuclear reactor materials will also be studied.

A further major part of the research programme is the chemical processing project, in which the chemistry, chemical engineering and other sections will investigate problems in the recycling of reactor fuels. The separation of fissile and fertile material is an essential part of a nuclear power programme, and the design and construction of a small-scale solvent extraction processing plant are in hand.

As in other laboratories of this kind, the work of the new establishment is organized on a project basis with joint teams of scientists and technologists participating. The various sections are engineering research, engineering services, reactor physics, technical physics, health physics, chemistry, chemical engineering, metallurgy, isotopes, medical physics and administrative services.

The opening ceremony was marked by excellent speeches from Mr. Menzies and from the Minister in charge of the programme, Senator the Hon. W. H. Spooner. The intense interest of the Australian Government in the development of the new power source was stated and the generous help received from the United Kingdom, other Commonwealth countries, and from the United States of America through Australia's bilateral agreement with that country, was acknowledged. It is intended that, within the limits of the man-power and financial resources available, the Australian project will make a maximum contribution to the development of the technology of the source of new power; care will be exercised to avoid unnecessary duplication of work going on elsewhere. Mr. Menzies said that for Australia it is the beginning of an epoch comparable with the introduction of steam and electricity. First and foremost, Lucas Heights is a research establishment, which will make Australia scientifically and technically equipped to take advantage of nuclear power. Australia, he said, aims at securing mutual arrangements for the exchange of information with Britain and the United States, and, he hoped, before long with Canada. "Nuclear energy has an unlimited future, and this future will be even greater if we can get rid of the threat of war. . . . We in Australia are lucky that whatever limits may exist on our resources, we have great supplies of coal, substantial supplies of hydro-electric power, either in existence or in the making, and we have uranium. Therefore, we can approach the problem of nuclear power scientifically, and coolly, and decide the best ways to go about taking our place in the development of nuclear power. With *HIFAR* we will be able to keep abreast of development and become scientifically equipped to take our place among the nuclear nations."

After his speech, the Prime Minister threw a switch which brought *HIFAR* up to full power of 10 MW., and the official party made a tour of the installation. During this period the guests at the opening were able to watch the proceedings on large-screen television sets which had been specially installed for the purpose. On completion of the official tour, the laboratories were thrown open and the visitors enjoyed the various demonstrations which had been especially arranged for the occasion.

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[1] Grout, H. J., and Fenning, F. W., 1955 Geneva Conference Papers A/Conf 8/P/42.
[2] Grout, H. J., *J. Brit. Nucl. Energy Conf.*, **1**, 35 (1956).
[3] Watson-Munro, C. N., *Aust. J. Sci.*, **19**, 133 (1957).
[4] Gregory, J. N., *Chem. Indust. and Eng.* (*Austral.*), **6**, 4, 26 (1956); **6**, 5, 24 (1956).