high levels of radiation that are encountered around reactors. Directly and indirectly, this is responsible for the current hesitation to construct a number of large plants that for economic power cost no less than $40,000,000 or $50,000,000 each. With every new design it is necessary to acquire operating experience before the reliability and availability can be effectively estimated. Experience with defective fuel has been deliberately sought at Chalk River, because this is one of the difficulties most likely to be encountered. Appropriate techniques of locating the defective element, removing it and cleaning up the released radioactive fission products, have been established and practised; at the same time fuel designs and ratings have been studied which lead to least difficulty in these operations. Experience of mechanical failures of control rods has lent weight to reactor designs such as NPD-2 where control rods are not needed. Temperature changes are liable to provoke mechanical failures, so design is aimed at keeping the reactor at power for all essential operations including refuelling and complete maintenance testing and readjustment of instruments and working parts of the control system.

These considerations lead to a vicious circle, for the quickest way to achieve reliability is to construct and operate a number of plants following these design principles, but until such plants have operated satisfactorily utilities are unwilling to take the risk of lost time for repairs. The same principles hold throughout the world. For example, the United Kingdom is following a program based on the Calder Hall type of reactor developed, not by a utility company, but by the government to serve a military requirement. Italy is purchasing three power reactors—one from the United Kingdom, one from the United States based on the Shippingport and Yankee reactors, and one from the United States closely following the Commonwealth Edison Dresden plant. Canada is pioneering another pattern financed by the government, and working at Chalk River to develop technical knowledge and experience that will give confidence to the utilities. The performance of the demonstration reactor (NPD) will tell whether the sought-for reliability has been achieved so that utilities can take over.

Because the CANDU type of reactor is suitable only in large units, AECL is undertaking to study another type of reactor proposed by the Canadian General Electric Company that should have a lower capital cost. This is also a heavy-water-moderated reactor, but the heat is taken from the fuel by an organic liquid specially chosen for a high boiling point and minimum decomposition by radiation. This is a hybrid design that should utilize the Chalk River experience with heavy water and uranium oxide fuel and the experience of the organic liquid developed in the United States as a coolant and moderator for a nuclear reactor. Development of metals that are suitable for use in such a reactor is required and may take a few years to effect.

A third type of power reactor is also under study: again heavy-water-moderated and uranium-oxide-fuelled, but the coolant is normal steam at high pressure. The steam would be superheated in the reactor. New materials are required also for this design and their development may be lengthy. Such a reactor would have a higher efficiency than the CANDU type and would be suitable for large sizes.

Section 3.—Space Research in Canada*

There is an active interest in space science in Canada. This is because research in the physics of the upper atmosphere and in nearby space (where the atmosphere merges into interplanetary space) has been stimulated for many years by Canada's unique position in relation to the axis of the earth's magnetic field. This geographic position also signifies a certain responsibility for Canadians to carry out research in their own northern areas as well as to co-operate with others conducting scientific work in or over Canadian territory.

Until the advent of space sounding rockets and satellites, activities were confined to indirect observations from the ground, but with the development of new techniques and the growing capabilities of Canadian science a comprehensive space science program is

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